Transnet Port Terminals

an Operating Division **TRANSNET SOC LTD**

[Registration Number 1990/000900/30]

REQUEST FOR PROPOSAL (RFP)

FOR THE SUPPLY AND INSTALLATION OF BULK ELECTRICAL SUPPLY INCLUDING TRANSFORMERS, SWITCHGEARS, MCC AND SUB-STATION BUILDINGS AT SALDANHA BULK TERMINAL FOR TRANSNET SOC LTD (REG.NO.1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS, (HEREINAFTER REFERRED TO AS "TPT")

RFP NUMBER	**: iCLM HQ 847/TPT**
ISSUE DATE	**: 08 March 2024**
COMPULSORY BRIEFING	**: 19 March 2024**
CLOSING DATE	**: 12 April 2024.**
CLOSING TIME	**: 12h00pm**
TENDER VALIDITY PERIOD	**: 12 weeks from closing date**

Contents

Number Heading

T1.1 TENDER NOTICE AND INVITATION TO TENDER

SECTION 1: NOTICE TO TENDERERS

1. INVITATION TO TENDER

Responses to this Tender [hereinafter referred to as a **Tender**] are requested from persons, companies, close corporations or enterprises [hereinafter referred to as a Tenderer].

DESCRIPTION	**For the supply and installation of Bulk Electrical supply including Transformers, Switchgears, MCC and sub-station buildings at Saldanha Bulk Terminal for Transnet Soc Ltd (reg.no.1990/000900/30) operating as Transnet Port Terminals, (hereinafter referred to as "TPT").**
TENDER DOWNLOADING	**This Tender may be downloaded directly from the National Treasury eTender Publication Portal at www.etenders.gov.za and the Transnet website at https://transnetetenders.azurewebsites.net (please use Google Chrome to access Transnet link) FREE OF CHARGE.**

COMPULSORY TENDER CLARIFICATION MEETING	A Compulsory Tender Clarification Meeting will be conducted at **TPT Saldanha, TFR Salkor Admin Building, Orex Road, Saldanha, 7395 on the 19 March 2023,** at **10:00am [10 O'clock]** for a period of ± 6 (Six) hours. [Tenderers to provide own transportation and accommodation]. The Compulsory Tender Clarification Meeting will start punctually and information will not be repeated for the benefit of Tenderers arriving late. **A Site visit/walk will take place, tenderers are to note**: • Tenderers are required to wear safety shoes, goggles, long sleeve shirts, high visibility vests and hard hats. • Tenderers without the recommended PPE will not be allowed on the site walk. • Tenderers and their employees, visitors, clients and customers entering Transnet Offices, Depots, Workshops and Stores will have to undergo breathalyser testing. • All forms of firearms are prohibited on Transnet properties and premises. • The relevant persons attending the meeting must ensure that their identity documents, passports or drivers licences are on them for inspection at the access control gates.

	Certificate of Attendance in the form set out in the **Returnable Schedule T2.2-01** hereto must be completed and submitted with your Tender as proof of attendance is required for a **compulsory** site meeting and/or tender briefing. **Tenderers are required to bring this Returnable Schedule T2.2-01 to the Compulsory Tender Clarification Meeting to be signed by the *Employer's* Representative.** **Tenderers failing to attend the compulsory tender briefing will be disqualified.**
CLOSING DATE	**12:00pm on (12 April 2024)** Tenderers must ensure that tenders are uploaded timeously onto the system. **If a tender is late, it will not be accepted for consideration**.

2. TENDER SUBMISSION

Transnet has implemented a new electronic tender submission system, the e-Tender Submission Portal, in line with the overall Transnet digitalization strategy where suppliers can view advertised tenders, register their information, log their intent to respond to bids and upload their bid proposals/responses on to the system.

a) The Transnet e-Tender Submission Portal can be accessed as follows:

Log on to the Transnet eTenders management platform website (https://transnetetenders.azurewebsites.net);

- Click on "ADVERTISED TENDERS" to view advertised tenders;
- Click on "SIGN IN/REGISTER – for bidder to register their information (must fill in all mandatory information);
- Click on "SIGN IN/REGISTER" - to sign in if already registered;
- Toggle (click to switch) the "Log an Intent" button to submit a bid;
- Submit bid documents by uploading them into the system against each tender selected.
- **Tenderers are required to ensure that electronic bid submissions are done at least a day before the closing date to prevent issues which they may encounter due to their internet speed, bandwidth or the size of the number of uploads they are submitting. Transnet will not be held liable for any challenges experienced by bidders as a result of the technical challenges. Please do not**

wait for the last hour to submit. A Tenderer can upload 30mb per upload and multiple uploads are permitted.

b) The tender offers to this tender will be opened as soon as possible after the closing date and time. Transnet shall not, at the opening of tenders, disclose to any other company any confidential details pertaining to the Tender Offers / information received, i.e. pricing, delivery, etc. The names and locations of the Tenderers will be divulged to other Tenderers upon request.

c) Submissions must not contain documents relating to any Tender other than that shown on the submission.

3. CONFIDENTIALITY

All information related to this RFP is to be treated with strict confidentiality. In this regard Tenderers are required to certify that they have acquainted themselves with the Non-Disclosure Agreement. All information related to a subsequent contract, both during and after completion thereof, will be treated with strict confidence. Should the need however arise to divulge any information gleaned from provision of the Works, which is either directly or indirectly related to Transnet's business, written approval to divulge such information must be obtained from Transnet.

4. DISCLAIMERS

Tenderers are hereby advised that Transnet is not committed to any course of action as a result of its issuance of this Tender and/or its receipt of a tender offer. In particular, please note that Transnet reserves the right to:

4.1. Award the business to the highest scoring Tenderer/s unless objective criteria justify the award to another tenderer.

4.2. Not necessarily accept the lowest priced tender or an alternative Tender;

4.3. Go to the open market if the quoted rates (for award of work) are deemed unreasonable;

4.4. Should the Tenderers be awarded business on strength of information furnished by the Tenderer, which after conclusion of the contract is proved to have been incorrect, Transnet reserves the right to terminate the contract;

4.5. Request audited financial statements or other documentation for the purposes of a due diligence exercise;

4.6. Not accept any changes or purported changes by the Tenderer to the tender rates after the closing date;

4.7. Verify any information supplied by a Tenderer by submitting a tender, the Tenderer/s hereby irrevocably grant the necessary consent to the Transnet to do so;

4.8. Conduct the evaluation process in parallel. The evaluation of Tenderers at any given stage must therefore not be interpreted to mean that Tenderers have necessarily passed any previous stage(s);

4.9. Unless otherwise expressly stated, each tender lodged in response to the invitation to tender shall be deemed to be an offer by the Tenderer. The Employer has the right in its sole and unfettered discretion not to accept any offer.

4.10. Not be held liable if tenderers do not provide the correct contact details during the clarification session and do not receive the latest information regarding this RFP with the possible consequence of being disadvantaged or disqualified as a result thereof.

4.11. Transnet reserves the right to exclude any Tenderers from the tender process who has been convicted of a serious breach of law during the preceding 5 [five] years including but not limited to breaches of the Competition Act 89 of 1998, as amended. Tenderers are required to indicate in tender returnable on T2.2-18], [**Breach of Law**] whether or not they have been found guilty of a serious breach of law during the past 5 [five] years.

4.12. Transnet reserves the right to perform a risk analysis on the preferred tenderer to ascertain if any of the following might present an unacceptable commercial risk to the employer*:*

- *unduly high or unduly low tendered rates or amounts in the tender offer;*
- *contract data of contract provided by the tenderer; or*
- *the contents of the tender returnables which are to be included in the contract.*

5. Transnet will not reimburse any Tenderer for any preparatory costs or other work performed in connection with this Tender, whether or not the Tenderer is awarded a contract.

6. NATIONAL TREASURY'S CENTRAL SUPPLIER DATABASE

Tenderer are required to self-register on National Treasury's Central Supplier Database (CSD) which has been established to centrally administer supplier information for all organs of state and facilitate the verification of certain key supplier information. The CSD can be accessed at https://secure.csd.gov.za/. Tenderer are required to provide the following to Transnet in order to enable it to verify information on the CSD:

Supplier Number…… and Unique registration reference number……(Tender Data)

Transnet urges its clients, suppliers and the general public

to report any fraud or corruption to

TIP-OFFS ANONYMOUS: 0800 003 056 OR Transnet@tip-offs.com

T1.2 TENDER DATA

The conditions of tender are the Standard Conditions of Tender as contained in Annex C of the CIDB Standard for Uniformity in Engineering and Construction Works Contracts. The Standard for Uniformity in Construction Procurement was first published in Board Notice 62 of 2004 in Government Gazette No 26427 of 9 June 2004. It was subsequently amended in Board Notice 67 of 2005 in Government Gazette No 28127 of 14 October 2005, Board Notice 93 of 2006 in Government Gazette No 29138 of 18 August 2006, Board Notice No 9 of 2008 in Government Gazette No 31823 of 30 January 2009, Board Notice 86 of 2010 in Government Gazette No 33239 of 28 May 2010, Board Notice 136 of 2015 in Government Gazette 38960 of 10 July 2015 and Board Notice 423 of 2019 in Government Gazette No 42622 of 8 August 2019.

This edition incorporates the amendments made in Board Notice 423 of 2019 in Government Gazette 42622 of 8 August 2019. (see www.cidb.org.za).

The Standard Conditions of Tender make several references to Tender data for detail that apply specifically to this tender. The Tender Data shall have precedence in the interpretation of any ambiguity or inconsistency between it and the Standard Conditions of Tender.

Each item of data given below is cross-referenced in the left-hand column to the clause in the Standard Conditions of Tender to which it mainly applies.

Clause		**Data**
C.1.1	The *Employer* is	**Transnet SOC Ltd (Reg No. 1990/000900/30) Operating as Transnet Port Terminals, (Hereinafter Referred to As "TPT"),**
C.1.2	The tender documents issued by the *Employer* comprise:	
	Part T: The Tender	
	Part T1: Tendering procedures	T1.1 Tender notice and invitation to tender T1.2 Tender data
	Part T2 : Returnable documents	T2.1 List of returnable documents T2.2 Returnable schedules
	Part C: The contract	
	Part C1: Agreements and contract data	C1.1 Form of offer and acceptance C1.2 Contract data (Part 1 & 2)

		C1.3 Form of Securities
	Part C2: Pricing data	C2.1 Pricing instructions C2.2 Bill of Quantities
	Part C3: Scope of work	C3.1 Works Information
	Part C4: Site information	C4.1 Site information
C.1.4	The Employer's agent is:	Strategic Sourcing Specialist
	Name:	Hlengiwe Zulu
	Address:	202 Anton Lembede Durban
	Tel No.	031 361 1034
	E – mail	Hlengiwe.Zulu@transnet.net

C.2.1 Only those tenderers who satisfy the following eligibility criteria are eligible to submit tenders:

1. **Stage One - Eligibility with regards to attendance at the compulsory clarification meeting:**
   An authorised representative of the tendering entity or a representative of a tendering entity that intends to form a Joint Venture (JV) must attend the compulsory clarification meeting in terms C2.7

2. **Stage Two - Eligibility in terms of the Construction Industry Development Board:**

a) Only those tenderers who are registered with the CIDB, or are capable of being so prior to the evaluation of submissions, in a contractor grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered or a value determined in accordance with Regulation 25 (1B) or 25(7A) of the Construction Industry Development Regulations, designation of **9 EP** class of construction work, are eligible to have their tenders evaluated.

b) Joint Venture (JV)
Joint ventures are eligible to submit tenders subject to the following:
   1. every member of the joint venture is registered with the CIDB;
   2. the lead partner has a contractor grading designation of not lower than one level below the required class of construction works under consideration and possesses the required recognition status; and
   3. the combined Contractor grading designation calculated in accordance with the Construction Industry Development Regulations is equal to or higher than a

Contractor grading designation determined in accordance with the sum tendered for a **9 EP** class of construction work or a value determined in accordance with Regulation 25(1B) or 25(7A) of the Construction Industry Development Regulations
The tenderer shall provide a certified copy of its signed joint venture agreement

3. Stage Three - Technical Eligibility - Professional Registration

The tenderer to submit all active professional registration certificates for all key engineering personnel with Engineering Council of South Africa (ECSA), or Washington Accord Equivalent. Curriculum Vitae to be submitted to demonstrate relevant experience in line with professional registration.

Evaluation Criteria	Description	Scoring Principal		Criteria
Eligibility	CIDB Electrical Engineering (EP)	Contractors to be registered with the Construction Industry Development Board (CIDB) as a Electrical Contractor and be able to handle contracts that are grade 9.		Yes/No
	Professional Registration	The tenderer to submit all active professional registration certificates for all key engineering personnel with Engineering Council of South Africa (ECSA), or Washington Accord Equivalent. Curriculum Vitae to be submitted to demonstrate relevant experience in line with professional registration.	Electrical Engineer (HV,LV, Substation & Distribution)	Yes/No
			Mechanical Engineer (HVAC)	Yes/No
			Electrical Engineer (MV, LV, Substations)	Yes/No
			Electronics Engineer (Control/Software - PLC/SCADA)	Yes/No
			Civil Engineer	Yes/No
			Structural Engineer (Buildings, Substations Infrastructure)	Yes/No

Any tenderer that fails to meet the stipulated eligibility criteria will be regarded as an unacceptable tender.

4. Stage Four - Functionality:

Only those tenderers who obtain the minimum qualifying score for functionality will be evaluated further in terms of price and the applicable preference point system. The minimum qualifying for score for functionality is **70 points**.

The evaluation criteria for measuring functionality and the points for each criteria and, if any, each sub-criterion are as stated in C3.11 below.

Any tenderer that fails to meet the stipulated pre-qualifying criteria will be regarded as an unacceptable tender.

C.2.7 The arrangements for a compulsory clarification meeting are as stated in the Tender Notice and Invitation to Tender. **Tenderers must complete and sign the attendance register.** Addenda will be issued to and tenders will only be received from those tendering entities including those entities that intends forming a joint venture appearing on the attendance register.

Tenderers are also **required to bring their RFP document to the briefing session and have their returnable document T2.2-01 certificate of attendance** signed off by the Employer's authorised representative.

C.2.12 No alternative tender offers will be considered.

C.2.13.3 Each tender offer shall be in the **English Language.**

C.2.13.5 C2.15.1 The *Employer*'s details and identification details that are to be shown on each tender offer are as follows:

Identification details: The tender documents must be uploaded with:

- Name of Tenderer: ……
- Contact person and details: ……..
- The Tender Number: iCLM HQ 847/TPT

The Tender Description: For the supply and installation of bulk electrical supply including transformers, switchgears, mcc and sub-station buildings at Saldanha bulk terminal for Transnet soc ltd (reg.no.1990/000900/30) operating as Transnet port terminals, (hereinafter referred to as "TPT")

Documents must be marked for the attention of:
***Employer*'s Agent: Hlengiwe Zulu**

C.2.13.9 Telephonic, telegraphic, facsimile or e-mailed tender offers will not be accepted.

C.2.15	The closing time for submission of tender offers is: Time: **12:00pm** on the **12 April 2024** Location: The Transnet e-Tender Submission Portal: (https://transnetetenders.azurewebsites.net); **NO LATE TENDERS WILL BE ACCEPTED**
C.2.16	The tender offer validity period is **12 weeks** after the closing date. Tenderers are to note that they may be requested to extend the validity period of their tender, on the same terms and conditions, if Transnet's internal evaluation and governance approval processes has not been finalised within the validity period.
C.2.23	The tenderer is required to submit with his tender: 1. A valid Tax Clearance Certificate issued by the South African Revenue Services. **Tenderers also to provide Transnet with a TCS PIN to verify Tenderers compliance status**. 2. A **valid B-BBEE Certificate** from a Verification Agency accredited by the South African Accreditation System [**SANAS**], or a **sworn affidavit** confirming annual turnover and level of black ownership, in line with the code of good practice, together with the tender; 3. A valid CIDB certificate in the correct designated grading; 4. Proof of registration on the Central Supplier Database; 5. Letter of Good Standing with the Workmen's compensation fund by the tendering entity or separate Letters of Good Standing from all members of a newly constituted JV. **Note:** Refer to Section T2.1 for List of Returnable Documents
C3.11	The minimum number of evaluation points for functionality is: **70**

The procedure for the evaluation of responsive tenders is Functionality, Price and Preference:

Only those tenderers who attain the minimum number of evaluation points for Functionality will be eligible for further evaluation, failure to meet the minimum threshold will result in the tender being disqualified and removed from any further consideration.

Functionality Criteria

The functionality criteria and maximum score in respect of each of the criteria are as follows:

<table>
<tr><th colspan="6"><u>TECHNICAL EVALUATION</u></th></tr>
<tr><td colspan="6"><u>DESCRIPTION OF THE WORKS: Complete outstanding work as set out in this scope; Supply and Install Bulk Electrical Supply including Transformers, Switchgear, MCC and Substation Buildings, and Commissioning of similar works as, for Transnet SOC Ltd (Reg. No. 1990/000900/30) Operating as Transnet Port Terminals, (Hereinafter Referred to as "TPT").</u></td></tr>
<tr><th>Evaluation Criteria</th><th>Description</th><th colspan="3">Scoring Principal</th><th>Criteria</th><th>Weighting</th></tr>
<tr><td rowspan="4">Management & CV's of Key Personnel = 20 Points</td><td rowspan="4">General experience, Knowledge Pertinent to Project (=10 points)</td><td rowspan="4">Site Management = 15%</td><td>Project Manager = 35%</td><td rowspan="4">(score 0) - The Tenderer has submitted no information to determine a score.
(score 20) - Key staff do not have relevant levels of experience and knowledge pertinent to the project.
(score 40) - Key staff has</td><td>2,63%</td><td>0,526</td></tr>
<tr><td>Project Planner = 20%</td><td>1,50%</td><td>0,3</td></tr>
<tr><td>Document Controller = 10%</td><td>0,75%</td><td>0,15</td></tr>
<tr><td>Quantity Surveyor = 35%</td><td>2,63%</td><td>0,526</td></tr>
</table>

			Electrical Engineer (HV,LV, Substation & Distribution) = 30%	limited levels of relevant experience and knowledge pertinent to the project. **(score 60)** - Key staff has the required minimum levels of experience and knowledge pertinent to the project.. **(score 80**) - Key staff has extensive levels of relevant experience and knowledge pertinent to the project. **(score 100)** - Key staff has outstanding levels of relevant experience and knowledge pertinent to the project.	12,00%	2,4
		Engineers = 80%	Mechanical Engineer (HVAC) = 20%		8,00%	1,6
			Electronics Engineer = 20%		8,00%	1,6
			Civil Engineer = 20%		8,00%	1,6
			Structural Engineer = 10%		4,00%	0,8
		Safety and Environment = 5%	Health and Safety Officer = 100%		2,50%	0,5
	Education, training and skills (=10 points)	Site Management = 15%	Project Manager = 35%	**(Score 0)** - The Tenderer has submitted no information to determine a score. **(Score 20) -** Key staff does not have project specific education, skills and training. (S**core 40) -** Key staff has limited levels of project specific education, skills and training. **(Score 60) -** Key staff has the required minimum levels of project specific education, skills and training. **(Score 80) -** Key staff has	2,63%	0,526
			Project Planner =20%		1,50%	0,3
			Document Controller = 10%		0,75%	0,15
			Quantity Surveyor = 35%		2,63%	0,526
		Engineers = 80%	Electrical Engineer (HV,LV, Substation & Distribution) = 30%		12,00%	2,4
			Mechanical Engineer (HVAC) = 20%		8,00%	1,6
			Elctronics Engineer = 20%		8,00%	1,6

			Civil Engineer = 20%	extensive levels of project specific education, skills and training. **(Score 100) -** Key staff has outstanding levels of project specific education, skills and training	8,00%	1,6
			Structural Engineer = 10%		4,00%	0,8
		Safety Management = 5%	Health and Safety Officer = 100%		2,50%	0,5
Method Statement = 10 Points	Contractor site establishment (=1 point)	Contractor site establishment to be completed by the tenderer taking into consideration all items in the scope of works, office facilities, safety and environmental requirements, connection of services and de-establishment when the project is complete.		**Score 0** - The tenderer has submitted no information to determine a score. **Score 20** - The methodology/approach and work alignment to project schedule is poorly presented and not tailored to address the specific project objectives and methodology. **Score 40** - The methodology/approach is not tailored to address the specific project objectives and methodology. The methodology approach does not deal with the critical characteristics of the project. **Score 60** - Satisfactory response/solution to the particular aspect of the	10%	1
	Design, Site Installation and Commissioning (=7 points)	The tenderer to issue a Method Statement on the required engineering, component procurement, component fabrication, installation and commissioning stages for the total scope of works which will include; 1. Main Intake Substation2. Substation M3. Substation N4. Ystervark Yard 5. Electrical and Comms Cabling 6. PLC/SCADA Works 7. Iscor Substation 8. Blouwater Substation 9. 132/66kV Overhead lines			70%	7

		Project handover (=2 points)	Handover of the project needs to include all training requirements, manual and data packs	requirement and evidence given that the stated employer's requirements will be met. **Score 80** - The methodology/approach is specifically tailored to address the specific project objectives and methodology and is sufficiently flexible to accommodate changes that may occur during execution. The methodology/approach to manage activities is specifically tailored to the critical characteristics of the project. **Score 100** - Besides meeting the "80" rating, the important issues are approached in an innovative and efficient way, indicating that the tenderer has outstanding knowledge of state-of-the-art approaches. The methodology approach details ways to improve the project outcomes and the quality of the outputs.	20%	2

Previous Experience = 30 Points	Previous Experience (=15 points)	**0** - The Tenderer failed to address the question / issue. Has not submitted any information. **20%** - The Tenderer's previous experience presented has no relevance to the scope of this project and did not address any of the required categories. **40%** - The Tenderer's previous experience presented has some relevance to the project but lacks detail i.e. Description of previous projects, value and references. **60%** - The Tenderer's previous experience presented demonstrates knowledge and experience to successfully execute this project scope. **80%** - The Tenderer's previous experience presented demonstrates a real understanding and substantial evidence of the ability meet the stated project requirements. The tenderer has extensive previous experience in relation to the works **100%** -The Tenderer's previous experience presented demonstrates real confidence extensive understanding in all of the categories as required.	50%	15
	References: Specific to the Design, Manufacture, Installation and Commissioning of Bulk Power (= 15 points)	**0** - The Tenderer failed to address the question / issue. Has not submitted any information. **20%** - One (1) reference letters from companies where the Respondent has provided a similar service with details of SOW **40%** - Two (2) reference letters from companies where the Respondent has provided a similar service with details of SoW **60%**- Three (3) reference letters from companies where the Respondent has provided a similar service with details of SoW **80%** - Four (4) reference letters from companies where the Respondent has provided a similar service with deatails of SoW **100%** - Five (5) reference letters from companies where the Respondent has provided a similar service with deatails of SoW	50%	15

Programme = 40 Points	Meet the required timeframes (= 16 points)	Ability to provide the services in terms of the Employer's requirements within the required timeframe as stated in the Works Information (Also Listed Below) and Tender Data by indicating, in a logical sequence, the order, the timing, and the duration of the works that will take place in order to Provide the Works. **Timeframe to be acheived:** 1. Completion is to be achieved no later than **160 working days** from award or to which ever period later amended.	**Score 0** -The tenderer has submitted no information or inadequate information to determine a score or a completion timeline of greater than 200 days..**Score 20** - The programme does not meet (191 to 200 days) the required timeframe.**Score 40** - The programme does not meet (181 to 190 days) the required timeframe..**Score 60** - The programme does not meet (171 to 180 days) of the required timeframe.**Score 80** - The programme does not meet (161 to 170 days) of the required timeframe.**Score 100** - The programme (160 days) does meet the required timeframe.	75%	30

		Programme information (= 8 points)	The Contractor clearly indicates in the schedule all milestones, activities & information related to the following – 1. Float, 2. Time Risk Allowances, 3. Health and safety requirements, 4. Procedures set out in this contract, 5. Work by the Employer and Others, 6. Access to a part of the site if later than its access date, 7. Acceptances, 8. Plant & Materials and other things to be provided by the employer, 9. Information by Others, 10. Starting date, access dates, Key Dates and Completion Date 11. Planned Completion for each Key Date for each option and the complete works 12. Shows how each activity on the Activity Schedule relates to the operations on each programme	**Score 0** - The tenderer has submitted no information or inadequate information to determine a score. **Score 20** - The tenderer has addressed some but not all requirements as listed in this returnable (4 or less of 12 addressed) **Score 40** - The tenderer has addressed some but not all requirements as listed in this returnable (5 or 6 of 12)addessed **Score 60** - The tenderer has addressed most but not all requirements as listed in this returnable (7 or 8 of 12 addressed) **Score 80** - The tenderer has addressed most but not all requirements as listed in this returnable (9 or 10 of 12 addressed) **Score 100** - The tenderer has addressed all requirements as listed in this returnable (11 or 12 of 12 addressed)	10%	4

		Resourcing & Equipment (= 16 points)	The Contractor indicates for each operation, how the Contractor plans to do the work identifying the principal Equipment and other resources which he plans to use. Resources & equipment are loaded against activities with their to the programme for evaluation.	**Score 0** - The tenderer has submitted no information or inadequate information to determine a score.**Score 20** - The tenderer has addressed some but not all resource requirements and the submission is missing critical both resources & equipment which renders it unrealistic / unachievable.**Score 40** - The tenderer has addressed some but not all resource requirements and the submission is missing either critical resources or equipment which renders it unrealistic / unachievable.**Score 60** - The tenderer has addressed some but not all resource requirements and the submission is missing some resources & equipment, but not critical providing the works, which renders it at risk of being unrealistic / unachievable.**Score 80** - The tenderer has addressed all resource requirements correctly and the submission contains resources & equipment, which is	15%	6

			accurate, and renders the submission realistic and achievable.**Score 100** - The tenderer has addressed all resource requirements correctly and the submission contains resources & equipment, which is accurate, and renders the submission realistic and achievable and is fully aligned to the method statements		
TOTAL RATING					100,00
Technical Qualification Threshold = 70%					

Functionality shall be scored independently by not less than 3 (three) evaluators and averaged in accordance with the following schedules:

- T2.2-04 Programme
- T2.2-05 Management & CVs of Key Persons
- T2.2-06 Previous experience
- T2.2-07 Method Statement

Each evaluation criteria will be assessed in terms of scores of 0, 20, 40, 60, 80 or 100

The scores of each of the evaluators will be averaged, weighted and then totalled to obtain the final score for functionality, unless scored collectively. (See CIDB Inform Practice Note #9).

Note: Any tender not complying with the above mentioned requirements, will be regarded as non-responsive and will therefore <u>not</u> be considered for further evaluation. This note must be read in conjunction with Clause C.2.1.

C.3.11. Only tenders that achieve the minimum qualifying score for functionality will be evaluated further in accordance with the 90/10 preference points systems as described in Preferential Procurement Regulations.

90 where the financial value of one or more responsive tenders received have a value equal to or above R50 million, inclusive of all applicable taxes.

Thresholds	Minimum Threshold
Technical / functionality	70

Evaluation Criteria	Final Weighted Scores
Price	90
Specific goals - Scorecard	10
TOTAL SCORE:	**100**

Up to 100 minus W_1 tender evaluation points will be awarded to tenderers who complete the preferencing schedule and who are found to be eligible for the preference claimed. **Should the evidence required for any of the Specific Goals applicable in this tender not be provided, a tenderer will score zero preference points for that particular "Specific Goal".**

In terms of Transnet Preferential Procurement Policy (TPPP) and Procurement Manuals, the following preference points must be awarded to a bidder who provides the relevant required evidence for claiming points

Selected Specific Goal	Number of points allocated (10)
B-BBEE Level of contributor – Level 1 and 2	3.34
Promotion of local content and local production.	3.33
Subcontracting 30% of the value of the contract to EME's and QSE's 51%	3.33
Non-Compliant and/or B-BBEE Level 3-8 contributors	10

The following Table represents the evidence to be submitted for claiming preference points for applicable specific goals in a particular tender:

Specific Goals	Acceptable Evidence
B-BBEE	B-BBEE Certificate / Sworn-Affidavit B-BBEE Certificate (in case of JV, a consolidate scorecard will be accept) as per DTIC guidelines
30% Black Women Owned Entities	B-BBEE Certificate / Sworn-Affidavit / CIPC B-BBEE Certificate (in case of JV, a consolidate scorecard will be accept) as per DTIC guidelines
50% Black Youth Owned Entities	Certified copy of ID Documents of the Owners and B-BBEE Certificate / Affidavit (in case of JV, a consolidate scorecard will be accept)
Entities Owned by People with Disability (PWD)	Certified copy of ID Documents of the Owners and Doctor's note confirming the disability and/or Employment Equity Act 1(EEA1) form.
Entities/Black People living in rural areas	Entity's Municipal/ESKOM bill or letter from Induna/chief confirming residential address not older than 3 months
South African Enterprises	CIPC Registration Documents
EME or QSE 51% Black Owned	B-BBEE Certificate / Affidavit (in case of JV, a consolidate scorecard will be accept) as per DTIC guidelines
Entities that are 51 % Black Owned	B-BBEE Certificate / Sworn-Affidavit B-BBEE Certificate (in case of JV, a consolidate scorecard will be accept) as per DTIC guidelines
Local Content and Local Production	Returnable Local Content and production Annexures
NIPP	NIPP Returnable documents
The promotion of supplier development through sub-contracting or JV for a minimum of 30% of the value of a contract to South African Companies which are: I. 30% Black Women, 51% black Youth and 51% people	Sub-contracting agreements and Declaration / Joint Venture Agreement. Certified copy of ID Documents of the Owners and B-BBEE Certificate / Affidavit (in case of JV, a consolidate scorecard will be accept) of the sub-contracted entities.

with disabilities II. Entities with a specified minimum B-BBEE level (1 and 2) III. EMEs and/or QSEs who are 51% black-owned	
The promotion of enterprises located in a specific province/region/municipal area for work to be done or services to be rendered in that province/region/municipal area	CIP - Registered address of entity

The maximum points for this bid are allocated as follows:

DISCRIPTION	POINTS
PRICE	90
B-BBEE STATUS LEVEL OF CONTRIBUTION B-BBEE Level 1 & 2= 3.34 Promotion of local content and local production = 3.33 Subcontracting 30% of the value of the contract to EME's and QSE's 51% =3.33	10
Total points for Price and Specific Goals must not exceed	100

Note: Transnet reserves the right to carry out an independent audit of the tenderers scorecard components at any stage from the date of close of the tenders until completion of the contract.

C.3.13 Tender offers will only be accepted if:

1. The tenderer or any of its directors/shareholders is not listed on the Register of Tender Defaulters in terms of the Prevention and Combating of Corrupt Activities Act of 2004 as a person prohibited from doing business with the public sector;

2. the tenderer does not appear on Transnet's list for restricted tenderers and National Treasury's list of Tender Defaulters;

3. the tenderer has fully and properly completed the Compulsory Enterprise Questionnaire and there are no conflicts of interest which may impact on the tenderer's ability to perform the contract in the best interests of the Employer or potentially compromise the tender process and persons in the employ of the state.

4. Transnet reserves the right to award the tender to the tenderer who scores the highest number of points overall, unless there are **objective criteria** which will justify the award of the tender to another tenderer. Objective criteria include but are not limited to the outcome of a due diligence exercise to be conducted. The due diligence exercise may take the following factors into account inter alia;

   the tenderer:

   a) is not under restrictions, or has principals who are under restrictions, preventing participating in the employer's procurement,
   b) is not undergoing a process of being restricted by Transnet or other state institution that Transnet may be aware of,
   c) can, as necessary and in relation to the proposed contract, demonstrate that he or she possesses the professional and technical qualifications, professional and technical competence, financial resources, equipment and other physical facilities, managerial capability, reliability, experience and reputation, expertise and the personnel, to perform the contract,
   d) has the legal capacity to enter into the contract,
   e) is not insolvent, in receivership, under Business Rescue as provided for in chapter 6 of the Companies Act, 2008, bankrupt or being wound up, has his affairs administered by a court or a judicial officer, has suspended his business activities, or is subject to legal proceedings in respect of any of the foregoing,
   f) complies with the legal requirements, if any, stated in the tender data and
   g) is able, in the option of the employer to perform the contract free of conflicts of interest.

C.3.17	The number of paper copies of the signed contract to be provided by the Employer is 1 (one).

T2.1 List of Returnable Documents

2.1.1 These schedules are required for pre-qualification and eligibility purposes:

T2.2-01 **Stage One as per CIDB: Eligibility Criteria Schedule -** Certificate of attendance at Compulsory Tender Clarification Meeting

T2.2-02 **Stage Two as per CIDB: Eligibility Criteria Schedule -** CIDB Registration

T2.2-03 **Stage Three : Technical Eligibility Criteria Schedule -** Professional Registration

2.1.2 Stage Four as per CIDB: these schedules will be utilised for evaluation purposes:

T2.2-04 **Evaluation Schedule:** Programme

T2.2-05 **Evaluation Schedule:** Management & CV's of Key Personnel

T2.2-06 **Evaluation Schedule:** Previous experience

T2.2-07 **Evaluation Schedule:** Method Statement

2.1.3 Returnable Schedules:

General:

T2.2-08 Authority to submit tender

T2.2-09 Record of addenda to tender documents

T2.2-10 BBEE

T2.2-11 Risk Elements

T2.2-12 Availability of equipment and other resources

T2.2-13 Subcontracting Form

T2.2-14 Local Content , Annexure C

T2.2-15 Site Establishment requirements

T2.2-16 Letter of Good Standing

Agreement and Commitment by Tenderer:

T2.2-17: CIDB SFU ANNEX G Compulsory Enterprise Questionnaire

T2.2-18 Non-Disclosure Agreement

T2.2-19 RFP Declaration Form

T2.2-20 RFP – Breach of Law

T2.2-21 Certificate of Acquaintance with Tender Document

T2.2-22 Service Provider Integrity Pact

T2.2-23 Supplier Code of Conduct

T2.2-24 POPIA

1.3.2 Bonds/Guarantees/Financial/Insurance:

T2.2-25 Insurance provided by the Contractor

T2.2-26 Form of Intent to provide a Performance Guarantee

T2.2-27 Forecast Rate of Invoicing

T2.2-28 Three (3) years audited financial statements

2.2 C1.1 Offer portion of Form of Offer & Acceptance

2.3 C1.2 Contract Data

2.4 C1.3 Forms of Securities

2.5 C2.1 Pricing Instructions (Bill of Quantities)

2.6 C2.2 Bill of Quantities

T2.2-01: Eligibility Criteria Schedule:

Certificate of Attendance at Tender Clarification Meeting

This is to certify that

.....

(Company Name)

Represented by: .....

(Name and Surname)

Was represented at the compulsory tender clarification meeting

Held at:	**TPT Saldanha, TFR Salkor Admin Building, Orex Road, Saldanha**	
On (date)	19 March 2024	Starting time: 10:00am

Particulars of person(s) attending the meeting:

Name ..... Signature .....

Capacity .....

Attendance of the above company at the meeting was confirmed:

Name ..... Signature .....

For and on Behalf of the *Employers Agent.* .....

Date .....

T2.2-02: Eligibility Criteria Schedule - CIDB Grading Designation

Note to tenderers:

Tenderers are to indicate their CIDB Grading by filling in the table below. **Attach a copy of the CIDB Grading Designation or evidence of being capable of being so registered.**

CRS Number	Status	Grading	Expiry Date

1. Only those tenderers who are registered with the CIDB, or are capable of being so prior to the evaluation of submissions, in a contractor grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered or a value determined in accordance with Regulation 25 (1B) or 25(7A) of the Construction Industry Development Regulations, for a **9 EP** class of construction work, are eligible to have their tenders evaluated.

2. Joint Venture (JV)

Joint ventures are eligible to submit tenders subject to the following:

1. every member of the joint venture is registered with the CIDB;
2. the lead partner has a contractor grading designation of not lower than one level one level below the required grading designation in the class of construction works under consideration and possesses the required recognition status; and
3. the combined Contractor grading designation calculated in accordance with the Construction Industry Development Regulations is equal to or higher than a Contractor grading designation determined in accordance with the sum tendered for a **9 EP** class of construction work or a value determined in accordance with Regulation 25(1B) or 25(7A) of the Construction Industry Development Regulations
4. the Contractor shall provide the employer with a certified copy of its signed joint venture agreement;
5. and in the event that the joint venture is an 'Incorporated Joint Venture' the Memorandum of Incorporation to be provided within 4 (four) weeks of the Contract Date.

Mandatory Returnable

T2.2-03 Professional Registration

The tender must be able to demonstrate that the project personnel have professional registration. The professional registration must be registered with the Engineering Council of South Africa (ECSA). Curriculum Vitae to be submitted to demonstrate relevant experience. The tenderer to submit the following professional registration with the tender:

Engineering Discipline	Name and Surname	Professional Registration	Certification Attached (Yes/No)
Mechanical Engineer		ECSA - Pr Eng / Pr Tech Eng	
Electrical Engineer		ECSA - Pr Eng / Pr Tech Eng	
Electronic Engineer		ECSA - Pr Eng / Pr Tech Eng	
Civil Engineer		ECSA - Pr Eng / Pr Tech Eng	

Reference to attached submissions to this schedule:

.....
.....
.....
.....
.....

The undersigned, who warrants that he *I* she is duly authorised to do so on behalf of the Tenderer, confirms that the contents and referenced submissions of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ..... Date .....

Name ..... Position .....

Tenderer .....

T2.2-04: Evaluation Schedule: Programme = 40 Points

Note to tenderers:

The Tenderer provides a hard copy proposed programme and/or refers to his proposed programme and attaches it to this returnable schedule.

The Programme should indicate the following columns as a bare minimum:

Task ID	Task description	Start date	Finish date	Successor	Resources & Equipment	Time risk allowances (TRA)

The tenderer shall provide the proposed programme detailed to minimum of level 3 showing as a minimum the following: -

1. **Meet the required timeframe in line with the works:**

   Ability to provide the services in terms of the *Employer's* requirements within the required timeframe as stated in the Works Information (Also Listed Below) and Tender Data by indicating, in a logical sequence, the order, the timing, and the duration of the works that will take place in order to Provide the Works.

   Completion is to be achieved no later than 160 working days from award or to which ever period later amended.

   Taking noted of the above requirements, the contractor to indicate at relevant milestones for each of the five work sites:

   1. List of Sites
   1. Main Intake Substation (MIS)
   2. Substation M
   3. Substation N
   4. Ystervark Yard
   5. Fibre Optic Cable

   2. List of Completion Milestones (For each of the above listed sites where applicable)
   6. Civil Works
   7. Architectural Works
   8. Electrical Equipment Procurement
   9. Electrical Equipment Installation
   10. HVAC Procurement
   11. HVAC Installation
   12. Cable laying from all substations to MIS
   13. Fire Protection System Installation
   14. PLC/SCADA
   15. Commissioning

2. Programme Information:

The *Contractor* clearly indicates in the schedule all milestones, activities & information related to

the following –

1. Float,
2. Time Risk Allowances,
3. Health and safety requirements,
4. Procedures set out in this contract,
5. Work by the Employer and Others,
6. Access to a part of the site if later than its access date,
7. Acceptances,
8. Plant & Materials and other things to be provided by the employer,
9. Information by Others,
10. Starting date, access dates, Key Dates and Completion Date
11. Planned Completion for each Key Date for each option and the complete works.
12. Shows how each activity on the Activity Schedule relates to the operations on each programme

3. Resourcing & Equipment:

The *Contractor* indicates for each operation, how the *Contractor* plans to do the work identifying the principal equipment and other resources which he plans to use. Resources & equipment are loaded against activities with their associated rates to the programme for evaluation.

The scoring of the programme will be as follows:

	Meet the required timeframe. (30)	**Programme Information**	**Resourcing & Equipment (6)**

		(4)	
Score 0	The tenderer has submitted no information or inadequate information to determine a score or has timeline of greater than 200 days.	The tenderer has submitted no information or inadequate information to determine a score.	The tenderer has submitted no information or inadequate information to determine a score.
Score 20	The programme does not meet (191-200 days) the required timeframe.	The tenderer has addressed some but not all requirements as listed in this returnable (4 or less of 12 addressed).	The tenderer has addressed some but not all resource requirements and the submission is missing critical both resources & equipment which renders it unrealistic / unachievable.
Score 40	The programme does not meet (181-190 days) the required timeframe.	The tenderer has addressed some but not all requirements as listed in this returnable (5 or 6 of 12) addressed.	The tenderer has addressed some but not all resource requirements and the submission is missing either critical resources or equipment which renders it unrealistic / unachievable.
Score 60	The programme does not meet (171-180 days) the required timeframe.	The tenderer has addressed most but not all requirements as listed in this returnable (7 or 8 of 12 addressed).	The tenderer has addressed some but not all resource requirements and the submission is missing some resources & equipment, but not critical providing the works, which renders it at risk of being unrealistic / unachievable.
Score 80	The programme does not meet (161- 170 days) the required timeframe.	The tenderer has addressed most but not all requirements as listed in this returnable (9 or 10 of 12 addressed).	The tenderer has addressed all resource requirements correctly and the submission contains resources & equipment, which is accurate, and renders the submission realistic and achievable.
Score 100	The programme meets the required timeframe (160 days).	The tenderer has addressed all requirements as listed in this returnable (11 or 12 of 12 addressed).	The tenderer has addressed all resource requirements correctly and the submission contains resources & equipment, which is accurate, and renders the submission realistic and achievable and is fully aligned to the method statements

Reference to attached submissions to this schedule:

.....
.....
.....

.....
.....

The undersigned, who warrants that he /she is duly authorised to do so on behalf of the Tenderer, confirms that the contents and referenced submissions of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ..... Date .....

Name ..... Position .....

Tenderer .....

T2.2-05: Evaluation Schedule - Management & CV's of Key Personnel (20 Points)

The tender must be able to demonstrate that the project personnel have sufficient knowledge, experience and qualifications to provide the required services and submit the following documents as a minimum with the tender:

1. The experience of assigned key persons in relation to the scope of work will be evaluated from three different points of view, namely:
   i. The education, training and skills of the assigned staff in the specific sector, field, subject, etc. which is directly linked to the Scope of Works. Proof of education and training must be attached to the C.V.
2. Comprehensive CV's should be attached to this schedule:

   As a minimum each CV should address the following, but not limited to;

   i. Personal particulars
      a. Name
      b. Place (s) of tertiary education and dates associated
   ii. Qualifications (degrees, diplomas, grades of membership of professional societies and professional registrations)
   iii. Name of current employer and position in enterprise
   iv. Overview of post graduate experience (year, organization and position)
   v. Outline of recent assignments / experience that has a bearing on the Scope of Works

The following table is to be populated by the tenderer identifying the resources for the key roles on the project.

Profession	Name and Surname	Professional Registration	CV attached (Yes/No)
Electrical Engineer (HV, MV, LV, Substation)		ECSA - Pr Eng / Pr Tech Eng	
Mechanical Engineer (HVAC, Wet Services)		ECSA - Pr Eng / Pr Tech Eng	
Quantity Surveyor		Professional Registration SACQSP	
Electronics Engineer PLC/SCADA		ECSA - Pr Eng / Pr Tech Eng	
Civil Engineer (Structural)		ECSA - Pr Eng / Pr Tech Eng	
Health and Safety Officer		NQF Level 5	
Project Manager		PMP Registration	

3. CV's for people proposed for all identified posts including, amongst others:

Site Management

- **Project Manager**
  The Project Manager should have a qualification of a minimum Diploma in Mechanical/Electrical Engineering. Registration as a professional project manager with SACPCMP or PMP registration experience in construction projects specifically focused on the Electrical Infrastructure/Buildings. The Project Manager must demonstrate evidence in working with the NEC suit of contracts.

- **Quantity Surveyor**

  The Quantity Surveyor should have a minimum qualification of a Diploma in Quantity Surveying and registered with SACQSP.

- **Document Controller**

  Document controller should have experience working in construction. Experience working with the NEC3 Engineering.

- **Project Planner**

  Project Planner should have experience working in construction as Planner and experience working with the NEC3 Engineering.

  The Planner is employed and shall be on-site for progress measurements and in attendance at progress meetings to present programme and tracking sheet updates to the *Project Manager* for the duration of the contract.

Engineering Team

- **Mechanical Engineer (HVAC and Wet Services)**

  The Mechanical Engineer must have a qualification of a, B.Tech or BSc.Eng in Mechanical Engineering with experience in design and installation of HVAC systems, wet services.

  The Mechanical Engineer must be professionally registered (Pr Tech Eng or Pr Eng) with ECSA, for final sign off and provision of relevant compliance certifications.

- **Electrical Engineer (HV, MV, LV)**

  The Electrical Engineer must have a qualification of a Diploma, B.Tech or BSc.Eng in Electrical Engineering with experience in design, construction and commissioning of Electrical Infrastructure HV, MV, LV – Overhead lines, Transformers, CT's, VT's, Switchgear and its associated infrastructure and equipment.

  The Electrical Engineer must be professionally registered (Pr Tech Eng or Pr Eng) with ECSA, for final sign off and provision of relevant compliance certifications.

- **Civil Engineer**

The Civil Engineer must have a minimum qualification of a Diploma, B.Tech or BSc.Eng (or equivalent) in Civil Engineering with experience in design and construction of civil structures.

The Civil Engineer must be ECSA Professional Registered (Pr. Eng./ Pr.Tech. Eng.).

- **Electronics Engineer (PLC/SCADA)**

  The Electronics Engineer must have a minimum qualification of a Diploma, B.Tech or BSc.Eng (or equivalent) in Electronic Engineering with experience in control systems of Building Management Systems – interface with I/O's.

  Experience with PLC systems and SCADA management systems.

  The Electronics Engineer must be ECSA Professional Registered (Pr. Eng./ Pr.Tech. Eng.).

Safety

- **Health and Safety Officer**

  NQF Level 5 Health and Safety Management Course as a minimum qualification. Relevant qualification and experience in Electrical, Mechanical and Civil constrcution projects.

The scoring of the Management & CV's of Key Persons will be as follows: **20 POINTS**

General experience, Knowledge Pertinent to Project:		**Education, training and skills Adequacy:**	
	Weight		Weight
Site Management	**15%**	**Site Management**	**15%**
Project Manager	35%	Project Manager	35%
Project Planner	20%	Project Planner	20%
Document Controller	10%	Document Controller	10%
Quantity Surveyor	35%	Quantity Surveyor	35%
Engineers	**80%**	**Engineers**	**80%**
Mechanical Engineer	20%	Mechanical Engineer	20%
Electrical Engineer	30%	Electrical Engineer	30%
Electronic Engineer	20%	Electronic Engineer	20%
Civil Engineer	30%	Civil Engineer	30%
Safety and Construction	**5%**	**Safety and Construction**	**5%**
Health and Safety Officer	100%	Health and Safety Officer	100%
	10 - POINTS		**10 – POINTS**

(Score 0)	The Tenderer has submitted no information to determine a score.	
(Score 20)	**Key staff do not have relevant levels of experience.** Site Management: ≤2 years Engineers (post professional registration experience): ≤2 years Safety and Construction: ≤2 years	**Key staff does not have project specific education, skills and training.** • Very poor response – Education, training and skills are totally insufficient to satisfy the minimum requirements. • Does not have necessary registrations or education.
(Score 40)	**Key staff has limited levels of relevant experience.** Site Management: >2 ≤ 5 years Engineers (post professional registration experience): >2 ≤ 5 years Safety and Construction: >2 ≤ 5 years	**Key staff has limited levels of project specific education, skills and training.** • Below minimum response – Education, Training and skills lacks convincing evidence to satisfy the minimum requirements. Does not have all of the required registrations required.
(Score 60)	**Key staff has the required minimum levels of experience.** Site Management: > 5 ≤ 7 years Engineers (post professional registration experience): > 5 ≤ 7 years Safety and Construction: > 5 ≤ 7 years	**Key staff has the required minimum levels of project specific education, skills and training.** • Satisfactory response – Education, training and skills meet certain aspects of the minimum requirements. The key staff have the respective registrations required.
(Score 80)	**Key staff has extensive levels of relevant experience.** Site Management: > 7 ≤ 9 years Engineers (post professional registration experience): > 7 ≤ 9 years Safety and Construction: > 7 ≤ 9 years	**Key staff has extensive levels of project specific education, skills and training.** • Good response – Education, training and skills meet the minimum requirements. Key staff have the required qualifications and registrations as well as one additional qualifications or training relating to the project needs.
(Score 100)	**Key staff has outstanding levels of relevant experience.** Site Management: ≥10 years	**Key staff has outstanding levels of project specific education, skills and training.** Excellent response – All specified education, training and skills minimum requirements are met and exceeded. Key staff have the

	Engineers (post professional registration experience): ≥10 years Safety and Construction: ≥10 years	required qualifications and registrations as well more than one additional qualification, training or skill relating to the project needs.

Reference to attached submissions to this schedule:

.....

.....

The undersigned, who warrants that he/she is duly authorised to do so on behalf of the Tenderer, confirms that the contents and referenced submissions of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ..... Date .....

Name ..... Position .....

Tenderer .....

T2.2-06: Evaluation Schedule: Previous Experience (30 Points)

Note to tenderers:

Tenderers are required to demonstrate performance in comparable projects of similar size and nature by supplying the following:

1. **Previous Experience: Supply and Install Bulk Electrical Supply including Transformers, Switchgear, MCC and Substation Buildings, and Commissioning of similar works as detailed in the Works Information:**
   - Mechanical/Structural/Civil/Electrical/ Control Systems C&I (SCADA) works.
   - 66V/11kV Electrical Infrastructure
   - 40MVA Transformer Installation
   - Eskom Installations
   - 11kV/400V Transformers
   - Switchgear Installation
   - Protection Systems and Panels
   - HVAC systems
   - Fire Protection

   Note: Detail description of the projects executed must include Scope of works, Complexity, Challenges, Execution Strategy/Methodology.

2. **Five (5) reference letters from companies where the Respondent has provided a similar service with details of scope of works completed.**

Index of documentation attached to this schedule.

Reference letters from companies where the Respondent has provided a similar service				
No	Project Name and Description	Client	Contactable reference details i.e., Name, Cell-phone, and email address	Specific Details of Scope of Works
1				
2				
3				
4				
5				

Score	Previous Experience	References

	Design, Supply, and Install Bulk Electrical Infrastructure including Transformers, Switchgear, MCC, Substation Buildings, and Commissioning **(15 Points)**	Design, Supply, and Install Bulk Electrical Infrastructure including Transformers, Switchgear, MCC, Substation Buildings, and Commissioning **(15 Points)**
0%	The Tenderer failed to address the question / issue. Has not submitted any information.	The Tenderer failed to address the question / issue. Has not submitted any information.
20%	The Tenderer's previous experience presented has no relevance to the scope of this project and did not address any of the required categories.	One (1) reference letter from companies that demonstrates the Respondent has provided a similar service with details of Scope of Work performed included in the reference.
40%	The Tenderer's previous experience presented has some relevance to the project but lacks detail i.e. Description of previous projects, value and references.	Two (2) reference letter from companies that demonstrates the Respondent has provided a similar service with details of Scope of Work performed included in the reference.
60%	The Tenderer's previous experience presented demonstrates knowledge and experience to successfully execute this project scope.	Three (3) reference letters from companies that demonstrates the Respondent has provided a similar service with details of Scope of Work performed included in the reference.
80%	The Tenderer's previous experience presented demonstrates a real understanding and substantial evidence of the ability meet the stated project requirements. The tenderer has extensive previous experience in relation to the *works*.	Four (4) reference letters from companies that demonstrates the Respondent has provided a similar service with details of Scope of Work performed included in the reference.
100%	The Tenderer's previous experience presented demonstrates real confidence extensive understanding in all of the categories as required.	Five (5) reference letters from companies that demonstrates the Respondent has provided a similar service with details of Scope of Work performed included in the reference.

Reference to attached submissions to this schedule:

.....
.....
.....
.....
.....

The undersigned, who warrants that he/she is duly authorised to do so on behalf of the Tenderer, confirms that the contents and referenced submissions of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ..... Date .....

Name

Position .....

Tenderer .....

T2.2-07: Evaluation Schedule: Method Statement = 10 Points

Note to tenderers:

Method statement - The tenderers must sufficiently demonstrate the approach/methodology that will be employed to cover the scope of the project linked to the submitted project programme.

The method statement should include as a minimum the following, the contractor must refer to the works information for the full description of the scope of works.

1. **Contractor site establishment -** Contractor site establishment to be completed by the tenderer taking into consideration all items in the scope of works, office facilities, safety and environmental requirements, connection of services and de-establishment when the project is complete.
2. **Design, Site Installation and Commissioning -**
   The tenderer to demonstrate the required engineering, component procurement, component manufacture/fabrication, installation and commissioning stages for the total scope of works which will include;
   1. Main Intake Substation
   2. Substation M
   3. Substation N
   4. Ystervark Yard
   5. Fibre Optic Cable

3. **Project Management and Handover -** Handover of the project needs to include all training requirements, manual and data packs

   The items above (1,2 and 3) will include as the minimum the following information.

   a) Outline of method statement
   b) Narrative to demonstrate alignment to the programme submission & basis of schedule.
   c) Detailed method statement, technical approach and sequencing of work
   d) Demonstrate and understanding on how the project objectives will be achieved.
   e) Demonstrate how risks and constraints will be addressed and managed.
   f) Detailed method statement for document control and review
   g) Narrative related to project close out, as-builts, training, operator's manual, data packs, etc.

The table below will be used as guidelines for scoring / evaluating the method statement submitted by the Tenderer:

No information submitted = 0	Contractor site establishment	Design Site installation and Commissioning	Project handover
	1 point	7 points	2 points
Score 0	The tenderer has submitted no information to determine a score.		
Score 20%	The methodology/approach and work alignment to project schedule is poorly presented and not tailored to address the specific project objectives and methodology.		
Score 40%	The methodology/approach is not tailored to address the specific project objectives and methodology. The methodology approach does not deal with the critical characteristics of the project.		
Score 60%	Satisfactory response/solution to the particular aspect of the requirement and evidence given that the stated employer's requirements will be met.		
Score 80%	The methodology/approach is specifically tailored to address the specific project objectives and methodology and is sufficiently flexible to accommodate changes that may occur during execution. The methodology/approach to manage activities is specifically tailored to the critical characteristics of the project.		
Score 100%	Besides meeting the "80" rating, the important issues are approached in an innovative and efficient way, indicating that the tenderer has outstanding knowledge an innovative approach. The methodology approach details ways to improve the project outcomes and the quality of the outputs.		

Reference to attached submissions to this schedule:

.....
.....
.....
.....
.....

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the Tenderer, confirms that the contents and referenced submissions of this schedule are within my personal knowledge and are to the best of my belief both true and correct.

Signed ..... Date .....

Name .....

Position .....

Tenderer .....

T2.2-08: Authority to submit a Tender

Indicate the status of the tenderer by ticking the appropriate box hereunder. The tenderer must complete the certificate set out below for his category of organisation or alternatively attach a certified copy of a company / organisation document which provides the same information for the relevant category as requested here.

A - COMPANY	B - PARTNERSHIP	C - JOINT VENTURE	D - SOLE PROPRIETOR

A. Certificate for Company

I, _____ chairperson of the board of directors _____ _____, hereby confirm that by resolution of the board taken on _____ (date), Mr/Ms _____, acting in the capacity of _____, was authorised to sign all documents in connection with this tender offer and any contract resulting from it on behalf of the company.

Signed ..... Date .....

Name ..... Position Chairman of the Board of Directors .....

B. Certificate for Partnership

We, the undersigned, being the **key partners** in the business trading as _____

_____ hereby authorise Mr/Ms _____

acting in the capacity of _____, to sign all documents in connection with the tender offer for Contract _____ and any contract resulting from it on our behalf.

Name	**Address**	**Signature**	**Date**

NOTE: This certificate is to be completed and signed by the full number of Partners necessary to commit the Partnership. Attach additional pages if more space is required.

C. Certificate for Joint Venture

We, the undersigned, are submitting this tender offer in Joint Venture and hereby authorise Mr/Ms _____, an authorised signatory of the company _____, acting in the capacity of lead partner, to sign all documents in connection with the tender offer for Contract _____ _____ and any contract resulting from it on our behalf.

This authorisation is evidenced by the attached power of attorney signed by legally authorised signatories of all the partners to the Joint Venture.

Furthermore we attach to this Schedule a copy of the joint venture agreement which incorporates a statement that all partners are liable jointly and severally for the execution of the contract and that the lead partner is authorised to incur liabilities, receive instructions and payments and be responsible for the entire execution of the contract for and on behalf of any and all the partners.

Name of firm	**Address**	**Authorising signature, name (in caps) and capacity**

D. Certificate for Sole Proprietor

I, _____, hereby confirm that I am the sole owner of the business trading as _____.

Signed		Date	
Name		Position	Sole Proprietor

T2.2-09: Record of Addenda to Tender Documents

This schedule as submitted confirms that the following communications received from the *Employer* before the submission of this tender offer, amending the tender documents, have been taken into account in this specific tender offer:

	Date	**Title or Details**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

Attach additional pages if more space is required.

T2.2-13 Schedule: B-BBEE Status Level 1 and 2

In an endeavour to grow and develop Black Owned (BO) companies as well as to ensure that Transnet meets its Shareholder Compact Objectives, Potential Tenderers are required to meet the B-BBEE Status Level 1 and 2

It is a specific tendering condition that tenderers:

- Have a minimum B-BBEE status level of 1 and 2

T2.2-11: Risk Elements

Tenderers to identify and evaluate the potential risk elements associated with the Works and possible mitigation thereof. The risk elements and the mitigation as identified thereof by the Tenderer are to be submitted.

If No Risks are identified "No Risks" must be stated on this schedule.

Tenderers are also to evaluate any risk/s stated by the *Employer* in Contract Data Part C1, and provide possible mitigation thereof.

Tenders to note: Notwithstanding this information, all costs related to risk elements which are at the Contractor's risk are deemed to be included in the tenderer's offered total of the Prices.

T2.2-12: Availability of Equipment and Other Resources

The Tenderer to submit a list of all Equipment and other resources that will be used to execute the *works* as described in the Works Information.

Equipment Type and Availability – Description	Hourly Rate	Number of Equipment	Details of Ownership

T2.2-13 Schedule: Sub-Contract:

Tenderers are required to Sub-contracting of **a minimum of 30%** to one or more company/ies that meets the requirements of the **TPPP as** indicated hereto:

i. an EME or QSE which is at least 51% owned by black people;
ii. an EME or QSE which is at least 51% owned by black people who are youth;
iii. an EME or QSE which is at least 51% owned by black people who are women; or
iv. an EME or QSE which is at least 51% owned by black people with disabilities;
v. an EME or QSE which is 51% owned by black people living in rural or undeveloped areas or townships;
vii. an EME or QSE which is at least 51%owned by black people who are military veterans.

Tenderer to note that if successful, any deviations from the list of proposed sub-contractors in the contract phase will be subject to acceptance by the *Project Manager* in terms of the Conditions of Contract. Please also note the applicable Z clauses in Contract Data by *Employer*.

Provide **detailed information** of the proposed Sub-contractors below:

	Name of proposed Subcontractor	**National Treasury CSD Number of sub-contractor**	**Address and Region**	**B-BBEEE Certificates or Sworn Affidavit attached to this schedule? Yes/No**	**Percentage (%) of the sub-contracted works in terms of the tendered total of the prices.**
1.					
2.					
3.					
4.					

5.					
6.					
7.					
8.					
9.					
10.					

The Tenderer is to submit the following documents or copies thereof for each of the proposed sub- contractors(s) with this schedule:

- Valid B-BBEE Sworn Affidavits or B-BBEE Certificates of each of the proposed sub-contractors(s).

NOTE TO TENDERERS: FAILURE TO PROVIDE THE ABOVE DOCUMENTS WILL RESULT IN THE NOMINATED SUBCONTRACTOR'S PERCENTAGE BEING DISCOUNTED TO ZERO.

Transnet reserves the right to request additional information of the nominated sub-consultants should it be deemed necessary to verify the compliance to the black ownership percentage or sub- contractors entity size. These may include but not limited to;

- Agreement or Letter of Intent confirming the Sub-Contracting Agreement between the tenderer and proposed sub-contractors(s);
- Copies of the identity documents of the members of shareholders of the contractors;
- Copies of the Audited Financial Statements or Income Statement of the sub- contractors.

SBD 6.2

T2.2-14: Schedule: Declaration of Certificate for Local Production and Content for Designated Sectors

This Standard Bidding Document (SBD) must form part of all bids invited. It contains general information and serves as a declaration form for local content (local production and local content are used interchangeably).

Before completing this declaration, bidders must study the General Conditions, Definitions, Directives applicable in respect of Local Content as prescribed in the Preferential Procurement Regulations, the South African Bureau of Standards (SABS) approved technical specification number SATS 1286:2011 (Edition 1) and the Guidance on the Calculation of Local Content together with the Local Content Declaration Templates [Annex C (Local Content Declaration: Summary Schedule),

1. **General Conditions**

1.1. Preferential Procurement Regulations, makes provision for the promotion of local production and content.

1.2. Regulation 8.(1) prescribes that in the case of designated sectors, where in the award of bids local production and content is of critical importance, such bids must be advertised with the specific bidding condition that only locally produced goods, services or works or locally manufactured goods, with a stipulated minimum threshold for local production and content will be considered.

1.3. Where necessary, for bids referred to in paragraph 1.2 above, a two stage bidding process may be followed, where the first stage involves a minimum threshold for local production and content and the second stage price and B-BBEE.

1.4. A person awarded a contract in relation to a designated sector, may not sub-contract in such a manner that the local production and content of the overall value of the contract is reduced to below the stipulated minimum threshold.

1.5. The local content (LC) expressed as a percentage of the bid price must be calculated in accordance with the SABS approved technical specification number SATS 1286: 2011 as follows:

LC = [1 - x / y] * 100

Where
x is the imported content in Rand
y is the bid price in Rand excluding value added tax (VAT)

Prices referred to in the determination of x must be converted to Rand (ZAR) by using the exchange rate published by South African Reserve Bank (SARB) at 12:00 on the date of advertisement of the bid as indicated in paragraph 4.1 below.

The SABS approved technical specification number SATS 1286:2011 is accessible on http:/www.thedti.gov.za/industrial development/ip.jsp at no cost.

1.6. A bid may be disqualified if this Declaration Certificate and the Annex C (Local Content Declaration: Summary Schedule) are not submitted as part of the bid documentation;

2. **Definitions**

2.1. **"bid"** includes written price quotations, advertised competitive bids or proposals;

2.2. **"bid price"** price offered by the bidder, excluding value added tax (VAT);

2.3. **"contract"** means the agreement that results from the acceptance of a bid by an organ of state;

2.4. **"designated sector"** means a sector, sub-sector or industry that has been designated by the Department of Trade and Industry in line with national development and industrial policies for local production, where only locally produced services, works or goods or locally manufactured goods meet the stipulated minimum threshold for local production and content;

2.5. **"duly sign"** means a Declaration Certificate for Local Content that has been signed by the Chief Financial Officer or other legally responsible person nominated in writing by the Chief Executive, or senior member / person with management responsibility(close corporation, partnership or individual).

2.6. **"imported content"** means that portion of the bid price represented by the cost of components, parts or materials which have been or are still to be imported (whether by the supplier or its subcontractors) and which costs are inclusive of the costs abroad (this includes labour or intellectual property costs), plus freight and other direct importation costs, such as landing costs, dock duties, import duty, sales duty or other similar tax or duty at the South African port of entry;

2.7. **"local content"** means that portion of the bid price which is not included in the imported content, provided that local manufacture does take place;

2.8. **"stipulated minimum threshold"** means that portion of local production and content as determined by the Department of Trade and Industry; and

2.9. **"sub-contract"** means the primary contractor's assigning, leasing, making out work to, or employing another person to support such primary contractor in the execution of part of a project in terms of the contract.

3. **The stipulated minimum threshold(s) for local production and content (refer to Annex A of SATS 1286:2011) for this bid is/are as follows:**

Description of services, works or goods	Stipulated minimum threshold
• Steel Bulk material Handling	85%
• Class 0	90%
• Class 1	70%
• Class 2	70%
• Class 3	45%
• Class 4	10%

4. Does any portion of the services, works or goods offered have any imported content?

(***Tick applicable box***)

YES		NO	

4.1. If yes, the rate(s) of exchange to be used in this bid to calculate the local content as prescribed in paragraph 1.5 of the general conditions must be the rate(s) published by SARB for the specific currency at 12:00 on the date of advertisement of the bid.

The relevant rates of exchange information is accessible on www.reservebank.co.za

Indicate the rate(s) of exchange against the appropriate currency in the table below (refer to Annex A of SATS 1286:2011):

Currency	**Rates of exchange**
US Dollar	
Pound Sterling	
Euro	
Yen	
Other	

NB: Bidders must submit proof of the SARB rate (s) of exchange used.

5. Where, after the award of a bid, challenges are experienced in meeting the stipulated minimum threshold for local content the dti must be informed accordingly in order for the dti to verify and in consultation with the AO/AA provide directives in this regard.

LOCAL CONTENT DECLARATION
(REFER TO ANNEX B OF SATS 1286:2011)

LOCAL CONTENT DECLARATION BY CHIEF FINANCIAL OFFICER OR OTHER LEGALLY RESPONSIBLE PERSON NOMINATED IN WRITING BY THE CHIEF EXECUTIVE OR SENIOR MEMBER/PERSON WITH MANAGEMENT RESPONSIBILITY (CLOSE CORPORATION, PARTNERSHIP OR INDIVIDUAL)

IN RESPECT OF BID NO. iCLM HQ 847/TPT

ISSUED BY: TRANSNET PORT TERMINALS ON BEHALF OF TRANSNET SOC LTD
NB

1 The obligation to complete, duly sign and submit this declaration cannot be transferred to an external authorized representative, auditor or any other third party acting on behalf of the bidder.

2 Guidance on the Calculation of Local Content together with Local Content Declaration Templates (Annex C, D and E) is accessible on http://www.thdti.gov.za/industrial_development/ip.jsp. Bidders should first complete Declaration D. After completing Declaration D, bidders should complete Declaration E and then consolidate the information on Declaration C. **Declaration C should be submitted with the bid documentation at the closing date and time of the bid in order to substantiate the declaration made in paragraph (c) below.** Declarations D and E should be kept by the bidders for verification purposes for a period of at least 5 years. The successful bidder is required to continuously update Declarations C, D and E with the actual values for the duration of the contract.

I, the undersigned, ... (full names), do hereby declare, in my capacity as .....of.....(name of bidder entity), the following:

(a) The facts contained herein are within my own personal knowledge.

(b) I have satisfied myself that:

(i) the goods/services/works to be delivered in terms of the above-specified bid comply with the minimum local content requirements as specified in the bid, and as measured in terms of SATS 1286:2011; and

(c) The local content percentage (%) indicated below has been calculated using the formula given in clause 3 of SATS 1286:2011, the rates of exchange indicated in paragraph 4.1 above and the information contained in Declaration D and E which has been consolidated in Declaration C:

Price of the Designated commodity **Bulk material Handling** Ex VAT	R
Imported content (x), as calculated in terms of SATS 1286:2011	R
Stipulated minimum threshold for local content (paragraph 3 above)	
Local content %, as calculated in terms of SATS 1286:2011	

Price of the Designated commodity **Transformers and Shunt Reactors- Class 0;** Ex Vat	R
Imported content (x), as calculated in terms of SATS 1286:2011	R
Stipulated minimum threshold for local content (paragraph 3 above)	

Local content %, as calculated in terms of SATS 1286:2011	

Price of the Designated commodity **Transformers and Shunt Reactors-Class 1**. Ex Vat	R
Imported content (x), as calculated in terms of SATS 1286:2011	R
Stipulated minimum threshold for local content (paragraph 3 above)	
Local content %, as calculated in terms of SATS 1286:2011	

Price of the Designated commodity **Transformers and Shunt Reactors-Class 2** Ex Vat	R
Imported content (x), as calculated in terms of SATS 1286:2011	R
Stipulated minimum threshold for local content (paragraph 3 above)	
Local content %, as calculated in terms of SATS 1286:2011	

Price of the Designated commodity **Transformers and Shunt Reactors-Class 3** Ex Vat	R
Imported content (x), as calculated in terms of SATS 1286:2011	R
Stipulated minimum threshold for local content (paragraph 3 above)	
Local content %, as calculated in terms of SATS 1286:2011	

Price of the Designated commodity **Transformers and Shunt Reactors-Class 4** Ex Vat	R
Imported content (x), as calculated in terms of SATS 1286:2011	R
Stipulated minimum threshold for local content (paragraph 3 above)	
Local content %, as calculated in terms of SATS 1286:2011	

If the bid is for more than one product, the local content percentages for each product contained in Declaration C shall be used instead of the table above. The local content percentages for each product has been calculated using the formula given in clause 3 of SATS 1286:2011, the rates of exchange indicated in paragraph 4.1 above and the information contained in Declaration D and E.

(d) I accept that the Procurement Authority / Institution has the right to request that the local content be verified in terms of the requirements of SATS 1286:2011.

(e) I understand that the awarding of the bid is dependent on the accuracy of the information furnished in this application. I also understand that the submission of incorrect data, or data that are not verifiable as described in SATS 1286:2011, may result in the Procurement Authority / Institution imposing any or all of the remedies.

SIGNATURE: _____ **DATE:** _____

WITNESS No. 1 _____ **DATE:** _____

WITNESS No. 2 _____ **DATE:** _____

NOTE TO TENDERERS: Failure to fully complete, declare, sign & date this SBD6.2 Declaration as well as the accompanying Annexure C "local content declaration - summary schedule" may result in the tender submission being non-responsive and disqualified from any further evaluation.

Schedule A – Non-compliance for Local Content

Non-compliance Penalties for Local Content:

a) If for any reason the *Contractor* is unable to achieve the local content undertaking, the *Contractor* must approach the Department of Trade and Industry ("DTI") to obtain exemption in order to supply the goods at a lower local content threshold. The *Contractor* is obliged to approach DTI for exemption within 10 (ten) days of determining that it is unable to achieve any milestone target or local content threshold.

b) Should the DTI provide exemption, the *Contractor* shall be entitled to provide the goods at the lower local content threshold set by DTI. In such event, the Parties shall in good faith renegotiate the milestone targets or local content undertaking to ensure that the lowered local content thresholds are achieved.

c) Should DTI not provide the necessary exemption, the *Contractor* shall be obliged to meet each milestone target as stated in the Local Content Plan or the local content undertaking.

d) Should the *Contractor* fail to meet any milestone target or the local content undertaking, the following remedies shall apply without limiting any of the *Employer's* other rights in law:

   i. The *Employer* shall afford the *Contractor* a period of thirty (30) days to remedy its non-compliance.

   ii. Should the *Contractor* fail to meet its obligations within the further 30 day period, the *Contractor* shall pay a Non-Compliance penalty ("Non-compliance Penalty") to the *Employer* in respect of such Non-compliance as set out in clause iv below. The penalties shall be imposed per milestone measurement for non-delivery of committed values in the case of a Local Content Plan or shall be imposed against the non-delivery of committed values where local content undertakings must be met immediately.

   iii. To the extent that the Actual Local Content Spend[1] is lower than the Required Local Content Spend[2] (or the Adjusted Required Local Content Spend[3], as the case may be), the *Contractor* shall be liable for Penalties which is the difference in value between the Actual Local Content Spend and the Required Local Content Spend (or the Adjusted Required Local Content Spend, as the case may be) plus an additional percentage of such difference. Such Non-compliance Penalties shall be calculated and levied at the relevant milestones as stipulated in the Local Content Plan or shall be imposed against the non-delivery of committed values where local content undertakings must be met immediately, in accordance with clause iv below.

[1] Actual Local Content Spend means the monetary value of local content initiatives actually delivered by the Supplier during the period under review.

[2] Required Local Content Spend means the monetary value of local content obligations that the Supplier has agreed to deliver during the period under review.

[3] Adjusted Required Local Content Spend means any adjustment to the Required Local Content Spend as prescribed by DTI through the process of exemption referred to in clause c) above and as agreed to between the parties, reduced to writing and signed by the parties.

iv. Non-compliance penalties shall apply at the following rate: the difference in value between the Required Local Content Spend and the Actual Local Content Spend, plus 5% of such difference.

v. In order to guarantee that the *Contractor* meets its obligations in terms of the Local Content Plan or its committed local content undertaking, the *Employer* shall be entitled to retain a Non-compliance Penalty at the rate of 1% of every monthly payment due by the *Employer* to the *Contractor* over the contract period ("the Local Content Retention Amount"). The Local Content Retention Amount shall be set off against any penalties payable by the *Contractor* at any milestone assessment.

e) Should no penalties be imposed during the duration of the contract, the *Employer* shall refund the full value of the Local Content Retention Amount to the *Contractor* at the end of the contract period.

f)Should any unpaid penalties remain at the end of the contract period, then without limiting other rights that the *Employer* may have in law, the *Contractor* shall forfeit the Local Content Retention Amount and shall have no further claim against the *Employer* for the repayment of such amount.

Non-compliance Penalty Certificate:

a) If any Non-compliance Penalty arises, the *Employer* shall issue a Non-compliance Penalty Certificate on the last day of each month during such Non-compliance indicating the Non-compliance Penalties which have accrued during that period.

b) A Non-compliance Penalty Certificate shall be prima facie proof of the matters to which it relates. If the *Contractor* disputes any of the amounts set out in a Non-compliance Penalty Certificate:

- the dispute shall be resolved in accordance with the provisions of the Contract; and
- if pursuant to that referral, it is determined that the *Contractor* owes any amount to the *Employer* pursuant to the Non-compliance Penalty Certificate, then the *Contractor* shall pay such amount to the *Employer* within 10 (ten) Business Days of the determination made pursuant to such determination and an accompanying valid Tax Invoice.

Payment of Non-compliance Penalties:

a) Subject to Clause i) above, the *Contractor* shall pay the Non-compliance Penalty indicated in the Non-compliance Penalty Certificate within 10 (ten) Business Days of the *Employer* issuing a valid Tax Invoice to the *Contractor* for the amount set out in that certificate. If the *Employer* does not issue a valid Tax Invoice to the *Contractor* for Non-compliance Penalties accrued during any relevant period, those Non-compliance Penalties shall be carried forward to the next period.

b) The *Contractor* shall pay the amount due within 10 (ten) days after receipt of a valid Tax Invoice from the *Employer*, failing which Transnet shall, without prejudice to any other rights of the *Employer* under this Agreement, be entitled to call for payment which may be in any form the *Employer* deems reasonable and appropriate.

c) It is agreed that the *Employer*, the DTI, the South African Bureau of Standards and/or any of their appointed agents shall be entitled to monitor, evaluate and audit the *Contractor's* compliance with its obligations under the Local Content Plan. To this end, the *Contractor* shall provide its full cooperation to the respective bodies referred to in this clause to ensure that effective monitoring, evaluation and auditing takes place.

The Non Compliance Penalties set forth in this Clause are stated exclusive of VAT. Any VAT payable on Non Compliance Penalties will be for the account of the *Contractor*.

T2.2-15: Site Establishment Requirements

Tenderers to indicate their Site establishment area requirements:

T2.2-16 Letter/s of Good Standing with the Workmen's Compensation Fund

Attached to this schedule is the Letter/s of Good Standing.

1.

2.

3.

4.

Name of Company/Members of Joint Venture:

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

T2.2-17: ANNEX G Compulsory Enterprise Questionnaire

The following particulars hereunder must be furnished.

In the case of a Joint Venture, separate enterprise questionnaires in respect of each partner/member must be completed and submitted.

Section 1: Name of enterprise: _____

Section 2: VAT registration number, if any: _____

Section 3: CIDB registration number, if any: _____

Section 4: CSD number: _____

Section 5: Particulars of sole proprietors and partners in partnerships

Name	Identity number	Personal income tax number

* Complete only if sole proprietor or partnership and attach separate page if more than 3 partners

Section 6: Particulars of companies and close corporations

Company registration number _____

Close corporation number _____

Tax reference number: _____

Section 7: The attached SBD4 must be completed for each tender and be attached as a tender requirement.
Section 8: The attached SBD 6 must be completed for each tender and be attached as a requirement.

The undersigned, who warrants that he / she is duly authorised to do so on behalf of the enterprise:

i) authorizes the Employer to obtain a tax clearance certificate from the South African Revenue Services that my / our tax matters are in order;

ii) confirms that the neither the name of the enterprise or the name of any partner, manager, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears on the Register of Tender Defaulters established in terms of the Prevention and Combating of Corrupt Activities Act of 2004;

iii) confirms that no partner, member, director or other person, who wholly or partly exercises, or may exercise, control over the enterprise appears, has within the last five years been convicted of fraud or corruption;

iv) confirms that I / we are not associated, linked or involved with any other tendering entities submitting tender offers and have no other relationship with any of the tenderers or those responsible for compiling the scope of work that could cause or be interpreted as a conflict of interest; and

v) confirms that the contents of this questionnaire are within my personal knowledge and are to the best of my belief both true and correct.

Signed		Date	
Name		Position	
Enterprise name			

SBD 6.1

PREFERENCE POINTS CLAIM FORM

This preference form must form part of all bids invited. It contains general information and serves as a claim for preference points for Specific Goals contribution. Transnet will award preference points to companies who provide valid proof of evidence as per the table of evidence in paragraph 4.1 below.

1. GENERAL CONDITIONS

1.1 The following preference point systems are applicable to all bids:

- the 80/20 system for requirements with a Rand value of up to R50 000 000 (all applicable taxes included); and
- the 90/10 system for requirements with a Rand value above R50 000 000 (all applicable taxes included).

1.2 The value of this bid is estimated to exceed R50 000 000 (all applicable taxes included) and therefore the 90/10 preference point system shall be applicable. Despite the stipulated preference point system, Transnet shall use the lowest acceptable bid to determine the applicable preference point system in a situation where all received acceptable bids are received outside the stated preference point system.

1.3 Preference points for this bid shall be awarded for:

(a) Price;

(b) B-BBEE Status Level of Contribution; and

(c) Any other specific goal determined in the Transnet preferential procurement policy

1.4 The maximum points for this bid are allocated as follows:

	POINTS
PRICE	**90**
B-BBEE STATUS LEVEL OF CONTRIBUTION Level 1 or 2 **LIST THE OTHER APPLICABLE SPECIFIC GOALS FOR THIS TENDER**	**10**
Total points for Price and B-BBEE must not exceed	**100**

1.5 Failure on the part of a bidder to submit proof of evidence required for any of the specific goals together with the bid will be interpreted to mean that preference points for that

specific goal are not claimed.

1.6 The purchaser reserves the right to require of a bidder, either before a bid is adjudicated or at any time subsequently, to substantiate any claim in regard to preferences, in any manner required by the purchaser.

2. DEFINITIONS

(a) **"all applicable taxes"** includes value-added tax, pay as you earn, income tax, unemployment insurance fund contributions and skills development levies;

(b) **"B-BBEE"** means broad-based black economic empowerment as defined in section 1 of the Broad-Based Black Economic Empowerment Act;

(c) "**B-BBEE status level of contributor"** means the B-BBEE status received by a measured entity based on its overall performance using the relevant scorecard contained in the Codes of Good Practice on Black Economic Empowerment, issued in terms of section 9(1) of the Broad-Based Black Economic Empowerment Act;

(d) **"bid"** means a written offer in a prescribed or stipulated form in response to an invitation by an organ of state for the supply/provision of services, works or goods, through price quotations, advertised competitive bidding processes or proposals;

(e) **"Broad-Based Black Economic Empowerment Act"** means the Broad-Based Black Economic Empowerment Act, 2003 (Act No. 53 of 2003);

(f) **"EME"** means an Exempted Micro Enterprise as defines by Codes of Good Practice under section 9 (1) of the Broad-Based Black Economic Empowerment Act, 2003 (Act No. 53 of 2003);

(g) **"functionality"** means the ability of a bidder to provide goods or services in accordance with specification as set out in the bid documents

(h) **"Price"** includes all applicable taxes less all unconditional discounts.

(i) **"Proof of B-BBEE Status Level of Contributor"**

i) the B-BBBEE status level certificate issued by an authorised body or person;

ii) a sworn affidavit as prescribed by the B-BBEE Codes of Good Practice; or

iii) any other requirement prescribed in terms of the B-BBEE Act.

(j) **"QSE"** means a Qualifying Small Enterprise as defines by Codes of Good Practice under section 9 (1) of the Broad-Based Black Economic Empowerment Act, 2003 (Act No. 53 of 2003);

(k) **"rand value"** means the total estimated value of a contract in South African currency, calculated at the time of bid invitations, and includes all applicable taxes and excise duties.

(l) **Specific goals"** means targeted advancement areas or categories of persons or groups either previously disadvantaged or falling within the scope of the Reconstruction and Development Programme identified by Transnet to be given preference in allocation of procurement contracts in line with section 2(1) of the

PPPFA.

3. POINTS AWARDED FOR PRICE

3.1 THE 90/10 PREFERENCE POINT SYSTEMS

A maximum of 90 points is allocated for price on the following basis:

90/10

$$Ps = 90\left(1 - \frac{Pt - P\min}{P\min}\right)$$

Where

Ps = Points scored for comparative price of bid under consideration

Pt = Comparative price of bid under consideration

Pmin = Comparative price of lowest acceptable bid

4. EVEDINCE REQUIRED FOR CLAIMING SPECIFIC GOALS

4.1 In terms of Transnet Preferential Procurement Policy (TPPP) and Procurement Manuals, preference points must be awarded to a bidder for providing evidence in accordance with the table below::

Specific Goals	Acceptable Evidence
B-BBEE Status contributor	B-BBEE Certificate / Sworn- Affidavit / B-BBEE CIPC Certificate (in case of JV, a consolidated scorecard will be accepted) as per DTIC guideline
30% Black Women Owned Entities	B-BBEE Certificate / Sworn- Affidavit / B-BBEE CIPC Certificate (in case of JV, a consolidated scorecard will be accepted) as per DTIC guideline
+50% Black Youth Owned Entities	Certified copy of ID Documents of the Owners and B-BBEE Certificate / Sworn- Affidavit / B-BBEE CIPC Certificate (in case of JV, a consolidated scorecard will be accepted) as per DTIC guideline
Entities Owned by People with Disability (PWD)	Certified copy of ID Documents of the Owners / Doctor's note and /or EEA1 form confirming the disability
Entities/Black People living in rural areas	Entity 's Municipal/ESKOM bill or letter from Induna/chief confirming residential address not older than 3 months.
South African Enterprises	CIPC Certificate
EME or QSE 51% Black Owned	B-BBEE Certificate / Sworn-Affidavit / CIPC Certificate
Entities that are 51 % Black Owned	CI B-BBEE Certificate / Sworn- Affidavit / B-BBEE CIPC Certificate (in case of JV, a consolidated scorecard will be accepted) as per DTIC guideline
Promoting exports Orientated for Job creation	Section……Job Creation Schedule Returnable documents
Local Content and Local Production	Returnable Local Content and production Annexures
NIPP	NIPP Returnable documents

Creation of new jobs and labour intensification	Section……Job Creation Schedule Returnable documents
The promotion of supplier development through sub-contracting or JV for a minimum of 30% of the value of a contract to South African Companies which are: I. 30% Black Women, 51% Black Youth and 51% Black people with disabilities II. Entities with a specified minimum B-BBEE level (1 and 2) III. EMEs and/or QSEs who are 51% black-owned	Sub-contracting agreements and Declaration / Joint Venture Agreement and CIPC – B-BBEE Certificate / Sworn- Affidavit / B-BBEE CIPC Certificate as per DTIC guideline
The promotion of enterprises located in a specific province/region/municipal area for work to be done or services to be rendered in that province/region/municipal area	CIPC – B-BBEE Certificate / Sworn- Affidavit / B-BBEE CIPC Certificate (in case of JV, a consolidated scorecard will be accepted) as per DTIC guidelines and Proof Registered address of entity

4.2 The table below indicates the required proof of B-BBEE status depending on the category of enterprises:

Enterprise	**B-BBEE Certificate & Sworn Affidavit**
Large	Certificate issued by SANAS accredited verification agency
QSE	Certificate issued by SANAS accredited verification agency Sworn Affidavit signed by the authorised QSE representative and attested by a Commissioner of Oaths confirming annual turnover and black ownership (only black-owned QSEs - 51% to 100% Black owned) [Sworn affidavits must substantially comply with the format that can be obtained on the DTI's website at www.dti.gov.za/economic_empowerment/bee_codes.jsp.]
EME[1]	Sworn Affidavit signed by the authorised EME representative and attested by a Commissioner of Oaths confirming annual turnover and black ownership Certificate issued by CIPC (formerly CIPRO) confirming annual turnover and black ownership

[1] In terms of the Implementation Guide: Preferential Procurement Regulations, 2017, Version 2, paragraph 11.11 provides that in the Transport Sector, EMEs can provide a letter from accounting officer or get verified and be issued with a B-BBEE certificate by SANAS accredited professional or agency as the Transport Sector Code has not been aligned to the generic Codes. EMEs in the Transport Sector are not allowed to provide a sworn affidavit as the generic codes are not applicable to them.

		Certificate issued by SANAS accredited verification agency only if the EME is being measured on the QSE scorecard

4.3 A trust, consortium or joint venture (including unincorporated consortia and joint ventures) must submit a consolidated B-BBEE Status Level verification certificate for every separate bid.

4.4 Tertiary Institutions and Public Entities will be required to submit their B-BBEE status level certificates in terms of the specialized scorecard contained in the B-BBEE Codes of Good Practice.

4.5 A person will not be awarded points for B-BBEE status level if it is indicated in the bid documents that such a bidder intends sub-contracting more than 25% of the value of the contract to any other enterprise that does not qualify for at least the points that such a bidder qualifies for, unless the intended sub-contractor is an EME that has the capability and ability to execute the sub-contract.

4.6 A person awarded a contract may not sub-contract more than 25% of the value of the contract to any other enterprise that does not have an equal or higher B-BBEE status level than the person concerned, unless the contract is sub-contracted to an EME that has the capability and ability to execute the sub-contract.

4.7 Bidders are to note that the rules pertaining to B-BBEE verification and other B-BBEE requirements may be changed from time to time by regulatory bodies such as National Treasury or the DTI. It is the Bidder's responsibility to ensure that his/her bid complies fully with all B-BBEE requirements at the time of the submission of the bid.

5. BID DECLARATION

5.1 Bidders who claim points in respect of B-BBEE Status Level of Contribution must complete the following:

6. B-BBEE STATUS LEVEL OF CONTRIBUTION CLAIMED IN TERMS OF PARAGRAPHS 1.4 AND 6.1

6.1 B-BBEE Status Level of Contribution: . = ……(maximum of 10 points)

(Points claimed in respect of paragraph 6.1 must be in accordance with the table reflected in paragraph 4.1 and must be substantiated by relevant proof of B-BBEE status level of contributor.

7. SUB-CONTRACTING

7.1 Will any portion of the contract be sub-contracted?

(***Tick applicable box***)

YES		NO	

7.1.1 If yes, indicate:

i) What percentage of the contract will be subcontracted.....%
ii) The name of the sub-contractor.....
iii) The B-BBEE status level of the sub-contractor.....
iv) Whether the sub-contractor is an EME or QSE.

(Tick applicable box)

YES		NO	

8. DECLARATION WITH REGARD TO COMPANY/FIRM

8.1 Name of company/firm:.....

8.2 VAT registration number:.....

8.3 Company registration number:.....

8.4 TYPE OF COMPANY/ FIRM

- ☐ Partnership/Joint Venture / Consortium
- ☐ One person business/sole propriety
- ☐ Close corporation
- ☐ Company
- ☐ (Pty) Limited

[TICK APPLICABLE BOX]

8.5 DESCRIBE PRINCIPAL BUSINESS ACTIVITIES

.....
.....
.....

8.6 COMPANY CLASSIFICATION

- ☐ Manufacturer
- ☐ Supplier
- ☐ Professional Service provider
- ☐ Other Service providers, e.g. transporter, etc.

[*TICK APPLICABLE BOX*]

8.7 Total number of years the company/firm has been in business:.....

8.8 I/we, the undersigned, who is / are duly authorised to do so on behalf of the company/firm, certify that the points claimed, based on the B-BBE status level of contribution indicated in paragraphs 1.4 and 6.1 of the foregoing certificate, qualifies the company/ firm for the preference(s) shown and I / we acknowledge that:

i) The information furnished is true and correct;

ii) The preference points claimed are in accordance with the General Conditions as indicated in paragraph 1 of this form;

iii) In the event of a contract being awarded as a result of points claimed as shown in paragraph 1.4 and 6.1, the contractor may be required to furnish documentary proof to the satisfaction of the purchaser that the claims are correct;

iv) If a bidder submitted false information regarding its B-BBEE status level of contributor,, which will affect or has affected the evaluation of a bid, or where a bidder has failed to declare any subcontracting arrangements or any of the conditions of contract have not been fulfilled, the purchaser may, in addition to any other remedy it may have

(a) disqualify the person from the bidding process;

(b) recover costs, losses or damages it has incurred or suffered as a result of that person's conduct;

(c) cancel the contract and claim any damages which it has suffered as a result of having to make less favourable arrangements due to such cancellation;

(d) if the successful bidder subcontracted a portion of the bid to another person without disclosing it, Transnet reserves the right to penalise the bidder up to 10 percent of the value of the contract;

(e) recommend that the bidder or contractor, its shareholders and directors, or only the shareholders and directors who acted on a fraudulent basis, be restricted by the National Treasury from obtaining business from any organ of state for a period not exceeding 10 years, after the audi alteram partem (hear the other side) rule has been applied; and

(f) forward the matter for criminal prosecution.

WITNESSES 1. …….. 2. ……	…… SIGNATURE(S) OF BIDDERS(S) DATE: ……..

BIDDER'S DISCLOSURE

1. PURPOSE OF THE FORM

Any person (natural or juristic) may make an offer or offers in terms of this invitation to bid. In line with the principles of transparency, accountability, impartiality, and ethics as enshrined in the Constitution of the Republic of South Africa and further expressed in various pieces of legislation, it is required for the bidder to make this declaration in respect of the details required hereunder.

Where a person/s are listed in the Register for Tender Defaulters and / or the List of Restricted Suppliers, that person will automatically be disqualified from the bid process.

2. Bidder's declaration

2.1 Is the bidder, or any of its directors / trustees / shareholders / members / partners or any person having a controlling interest2 in the enterprise, employed by the state? **YES/NO**

2.1.1 If so, furnish particulars of the names, individual identity numbers, and, if applicable, state employee numbers of sole proprietor/ directors / trustees / shareholders / members/ partners or any person having a controlling interest in the enterprise, in table below.

Full Name	**Identity Number**	**Name of State institution**

2.2 Do you, or any person connected with the bidder, have a relationship with any person

[2] the power, by one person or a group of persons holding the majority of the equity of an enterprise, alternatively, the person/s having the deciding vote or power to influence or to direct the course and decisions of the enterprise.

who is employed by the procuring institution? **YES/NO**

2.2.1 If so, furnish particulars:

.....

.....

2.3 Does the bidder or any of its directors / trustees / shareholders / members / partners or any person having a controlling interest in the enterprise have any interest in any other related enterprise whether or not they are bidding for this contract?

YES/NO

2.3.1 If so, furnish particulars:

.....

.....

3 DECLARATION

I, the undersigned, (name)..... in submitting the accompanying bid, do hereby make the following statements that I certify to be true and complete in every respect:

3.1 I have read and I understand the contents of this disclosure;

3.2 I understand that the accompanying bid will be disqualified if this disclosure is found not to be true and complete in every respect;

3.3 The bidder has arrived at the accompanying bid independently from, and without consultation, communication, agreement or arrangement with any competitor. However, communication between partners in a joint venture or consortium3 will not be construed as collusive bidding.

3.4 In addition, there have been no consultations, communications, agreements or arrangements with any competitor regarding the quality, quantity, specifications, prices, including methods, factors or formulas used to calculate prices, market allocation, the intention or decision to submit or not to submit the bid, bidding with the intention not to win the bid and conditions or delivery particulars of the products or services to which this bid invitation relates.

3.4 The terms of the accompanying bid have not been, and will not be, disclosed by the bidder, directly or indirectly, to any competitor, prior to the date and time of the official bid opening or of the awarding of the contract.

3.5 There have been no consultations, communications, agreements or arrangements made by the bidder with any official of the procuring institution in relation to this procurement process prior to and during the bidding process except to provide clarification on the bid submitted where so required by the institution; and the bidder was not involved in the drafting of the specifications or terms of reference for this bid.

3.6 I am aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practices related to bids and contracts, bids that are suspicious

[3] Joint venture or Consortium means an association of persons for the purpose of combining their expertise, property, capital, efforts, skill and knowledge in an activity for the execution of a contract.

will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No 89 of 1998 and or may be reported to the National Prosecuting Authority (NPA) for criminal investigation and or may be restricted from conducting business with the public sector for a period not exceeding ten (10) years in terms of the Prevention and Combating of Corrupt Activities Act No 12 of 2004 or any other applicable legislation.

I CERTIFY THAT THE INFORMATION FURNISHED IN PARAGRAPHS 1, 2 and 3 ABOVE IS CORRECT.
I ACCEPT THAT THE STATE MAY REJECT THE BID OR ACT AGAINST ME IN TERMS OF PARAGRAPH 6 OF PFMA SCM INSTRUCTION 03 OF 2021/22 ON PREVENTING AND COMBATING ABUSE IN THE SUPPLY CHAIN MANAGEMENT SYSTEM SHOULD THIS DECLARATION PROVE TO BE FALSE.

.....	.....
Signature	Date
.....	.....
Position	Name of bidder

T2.2-18 NON-DISCLOSURE AGREEMENT

Note to tenderers: This Non-Disclosure Agreement is to be completed and signed by an authorised signatory:

THIS AGREEMENT is made effective as of ..... day of ..... 20..... by and between:

TRANSNET SOC LTD

(Registration No. 1990/000900/30), a company incorporated and existing under the laws of South Africa, having its principal place of business at Transnet Corporate Centre 138 Eloff Street , Braamfontein , Johannesburg 2000

and

.....

(Registration No. .....),a private company incorporated and existing under the laws of South Africa having its principal place of business at

.....

.....

WHEREAS

Transnet and the Company wish to exchange Information [as defined below] and it is envisaged that each party may from time to time receive Information relating to the other in respect thereof. In consideration of each party making available to the other such Information, the parties jointly agree that any dealings between them shall be subject to the terms and conditions of this Agreement which themselves will be subject to the parameters of the Tender Document.

IT IS HEREBY AGREED

1. INTERPRETATION

In this Agreement:

1.1 **Agents** mean directors, officers, employees, agents, professional advisers, contractors or sub-contractors, or any Group member;

1.2 **Bid** or **Bid Document** (hereinafter Tender) means Transnet's Request for Information [**RFI**] Request for Proposal [**RFP**] or Request for Quotation [**RFQ**], as the case may be;

1.3 **Confidential Information** means any information or other data relating to one party [the **Disclosing Party**] and/or the business carried on or proposed or intended to be carried on by that party and which is made available for the purposes of the Bid to the other party [the **Receiving Party**] or its Agents by the Disclosing Party or its Agents or recorded in agreed minutes following oral disclosure and any other information otherwise made available by the Disclosing Party or its Agents to the Receiving Party or its Agents, whether before, on or after the date of this Agreement, and whether in writing or otherwise,

including any information, analysis or specifications derived from, containing or reflecting such information but excluding information which:

1.3.1 is publicly available at the time of its disclosure or becomes publicly available [other than as a result of disclosure by the Receiving Party or any of its Agents contrary to the terms of this Agreement]; or

1.3.2 was lawfully in the possession of the Receiving Party or its Agents [as can be demonstrated by its written records or other reasonable evidence] free of any restriction as to its use or disclosure prior to its being so disclosed; or

1.3.3 following such disclosure, becomes available to the Receiving Party or its Agents [as can be demonstrated by its written records or other reasonable evidence] from a source other than the Disclosing Party or its Agents, which source is not bound by any duty of confidentiality owed, directly or indirectly, to the Disclosing Party in relation to such information;

1.4 **Group** means any subsidiary, any holding company and any subsidiary of any holding company of either party; and

1.5 **Information** means all information in whatever form including, without limitation, any information relating to systems, operations, plans, intentions, market opportunities, know-how, trade secrets and business affairs whether in writing, conveyed orally or by machine-readable medium.

2. CONFIDENTIAL INFORMATION

2.1 All Confidential Information given by one party to this Agreement [the **Disclosing Party**] to the other party [the **Receiving Party**] will be treated by the Receiving Party as secret and confidential and will not, without the Disclosing Party's written consent, directly or indirectly communicate or disclose [whether in writing or orally or in any other manner] Confidential Information to any other person other than in accordance with the terms of this Agreement.

2.2 The Receiving Party will only use the Confidential Information for the sole purpose of technical and commercial discussions between the parties in relation to the Tender or for the subsequent performance of any contract between the parties in relation to the Tender.

2.3 Notwithstanding clause 2.1 above, the Receiving Party may disclose Confidential Information:

2.3.1 to those of its Agents who strictly need to know the Confidential Information for the sole purpose set out in clause 2.2 above, provided that the Receiving Party shall ensure that such Agents are made aware prior to the disclosure of any part of the Confidential Information that the same is confidential and that they owe a duty of confidence to the Disclosing Party. The Receiving Party shall at all times remain liable for any actions of such Agents that would constitute a breach of this Agreement; or

2.3.2 to the extent required by law or the rules of any applicable regulatory authority, subject to clause 2.4 below.

2.4 In the event that the Receiving Party is required to disclose any Confidential Information in accordance with clause 2.3.2 above, it shall promptly notify the Disclosing Party and cooperate with the Disclosing

Party regarding the form, nature, content and purpose of such disclosure or any action which the Disclosing Party may reasonably take to challenge the validity of such requirement.

2.5 In the event that any Confidential Information shall be copied, disclosed or used otherwise than as permitted under this Agreement then, upon becoming aware of the same, without prejudice to any rights or remedies of the Disclosing Party, the Receiving Party shall as soon as practicable notify the Disclosing Party of such event and if requested take such steps [including the institution of legal proceedings] as shall be necessary to remedy [if capable of remedy] the default and/or to prevent further unauthorised copying, disclosure or use.

2.6 All Confidential Information shall remain the property of the Disclosing Party and its disclosure shall not confer on the Receiving Party any rights, including intellectual property rights over the Confidential Information whatsoever, beyond those contained in this Agreement.

3. RECORDS AND RETURN OF INFORMATION

3.1 The Receiving Party agrees to ensure proper and secure storage of all Information and any copies thereof.

3.2 The Receiving Party shall keep a written record, to be supplied to the Disclosing Party upon request, of the Confidential Information provided and any copies made thereof and, so far as is reasonably practicable, of the location of such Confidential Information and any copies thereof.

3.3 The Company shall, within 7 [seven] days of receipt of a written demand from Transnet:

3.3.1 return all written Confidential Information [including all copies]; and

3.3.2 expunge or destroy any Confidential Information from any computer, word processor or other device whatsoever into which it was copied, read or programmed by the Company or on its behalf.

3.4 The Company shall on request supply a certificate signed by a director as to its full compliance with the requirements of clause 3.3.2 above.

4. ANNOUNCEMENTS

4.1 Neither party will make or permit to be made any announcement or disclosure of its prospective interest in the Tender without the prior written consent of the other party.

4.2 Neither party shall make use of the other party's name or any information acquired through its dealings with the other party for publicity or marketing purposes without the prior written consent of the other party.

5. DURATION

The obligations of each party and its Agents under this Agreement shall survive the termination of any discussions or negotiations between the parties regarding the Tender and continue thereafter for a period of 5 [five] years.

6. PRINCIPAL

Each party confirms that it is acting as principal and not as nominee, agent or broker for any other person and that it will be responsible for any costs incurred by it or its advisers in considering or pursuing the Tender and in complying with the terms of this Agreement.

7. ADEQUACY OF DAMAGES

Nothing contained in this Agreement shall be construed as prohibiting the Disclosing Party from pursuing any other remedies available to it, either at law or in equity, for any such threatened or actual breach of this Agreement, including specific performance, recovery of damages or otherwise.

8. PRIVACY AND DATA PROTECTION

8.1 The Receiving Party undertakes to comply with South Africa's general privacy protection in terms Section 14 of the Bill of Rights in connection with this Tender and shall procure that its personnel shall observe the provisions of such Act [as applicable] or any amendments and re-enactments thereof and any regulations made pursuant thereto.

8.2 The Receiving Party warrants that it and its Agents have the appropriate technical and organisational measures in place against unauthorised or unlawful processing of data relating to the Tender and against accidental loss or destruction of, or damage to such data held or processed by them.

9. GENERAL

9.1 Neither party may assign the benefit of this Agreement, or any interest hereunder, except with the prior written consent of the other, save that Transnet may assign this Agreement at any time to any member of the Transnet Group.

9.2 No failure or delay in exercising any right, power or privilege under this Agreement will operate as a waiver of it, nor will any single or partial exercise of it preclude any further exercise or the exercise of any right, power or privilege under this Agreement or otherwise.

9.3 The provisions of this Agreement shall be severable in the event that any of its provisions are held by a court of competent jurisdiction or other applicable authority to be invalid, void or otherwise unenforceable, and the remaining provisions shall remain enforceable to the fullest extent permitted by law.

9.4 This Agreement may only be modified by a written agreement duly signed by persons authorised on behalf of each party.

9.5 Nothing in this Agreement shall constitute the creation of a partnership, joint venture or agency between the parties.

9.6 This Agreement will be governed by and construed in accordance with South African law and the parties irrevocably submit to the exclusive jurisdiction of the South African courts.

Signed	.....	Date	.....
Name	.....	Position	.....
Tenderer	.....		

T2.2-19: RFP DECLARATION FORM

NAME OF COMPANY: _____

We _____ do hereby certify that:

1. Transnet has supplied and we have received appropriate tender offers to any/all questions (as applicable) which were submitted by ourselves for tender clarification purposes;
2. we have received all information we deemed necessary for the completion of this Tender;
3. at no stage have we received additional information relating to the subject matter of this tender from Transnet sources, other than information formally received from the designated Transnet contact(s) as nominated in the tender documents;
4. we are satisfied, insofar as our company is concerned, that the processes and procedures adopted by Transnet in issuing this tender and the requirements requested from tenderers in responding to this tender have been conducted in a fair and transparent manner; and
5. furthermore, we acknowledge that a direct relationship exists between a family member and/or an owner / member / director / partner / shareholder (unlisted companies) of our company and an employee or board member of the Transnet Group as indicated below: *[Respondent to indicate if this section is not applicable]*

   FULL NAME OF OWNER/MEMBER/DIRECTOR/
   PARTNER/SHAREHOLDER: ADDRESS:

   _____

   _____

   _____

   Indicate nature of relationship with Transnet:

   _____

   _____

   _____

   _____

   [Failure to furnish complete and accurate information in this regard may lead to the disqualification of your response and may preclude a Respondent from doing future business with Transnet]

We declare, to the extent that we are aware or become aware of any relationship between ourselves and Transnet (other than any existing and appropriate business relationship with Transnet) which could unfairly advantage our company in the forthcoming adjudication process, we shall notify Transnet immediately in writing of such circumstances.

6. We accept that any dispute pertaining to this tender will be resolved through the Ombudsman process and will be subject to the Terms of Reference of the Ombudsman. The Ombudsman process must first be exhausted before judicial review of a decision is sought. (Refer "Important Notice to respondents" below).

7. We further accept that Transnet reserves the right to reverse a tender award or decision based on the recommendations of the Ombudsman without having to follow a formal court process to have such award or decision set aside.

8. We have acquainted ourselves and agree with the content of T2.2-22 "Service Provider Integrity Pact".

For and on behalf of ..... duly authorised thereto
Name:
Signature:
Date:

IMPORTANT NOTICE TO TENDERERS

- Transnet has appointed a Procurement Ombudsman to investigate any material complaint in respect of tenders exceeding R5,000,000.00 (five million S.A. Rand) in value. Should a Tenderer have any material concern regarding an tender process which meets this value threshold, a complaint may be lodged with Transnet's Procurement Ombudsman for further investigation.

- It is incumbent on the Tenderer to familiarise himself/herself with the Terms of Reference for the Transnet Procurement Ombudsman, details of which are available for review at Transnet's website www.transnet.net.

- An official complaint form may be downloaded from this website and submitted, together with any supporting documentation, within the prescribed period, to procurement.ombud@transnet.net
- For transactions below the R5,000,000.00 (five million S.A. Rand) threshold, a complaint may be lodged with the Chief Procurement Officer of the relevant Transnet Operating Division.
- All Tenderers should note that a complaint must be made in good faith. If a complaint is made in bad faith, Transnet reserves the right to place such a tenderer on its List of Excluded Bidders.

T2.2-20: REQUEST FOR PROPOSAL – BREACH OF LAW

NAME OF COMPANY: _____

I / We _____ do hereby certify that ***I/we have/have not been*** found guilty during the preceding 5 (five) years of a serious breach of law, including but not limited to a breach of the Competition Act, 89 of 1998, by a court of law, tribunal or other administrative body. The type of breach that the Tenderer is required to disclose excludes relatively minor offences or misdemeanours, e.g. traffic offences.

Where found guilty of such a serious breach, please disclose:

NATURE OF BREACH:

_____
_____
_____

DATE OF BREACH:

_____

Furthermore, I/we acknowledge that Transnet SOC Ltd reserves the right to exclude any Tenderer from the tendering process, should that person or company have been found guilty of a serious breach of law, tribunal or regulatory obligation.

Signed on this _____ day of _____ 20____

_____

SIGNATURE OF TENDER

T2.2-21 Certificate of Acquaintance with Tender Documents

NAME OF TENDERING ENTITY:

1. By signing this certificate I/we acknowledge that I/we have made myself/ourselves thoroughly familiar with, and agree with all the conditions governing this RFP. This includes those terms and conditions of the Contract, the Supplier Integrity Pact, Non-Disclosure Agreement etc. contained in any printed form stated to form part of the documents thereof, but not limited to those listed in this clause.

2. I/we furthermore agree that Transnet SOC Ltd shall recognise no claim from me/us for relief based on an allegation that I/we overlooked any tender/contract condition or failed to take it into account for the purpose of calculating my/our offered prices or otherwise.

3. I/we understand that the accompanying Tender will be disqualified if this Certificate is found not to be true and complete in every respect.

4. For the purposes of this Certificate and the accompanying Tender, I/we understand that the word "competitor" shall include any individual or organisation, other than the Tenderer, whether or not affiliated with the Tenderer, who:

   a) has been requested to submit a Tender in response to this Tender invitation;

   b) could potentially submit a Tender in response to this Tender invitation, based on their qualifications, abilities or experience; and

   c) provides the same Services as the Tenderer and/or is in the same line of business as the Tenderer

5. The Tenderer has arrived at the accompanying Tender independently from, and without consultation, communication, agreement or arrangement with any competitor. However communication between partners in a joint venture or consortium will not be construed as collusive Tendering.

6. In particular, without limiting the generality of paragraph 5 above, there has been no consultation, communication, agreement or arrangement with any competitor regarding:

a) prices;

b) geographical area where Services will be rendered [market allocation]

c) methods, factors or formulas used to calculate prices;

d) the intention or decision to submit or not to submit, a Tender;

e) the submission of a tender which does not meet the specifications and conditions of the tender; or

f) Tendering with the intention not winning the tender.

7. In addition, there have been no consultations, communications, agreements or arrangements with any competitor regarding the quality, quantity, specifications and conditions or delivery particulars of the Services to which this tender relates.

8. The terms of the accompanying tender have not been, and will not be, disclosed by the Tenderer, directly or indirectly, to any competitor, prior to the date and time of the official tender opening or of the awarding of the contract.

9. I/We am/are aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practices related to tenders and contracts, tenders that are suspicious will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No 89 of 1998 and/or may be reported to the National Prosecuting Authority [NPA] for criminal investigation. In addition, Tenderers that submit suspicious tenders may be restricted from conducting business with the public sector for a period not exceeding 10 [ten] years in terms of the Prevention and Combating of Corrupt Activities Act No 12 of 2004 or any other applicable legislation.

Signed on this _____ day of _____20___

_____

SIGNATURE OF TENDERER

T2.2-22 Service Provider Integrity Pact

Important Note: All potential tenderers must read this document and certify in the RFP Declaration Form that that have acquainted themselves with, and agree with the content.

The contract with the successful tenderer will automatically incorporate this Integrity Pact and shall be deemed as part of the final concluded contract.

INTEGRITY PACT

Between

TRANSNET SOC LTD

Registration Number: 1990/000900/30

("Transnet")

and

The Contractor (hereinafter referred to as the "Tenderer/Service Providers/Contractor")

PREAMBLE

Transnet values full compliance with all relevant laws and regulations, ethical standards and the principles of economical use of resources, fairness and transparency in its relations with its Tenderers/Service Providers/Contractors.

In order to achieve these goals, Transnet and the Tenderer/Service Provider/Contractor hereby enter into this agreement hereinafter referred to as the "Integrity Pact" which will form part of the Tenderer's/Service Provider's/Contractor's application for registration with Transnet as a vendor.

The general purpose of this Integrity Pact is to agree on avoiding all forms of dishonesty, fraud and corruption by following a system that is fair, transparent and free from any undue influence prior to, during and subsequent to the currency of any procurement and/or reverse logistics event and any further contract to be entered into between the Parties, relating to such event.

All Tenderers/Service Providers/Contractor's will be required to sign and comply with undertakings contained in this Integrity Pact, should they want to be registered as a Transnet vendor.

1 OBJECTIVES

1.1 Transnet and the Tenderer/Service Provider/Contractor agree to enter into this Integrity Pact, to avoid all forms of dishonesty, fraud and corruption including practices that are anti-competitive in nature, negotiations made in bad faith and under-pricing by following a system that is fair, transparent and free from any influence/unprejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to:

a) Enable Transnet to obtain the desired contract at a reasonable and competitive price in conformity to the defined specifications of the works, goods and services; and

b) Enable Tenderers/Service Providers/Contractors to abstain from bribing or participating in any corrupt practice in order to secure the contract.

2 COMMITMENTS OF TRANSNET

Transnet commits to take all measures necessary to prevent dishonesty, fraud and corruption and to observe the following principles:

2.1 Transnet hereby undertakes that no employee of Transnet connected directly or indirectly with the sourcing event and ensuing contract, will demand, take a promise for or accept directly or through intermediaries any bribe, consideration, gift, reward, favour or any material or immaterial benefit or any other advantage from the Tenderer, either for themselves or for any person, organisation or third

party related to the contract in exchange for an advantage in the tendering process, Tender evaluation, contracting or implementation process related to any contract.

2.2 Transnet will, during the registration and tendering process treat all Tenderers/ Service Providers/Contractor with equity, transparency and fairness. Transnet will in particular, before and during the registration process, provide to all Tenderers/ Service Providers/Contractors the same information and will not provide to any Tenderers/Service Providers/Contractors confidential/additional information through which the Tenderers/Service Providers/Contractors could obtain an advantage in relation to any tendering process.

2.3 Transnet further confirms that its employees will not favour any prospective Tenderers/Service Providers/Contractors in any form that could afford an undue advantage to a particular Tenderer during the tendering stage, and will further treat all Tenderers/Service Providers/Contractors participating in the tendering process in a fair manner.

2.4 Transnet will exclude from the tender process such employees who have any personal interest in the Tenderers/Service Providers/Contractors participating in the tendering process.

3 OBLIGATIONS OF THE TENDERER / SERVICE PROVIDER

3.1 Transnet has a '**Zero Gifts'** Policy. No employee is allowed to accept gifts, favours or benefits.

a) Transnet officials and employees **shall not** solicit, give or accept, or from agreeing to solicit, give, accept or receive directly or indirectly, any gift, gratuity, favour, entertainment, loan, or anything of monetary value, from any person or juridical entities in the course of official duties or in connection with any operation being managed by, or any transaction which may be affected by the functions of their office.

b) Transnet officials and employees **shall not** solicit or accept gifts of any kind, from vendors, suppliers, customers, potential employees, potential vendors, and suppliers, or any other individual or organisation irrespective of the value.

c) Under **no circumstances** should gifts, business courtesies or hospitality packages be accepted from or given to prospective suppliers participating in a tender process at the respective employee's Operating Division, regardless of retail value.

d) Gratuities, bribes or kickbacks of any kind must never be solicited, accepted or offered, either directly or indirectly. This includes money, loans, equity, special privileges, personal favours, benefit or services. Such favours will be considered to constitute corruption.

3.2 The Tenderer/Service Provider/Contractor commits itself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of its Tender or during any ensuing contract stage in order to secure the contract or in furtherance to secure it and in particular the Tenderer/Service Provider/Contractor commits to the following:

a) The Tenderer/Service Provider/Contractor will not, directly or through any other person or firm, offer, promise or give to Transnet or to any of Transnet's employees involved in the tendering process or to any third person any material or other benefit or payment, in order to obtain in exchange an advantage during the tendering process; and

b) The Tenderer/Service Provider/Contractor will not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any employee of Transnet, connected directly or indirectly with the tendering process, or to any person, organisation or third party related to the contract in exchange for any advantage in the tendering, evaluation, contracting and implementation of the contract.

3.3 The Tenderer/Service Provider/Contractor will not collude with other parties interested in the contract to preclude a competitive Tender price, impair the transparency, fairness and progress of the tendering process, Tender evaluation, contracting and implementation of the contract. The Tenderer / Service Provider further commits itself to delivering against all agreed upon conditions as stipulated within the contract.

3.4 The Tenderer/Service Provider/Contractor will not enter into any illegal or dishonest agreement or understanding, whether formal or informal with other Tenderers/Service Providers/Contractors. This applies in particular to certifications, submissions or non-submission of documents or actions that are restrictive or to introduce cartels into the tendering process.

3.5 The Tenderer/Service Provider/Contractor will not commit any criminal offence under the relevant anti-corruption laws of South Africa or any other country. Furthermore, the Tenderer/Service Provider/Contractor will not use for illegitimate purposes or for restrictive purposes or personal gain, or pass on to others, any information provided by Transnet as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

3.6 A Tenderer/Service Provider/Contractor of foreign origin shall disclose the name and address of its agents or representatives in South Africa, if any, involved directly or indirectly in the registration or tendering process. Similarly, the Tenderer / Service Provider / Contractor of South African nationality shall furnish

the name and address of the foreign principals, if any, involved directly or indirectly in the registration or tendering process.

3.7 The Tenderer/Service Provider/Contractor will not misrepresent facts or furnish false or forged documents or information in order to influence the tendering process to the advantage of the Tenderer/Service Provider/Contractor or detriment of Transnet or other competitors.

3.8 Transnet may require the Tenderer/Service Provider/Contractor to furnish Transnet with a copy of its code of conduct. Such code of conduct must address the compliance programme for the implementation of the code of conduct and reject the use of bribes and other dishonest and unethical conduct.

3.9 The Tenderer/Service Provider/Contractor will not instigate third persons to commit offences outlined above or be an accessory to such offences.

3.10 The Tenderer/Service Provider/Contractor confirms that they will uphold the ten principles of the United Nations Global Compact (UNGC) in the fields of Human Rights, Labour, Anti-Corruption and the Environment when undertaking business with Transnet as follows:

a) Human Rights

- Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights; and
- Principle 2: make sure that they are not complicit in human rights abuses.

b) Labour

- Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;
- Principle 4: the elimination of all forms of forced and compulsory labour;
- Principle 5: the effective abolition of child labour; and
- Principle 6: the elimination of discrimination in respect of employment and occupation.

c) Environment

- Principle 7: Businesses should support a precautionary approach to environmental challenges;
- Principle 8: undertake initiatives to promote greater environmental responsibility; and

• Principle 9: encourage the development and diffusion of environmentally friendly technologies.

d) Anti-Corruption

• Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

4 INDEPENDENT TENDERING

4.1 For the purposes of that Certificate in relation to any submitted Tender, the Tenderer declares to fully understand that the word "competitor" shall include any individual or organisation, other than the Tenderer, whether or not affiliated with the Tenderer, who:

a) has been requested to submit a Tender in response to this Tender invitation;
b) could potentially submit a Tender in response to this Tender invitation, based on their qualifications, abilities or experience; and
c) provides the same Goods and Services as the Tenderer and/or is in the same line of business as the Tenderer.

4.2 The Tenderer has arrived at his submitted Tender independently from, and without consultation, communication, agreement or arrangement with any competitor. However communication between partners in a joint venture or consortium will not be construed as collusive tendering.

4.3 In particular, without limiting the generality of paragraph 5 above, there has been no consultation, communication, agreement or arrangement with any competitor regarding:

a) prices;
b) geographical area where Goods or Services will be rendered [market allocation];
c) methods, factors or formulas used to calculate prices;
d) the intention or decision to submit or not to submit, a Tender;
e) the submission of a Tender which does not meet the specifications and conditions of the RFP; or
f) tendering with the intention of not winning the Tender.

4.4 In addition, there have been no consultations, communications, agreements or arrangements with any competitor regarding the quality, quantity, specifications and conditions or delivery particulars of the Goods or Services to which his/her tender relates.

4.5 The terms of the Tender as submitted have not been, and will not be, disclosed by the Tenderer, directly or indirectly, to any competitor, prior to the date and time of the official Tender opening or of the awarding of the contract.

4.6 Tenderers are aware that, in addition and without prejudice to any other remedy provided to combat any restrictive practices related to Tenders and contracts, Tenders that are suspicious will be reported to the Competition Commission for investigation and possible imposition of administrative penalties in terms of section 59 of the Competition Act No 89 of 1998 and/or may be reported to the National Prosecuting Authority [**NPA**] for criminal investigation and/or may be restricted from conducting business with the public sector for a period not exceeding 10 [ten] years in terms of the Prevention and Combating of Corrupt Activities Act No 12 of 2004 or any other applicable legislation.

4.7 Should the Tenderer find any terms or conditions stipulated in any of the relevant documents quoted in the Tender unacceptable, it should indicate which conditions are unacceptable and offer alternatives by written submission on its company letterhead, attached to its submitted Tender. Any such submission shall be subject to review by Transnet's Legal Counsel who shall determine whether the proposed alternative(s) are acceptable or otherwise, as the case may be.

5 DISQUALIFICATION FROM TENDERING PROCESS

5.1 If the Tenderer/Service Provider/Contractor has committed a transgression through a violation of section 3 of this Integrity Pact or in any other form such as to put its reliability or credibility as a Tenderer/Service Provider/Contractor into question, Transnet may reject the Tenderer's / Service Provider's / Contractor's application from the registration or tendering process and remove the Tenderer/Service Provider/Contractor from its database, if already registered.

5.2 If the Tenderer/Service Provider/Contractor has committed a transgression through a violation of section 3, or any material violation, such as to put its reliability or credibility into question. Transnet may after following due procedures and at its own discretion also exclude the Tenderer/Service Provider /Contractor from future tendering processes. The imposition and duration of the exclusion will be determined by the severity of the transgression. The severity will be determined by the circumstances of the case, which will include amongst others the number of transgressions, the position of the transgressors within the company hierarchy of the Tenderer/Service Provider/Contractor and the amount of the damage. The exclusion will be imposed for up to a maximum of 10 (ten) years. However, Transnet reserves the right to impose a longer period of exclusion, depending on the gravity of the misconduct.

5.3 If the Tenderer/Service Provider/Contractor can prove that it has restored the damage caused by it and has installed a suitable corruption prevention system, or taken other remedial measures as the circumstances of the case may require, Transnet may at its own discretion revoke the exclusion or suspend the imposed penalty.

6 TRANSNET'S LIST OF EXCLUDED TENDERERS (BLACKLIST)

6.1 The process of restriction is used to exclude a company/person from conducting future business with Transnet and other organs of state for a specified period. No Tender shall be awarded to a Tenderer whose name (or any of its members, directors, partners or trustees) appear on the Register of Tender Defaulters kept by National Treasury, or who have been placed on National Treasury's List of Restricted Suppliers. Transnet reserves the right to withdraw an award, or cancel a contract concluded with a Tenderer should it be established, at any time, that a tenderer has been restricted with National Treasury by another government institution.

6.2 All the stipulations on Transnet's restriction process as laid down in Transnet's Supply Chain Policy and Procurement Procedures Manual (CPM included) are included herein by way of reference. Below follows a condensed summary of this restriction procedure.

6.3 On completion of the restriction procedure, Transnet will submit the restricted entity's details (including the identity number of the individuals and registration number of the entity) to National Treasury for placement on National Treasury's Database of Restricted Suppliers for the specified period of exclusion. National Treasury will make the final decision on whether to restrict an entity from doing business with any organ of state for a period not exceeding 10 years and place the entity concerned on the Database of Restricted Suppliers published on its official website.

6.4 The decision to restrict is based on one of the grounds for restriction. The standard of proof to commence the restriction process is whether a "*prima facie*" (i.e. on the face of it) case has been established.

6.5 Depending on the seriousness of the misconduct and the strategic importance of the Goods/Services, in addition to restricting a company/person from future business, Transnet may decide to terminate some or all existing contracts with the company/person as well.

6.6 A Service Provider or Contractor to Transnet may not subcontract any portion of the contract to a blacklisted company.

6.7 Grounds for blacklisting include: If any person/Enterprise which has submitted a Tender, concluded a contract, or, in the capacity of agent or subcontractor, has been associated with such Tender or contract:

a) Has, in bad faith, withdrawn such Tender after the advertised closing date and time for the receipt of Tenders;
b) has, after being notified of the acceptance of his Tender, failed or refused to sign a contract when called upon to do so in terms of any condition forming part of the Tender documents;
c) has carried out any contract resulting from such Tender in an unsatisfactory manner or has breached any condition of the contract;
d) has offered, promised or given a bribe in relation to the obtaining or execution of the contract;
e) has acted in a fraudulent or improper manner or in bad faith towards Transnet or any Government Department or towards any public body, Enterprise or person;
f) has made any incorrect statement in a certificate or other communication with regard to the Local Content of his Goods or his B-BBEE status and is unable to prove to the satisfaction of Transnet that:

(i) he made the statement in good faith honestly believing it to be correct; and

(ii) before making such statement he took all reasonable steps to satisfy himself of its correctness;

g) caused Transnet damage, or to incur costs in order to meet the contractor's requirements and which could not be recovered from the contractor;
h) has litigated against Transnet in bad faith.

6.8 Grounds for blacklisting include a company/person recorded as being a company or person prohibited from doing business with the public sector on National Treasury's database of Restricted Service Providers or Register of Tender Defaulters.

6.9 Companies associated with the person/s guilty of misconduct (i.e. entities owned, controlled or managed by such persons), any companies subsequently formed by the person(s) guilty of the misconduct and/or an existing company where such person(s) acquires a controlling stake may be considered for

blacklisting. The decision to extend the blacklist to associated companies will be at the sole discretion of Transnet.

7 PREVIOUS TRANSGRESSIONS

7.1 The Tenderer/Service Provider/Contractor hereby declares that no previous transgressions resulting in a serious breach of any law, including but not limited to, corruption, fraud, theft, extortion and contraventions of the Competition Act 89 of 1998, which occurred in the last 5 (five) years with any other public sector undertaking, government department or private sector company that could justify its exclusion from its registration on the Tenderer's/Service Provider's/Contractor's database or any tendering process.

7.2 If it is found to be that the Tenderer/Service Provider/Contractor made an incorrect statement on this subject, the Tenderer/Service Provider/Contractor can be rejected from the registration process or removed from the Tenderer/ Service Provider/Contractor database, if already registered, for such reason (refer to the Breach of Law Returnable Form contained in the document.)

8 SANCTIONS FOR VIOLATIONS

8.1 Transnet shall also take all or any one of the following actions, wherever required to:

a) Immediately exclude the Tenderer/Service Provider/Contractor from the tendering process or call off the pre-contract negotiations without giving any compensation the Tenderer/Service Provider/Contractor. However, the proceedings with the other Tenderer/ Service Provider/Contractor may continue;
b) Immediately cancel the contract, if already awarded or signed, without giving any compensation to the Tenderer/Service Provider/Contractor;
c) Recover all sums already paid by Transnet;
d) Encash the advance bank guarantee and performance bond or warranty bond, if furnished by the Tenderer/Service Provider/Contractor, in order to recover the payments, already made by Transnet, along with interest;
e) Cancel all or any other contracts with the Tenderer/Service Provider/Contractor; and
f) Exclude the Tenderer/ Service Provider/Contractor from entering into any Tender with Transnet in future.

9 CONFLICTS OF INTEREST

9.1 A conflict of interest includes, inter alia, a situation in which:
a) A Transnet employee has a personal financial interest in a tendering / supplying entity; and

b) A Transnet employee has private interests or personal considerations or has an affiliation or a relationship which affects, or may affect, or may be perceived to affect his / her judgment in action in the best interest of Transnet, or could affect the employee's motivations for acting in a particular manner, or which could result in, or be perceived as favouritism or nepotism.

9.2 A Transnet employee uses his / her position, or privileges or information obtained while acting in the capacity as an employee for:

a) Private gain or advancement; or

b) The expectation of private gain, or advancement, or any other advantage accruing to the employee must be declared in a prescribed form.

Thus, conflicts of interest of any Tender committee member or any person involved in the sourcing process must be declared in a prescribed form.

9.3 If a Tenderer/Service Provider/Contractor has or becomes aware of a conflict of interest i.e. a family, business and / or social relationship between its owner(s)/ member(s)/director(s)/partner(s)/shareholder(s) and a Transnet employee/ member of Transnet's Board of Directors in respect of a Tender which will be considered for the Tender process, the Tenderer/Service Provider/ Contractor:

a) must disclose the interest and its general nature, in the Request for Proposal ("RFX") declaration form; or

b) must notify Transnet immediately in writing once the circumstances has arisen.

9.4 The Tenderer/Service Provider/Contractor shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any committee member or any person involved in the sourcing process, where this is done, Transnet shall be entitled forthwith to rescind the contract and all other contracts with the Tenderer/Service Provider/Contractor.

10 DISPUTE RESOLUTION

10.1 Transnet recognises that trust and good faith are pivotal to its relationship with its Tenderer / Service Provider / Contractor. When a dispute arises between Transnet and its Tenderer / Service Provider / Contractor, the parties should use their best endeavours to resolve the dispute in an amicable manner, whenever possible. Litigation in bad faith negates the principles of trust and good faith on which commercial relationships are based. Accordingly, following a blacklisting process as mentioned in paragraph 6 above, Transnet will not do business with a company that litigates against it in bad faith or is involved in any action that reflects bad faith on its part. Litigation in bad faith includes, but is not limited to the following instances:

a) **Vexatious proceedings**: these are frivolous proceedings which have been instituted without proper grounds;

b) **Perjury:** where a Tenderer / Service Provider / Contractor make a false statement either in giving evidence or on an affidavit;
c) **Scurrilous allegations:** where a Tenderer / Service Provider / Contractor makes allegations regarding a senior Transnet employee which are without proper foundation, scandalous, abusive or defamatory; and
d) **Abuse of court process:** when a Tenderer / Service Provider / Contractor abuses the court process in order to gain a competitive advantage during a Tender process.

11 GENERAL

11.1 This Integrity Pact is governed by and interpreted in accordance with the laws of the Republic of South Africa.

11.2 The actions stipulated in this Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the law relating to any civil or criminal proceedings.

11.3 The validity of this Integrity Pact shall cover all the tendering processes and will be valid for an indefinite period unless cancelled by either Party.

11.4 Should one or several provisions of this Integrity Pact turn out to be invalid the remainder of this Integrity Pact remains valid.

11.5 Should a Tenderer/Service Provider/Contractor be confronted with dishonest, fraudulent or corruptive behaviour of one or more Transnet employees, Transnet expects its Tenderer/Service Provider/Contractor to report this behaviour directly to a senior Transnet official/employee or alternatively by using Transnet's "Tip-Off Anonymous" hotline number 0800 003 056, whereby your confidentiality is guaranteed.

The Parties hereby declare that each of them has read and understood the clauses of this Integrity Pact and shall abide by it. To the best of the Parties' knowledge and belief, the information provided in this Integrity Pact is true and correct.

I …….. duly authorised by the tendering entity, hereby certify that the tendering entity are **fully acquainted** with the contents of the Integrity Pact and further **agree to abide by it** in full.

Signature ……

Date ……..

T2.2-23 : Supplier Code of Conduct

Transnet SOC Limited aims to achieve the best value for money when buying or selling goods and obtaining services. This however must be done in an open and fair manner that supports and drives a competitive economy. Underpinning our process are several acts and policies that any supplier dealing with Transnet must understand and support. These are:

- The Transnet Procurement Policy – A guide for Tenderers.
- Section 217 of the Constitution - the five pillars of Public PSCM (Procurement and Supply Chain Management): fair, equitable, transparent, competitive and cost effective;
- The Public Finance Management Act (PFMA);
- The Broad Based Black Economic Empowerment Act (BBBEE)
- The Prevention and Combating of Corrupt Activities Act (PRECCA); and
- The Construction Industry Development Board Act (CIDB Act).

This code of conduct has been included in this contract to formally appraise Transnet Suppliers of Transnet's expectations regarding behaviour and conduct of its Suppliers.

Prohibition of Bribes, Kickbacks, Unlawful Payments, and Other Corrupt Practices

Transnet is in the process of transforming itself into a self-sustaining State Owned Enterprise, actively competing in the logistics industry. Our aim is to become a world class, profitable, logistics organisation. As such, our transformation is focused on adopting a performance culture and to adopt behaviours that will enable this transformation.

1. Transnet SOC Limited will not participate in corrupt practices. Therefore, it expects its suppliers to act in a similar manner.

- Transnet and its employees will follow the laws of this country and keep accurate business records that reflect actual transactions with, and payments to, our suppliers.
- Employees must not accept or request money or anything of value, directly or indirectly, from suppliers.
- Employees may not receive anything that is calculated to:

- Illegally influence their judgement or conduct or to ensure the desired outcome of a sourcing activity;
- Win or retain business or to influence any act or decision of any person involved in sourcing decisions; or
- Gain an improper advantage.

- There may be times when a supplier is confronted with fraudulent or corrupt behaviour of Transnet employees. We expect our Suppliers to use our "Tip-offs Anonymous" Hot line to report these acts. (0800 003 056).

2. *Transnet SOC Limited is firmly committed to the ideas of free and competitive enterprise.*

- Suppliers are expected to comply with all applicable laws and regulations regarding fair competition and antitrust practices.
- Transnet does not engage with non-value adding agents or representatives solely for the purpose of increasing BBBEE spend (fronting).

3. Transnet's relationship with suppliers requires us to clearly define requirements, to exchange information and share mutual benefits.

- Generally, suppliers have their own business standards and regulations. Although Transnet cannot control the actions of our suppliers, we will not tolerate any illegal activities. These include, but are not limited to:
  - Misrepresentation of their product (origin of manufacture, specifications, intellectual property rights, etc);
  - Collusion;
  - Failure to disclose accurate information required during the sourcing activity (ownership, financial situation, BBBEE status, etc.);
  - Corrupt activities listed above; and
  - Harassment, intimidation or other aggressive actions towards Transnet employees.

- Suppliers must be evaluated and approved before any materials, components, products or services are purchased from them. Rigorous due diligence is conducted and the supplier is expected to participate in an honest and straight forward manner.
- Suppliers must record and report facts accurately, honestly and objectively. Financial records must be accurate in all material respects.

Conflicts of Interest

A conflict of interest arises when personal interests or activities influence (or appear to influence) the ability to act in the best interests of Transnet SOC Limited.

- Doing business with family members.
- Having a financial interest in another company in our industry

Where possible, contracts will be negotiated to include the above in the terms of such contracts. To the extent such terms are not included in contractual obligations and any of the above code is breached, then Transnet reserves its right to review doing business with these suppliers.

I, _____ of _____

(insert name of Director or as per Authority Resolution from Board of Directors)

(insert name of Company)

hereby acknowledge having read, understood and agree to the terms and conditions set out in the "Transnet Supplier Code of Conduct."

Signed this on day _____ at _____

_____

Signature

T2.2-24 Agreement in terms of Protection of Personal Information Act, 4 of 2013 ("POPIA")

1. PREAMBLE AND INTRODUCTION

1.1. The rights and obligation of the Parties in terms of the Protection of Personal Information Act, 4 of 2013 ("POPIA") are included as forming part of the terms and conditions of this contract.

2. PROTECTION OF PERSONAL INFORMATION

2.1. The following terms shall bear the same meaning as contemplated in Section 1 of the Protection of Person information act, No. of 2013 "(POPIA"):

consent; data subject; electronic communication; information officer; operator; person; personal information; processing; record; Regulator; responsible party; special information; as well as any terms derived from these terms.

2.2. The Operator will process all information by the Transnet in terms of the requirements contemplated in Section 4(1) of the POPIA:

Accountability; Processing limitation; Purpose specification; Further processing limitation; Information quality; Openness; Security safeguards and Data subject participation.

2.3. The Parties acknowledge and agree that, in relation to personal information of Transnet and the information of a third party that will be processed pursuant to this Agreement , the Operator is (... .....insert name of Tenderer/Contractor) hereinafter Operator and the Data subject is "Transnet". Operator will process personal information only with the knowledge and authorisation of Transnet and will treat personal information and the information of a third party which comes to its knowledge as confidential and will not disclose it, unless so required by law or subject to the exceptions contained in the POPIA.

2.4. Transnet reserves all the rights afforded to it by the POPIA in the processing of any of its information as contained in this Agreement and the Operator is required to comply with all prescripts as detailed in the POPIA relating to all information concerning Transnet.

2.5. In terms of this Agreement, the Operator acknowledges that it will obtain and have access to personal information of Transnet and the information of a third party and agrees that it shall only process the information disclosed by Transnet in terms of this Agreement and only for the purposes as detailed in this Agreement and in accordance with any applicable law.

2.6. Should there be a need for the Operator to process the personal information and the information of a third party in a way that is not agreed to in this Agreement, the Operator must request consent

from Transnet to the processing of its personal information or and the information of a third party in a manner other than that it was collected for, which consent cannot be unreasonably withheld.

2.7. Furthermore, the Operator will not otherwise modify, amend or alter any personal information and the information of a third party submitted by Transnet or disclose or permit the disclosure of any personal information and the information of a third party to any third party without prior written consent from Transnet.

2.8. The Operator shall, at all times, ensure compliance with any applicable laws put in place and maintain sufficient measures, policies and systems to manage and secure against all forms of risks to any information that may be shared or accessed pursuant to the services offered to Transnet in terms of this Agreement (physically, through a computer or any other form of electronic communication).

2.9. The Operator shall notify Transnet in writing of any unauthorised access to personal information and the information of a third party , cybercrimes or suspected cybercrimes, in its knowledge and report such crimes or suspected crimes to the relevant authorities in accordance with applicable laws, after becoming aware of such crimes or suspected crime. The Operator must inform Transnet of the breach as soon as it has occurred to allow Transnet to take all necessary remedial steps to mitigate the extent of the loss or compromise of personal information and the information of a third party and to restore the integrity of the affected personal information as quickly as is possible.

2.10. Transnet may, in writing, request the Operator to confirm and/or make available any personal information and the information of a third party in its possession in relation to Transnet and if such personal information has been accessed by third parties and the identity thereof in terms of the POPIA.

2.11. Transnet may further request that the Operator correct, delete, destroy, withdraw consent or object to the processing of any personal information and the information of a third party relating to the Transnet or a third party in the Operator's s possession in terms of the provision of the POPIA and utilizing Form 2 of the POPIA Regulations .

2.12. In signing this addendum that is in terms of the POPIA, the Operator hereby agrees that it has adequate measures in place to provide protection of the personal information and the information of a third party given to it by Transnet in line with the 8 conditions of the POPIA and that it will provide to Transnet satisfactory evidence of these measures whenever called upon to do so by Transnet.

The Operator is required to provide confirmation that all measures in terms of the POPIA are in place when processing personal information and the information of a third party received from Transnet:

YES		NO	

2.13. Further, the Operator acknowledges that it will be held liable by Transnet should it fail to process personal information in line with the requirements of the POPIA. The Operator will be subject to any civil or criminal action, administrative fines or other penalty or loss that may arise as a result of the processing of any personal information that Transnet submitted to it.

2.14. Should a Tenderer have any complaints or objections to processing of its personal information, by Transnet, the Tenderer can submit a complaint to the Information Regulator on https://www.justice.gov.za/inforeg/, click on contact us, click on complaints.IR@justice.gov.za

3. SOLE AGREEMENT

3.1. The Agreement, constitute the sole agreement between the parties relating to the subject matter referred to in paragraph 1.1 of this and no amendment/variation/change shall be of any force and effect unless reduced to writing and signed by or on behalf of both parties.

Signed at _____ on this _____day of _____ 2021

Name: _____

Title: _____

Signature: _____

.....

(Operator)

Authorised signatory for and on behalf of ..... (Pty) Ltd who warrants that he/she is duly authorised to sign this Agreement.

AS WITNESSES:

1. Name: _____ Signature: _____

2. Name: _____ Signature: _____

T2.2-24 Agreement in terms of Protection of Personal Information Act, 4 of 2013 ("POPIA")

1. PREAMBLE AND INTRODUCTION

1.1. The rights and obligation of the Parties in terms of the Protection of Personal Information Act, 4 of 2013 ("POPIA") are included as forming part of the terms and conditions of this contract.

2. PROTECTION OF PERSONAL INFORMATION

2.1. The following terms shall bear the same meaning as contemplated in Section 1 of the Protection of Person information act, No. of 2013 "(POPIA"):

consent; data subject; electronic communication; information officer; operator; person; personal information; processing; record; Regulator; responsible party; special information; as well as any terms derived from these terms.

2.2. The Operator will process all information by the Transnet in terms of the requirements contemplated in Section 4(1) of the POPIA:

Accountability; Processing limitation; Purpose specification; Further processing limitation; Information quality; Openness; Security safeguards and Data subject participation.

2.3. The Parties acknowledge and agree that, in relation to personal information of Transnet and the information of a third party that will be processed pursuant to this Agreement , the Operator is (... .....insert name of Tenderer/Contractor) hereinafter Operator and the Data subject is "Transnet". Operator will process personal information only with the knowledge and authorisation of Transnet and will treat personal information and the information of a third party which comes to its knowledge as confidential and will not disclose it, unless so required by law or subject to the exceptions contained in the POPIA.

2.4. Transnet reserves all the rights afforded to it by the POPIA in the processing of any of its information as contained in this Agreement and the Operator is required to comply with all prescripts as detailed in the POPIA relating to all information concerning Transnet.

2.5. In terms of this Agreement, the Operator acknowledges that it will obtain and have access to personal information of Transnet and the information of a third party and agrees that it shall only process the information disclosed by Transnet in terms of this Agreement and only for the purposes as detailed in this Agreement and in accordance with any applicable law.

2.6. Should there be a need for the Operator to process the personal information and the information of a third party in a way that is not agreed to in this Agreement, the Operator must request consent

from Transnet to the processing of its personal information or and the information of a third party in a manner other than that it was collected for, which consent cannot be unreasonably withheld.

2.7. Furthermore, the Operator will not otherwise modify, amend or alter any personal information and the information of a third party submitted by Transnet or disclose or permit the disclosure of any personal information and the information of a third party to any third party without prior written consent from Transnet.

2.8. The Operator shall, at all times, ensure compliance with any applicable laws put in place and maintain sufficient measures, policies and systems to manage and secure against all forms of risks to any information that may be shared or accessed pursuant to the services offered to Transnet in terms of this Agreement (physically, through a computer or any other form of electronic communication).

2.9. The Operator shall notify Transnet in writing of any unauthorised access to personal information and the information of a third party , cybercrimes or suspected cybercrimes, in its knowledge and report such crimes or suspected crimes to the relevant authorities in accordance with applicable laws, after becoming aware of such crimes or suspected crime. The Operator must inform Transnet of the breach as soon as it has occurred to allow Transnet to take all necessary remedial steps to mitigate the extent of the loss or compromise of personal information and the information of a third party and to restore the integrity of the affected personal information as quickly as is possible.

2.10. Transnet may, in writing, request the Operator to confirm and/or make available any personal information and the information of a third party in its possession in relation to Transnet and if such personal information has been accessed by third parties and the identity thereof in terms of the POPIA.

2.11. Transnet may further request that the Operator correct, delete, destroy, withdraw consent or object to the processing of any personal information and the information of a third party relating to the Transnet or a third party in the Operator's s possession in terms of the provision of the POPIA and utilizing Form 2 of the POPIA Regulations .

2.12. In signing this addendum that is in terms of the POPIA, the Operator hereby agrees that it has adequate measures in place to provide protection of the personal information and the information of a third party given to it by Transnet in line with the 8 conditions of the POPIA and that it will provide to Transnet satisfactory evidence of these measures whenever called upon to do so by Transnet.

The Operator is required to provide confirmation that all measures in terms of the POPIA are in place when processing personal information and the information of a third party received from Transnet:

YES		NO	

2.13. Further, the Operator acknowledges that it will be held liable by Transnet should it fail to process personal information in line with the requirements of the POPIA. The Operator will be subject to any civil or criminal action, administrative fines or other penalty or loss that may arise as a result of the processing of any personal information that Transnet submitted to it.

2.14. Should a Tenderer have any complaints or objections to processing of its personal information, by Transnet, the Tenderer can submit a complaint to the Information Regulator on https://www.justice.gov.za/inforeg/, click on contact us, click on complaints.IR@justice.gov.za

3. SOLE AGREEMENT

3.1. The Agreement, constitute the sole agreement between the parties relating to the subject matter referred to in paragraph 1.1 of this and no amendment/variation/change shall be of any force and effect unless reduced to writing and signed by or on behalf of both parties.

Signed at _____ on this _____day of _____ 2021

Name: _____

Title: _____

Signature: _____

.....

(Operator)

Authorised signatory for and on behalf of ..... (Pty) Ltd who warrants that he/she is duly authorised to sign this Agreement.

AS WITNESSES:

1. Name: _____ Signature: _____

2. Name: _____ Signature: _____

T2.2-25: Insurance provided by the *Contractor*

Clause 84.1 in NEC3 Engineering & Construction Contract (June 2005)(amended June 2006 and April 2013) requires that the *Contractor* provides the insurance stated in the insurance table except any insurance which the *Employer* is to provide as stated in the Contract Data.

Please provide the following details for insurance which the *Contractor* is still to provide. Notwithstanding this information all costs related to insurance are deemed included in the tenderer's rates and prices.

Insurance against (See clause 84.2 of the ECC)	**Name of Insurance Company**	**Cover**	**Premium**
Liability for death of or bodily injury to employees of the *Contractor* arising out of and in the course of their employment in connection with this contract			
Motor Vehicle Liability Insurance comprising (as a minimum) "Balance of Third Party" Risks including Passenger and Unauthorised Passenger Liability indemnity with a minimum indemnity limit of R5 000 000/R10 000 000.			
Insurance in respect of loss of or damage to own property and equipment.			
(Other)			

T2.2-26: Form of Intent to Provide a Performance Guarantee

It is hereby agreed by the Tenderer that a Performance Guarantee drafted **exactly** as provided in the tender documents will be provided by the Guarantor named below, which is a **bank or insurer registered in South Africa**:

Name of Guarantor (Bank/Insurer) .....

Address .....

The Performance Guarantee shall be provided within **2** (**Two**) weeks after the Contract Date defined in the contract unless otherwise agreed to by the parties.

Signed .....

Name .....

Capacity .....

On behalf of (name of tenderer) .....

.....

Date .....

Confirmed by Guarantor's Authorised Representative

Signature(s) .....

Name (print) .....

Capacity .....

On behalf of Guarantor (Bank/insurer) .....

Date .....

T2.2-27: Forecast Rate of Invoicing

Tenderer to submit the forecast rate of invoicing (cash-flow) based on the Tender Price and Tender Programme.

Index of documentation attached to this schedule:

.....

.....

.....

.....

.....

.....

.....

.....

T2.2-28: Three (3) years audited financial statements

Attached to this schedule is the last three (3) years audited financial statements of the single tenderer/members of the Joint Venture.

NAME OF COMPANY/IES and INDEX OF ATTACHMENTS:

……

……

……

……

……

……

……

TECHNICAL EVALUATION

DESCRIPTION OF THE WORKS: Complete outstanding work as set out in this scope; Supply and Install Bulk Electrical Supply including Transformers, Switchgear, MCC and Substation Buildings, and Commissioning of similar works as, for Transnet SOC Ltd (Reg. No. 1990/000900/30) Operating as Transnet Port Terminals, (Hereinafter Referred to as "TPT").

Evaluation Criteria	Description	Scoring Principal			Returnable Schedule	Criteria	Weighting
Eligibility	CIDB Electrical Engineering (EP)	Contractors to be registered with the Construction Industry Development Board (CIDB) as a Electrical Contractor and be able to handle contracts that are grade 9.			T00-02	Yes/No	N/A
	Professional Registration	The tenderer to submit all active professional registration certificates for all key engineering personnel with Engineering Council of South Africa (ECSA), or Washington Accord Equivalent. Curriculum Vitae to be submitted to demonstrate relevant experience in line with professional registration.		Electrical Engineer (HV,LV, Substation & Distribution)	T00-03	Yes/No	N/A
				Mechanical Engineer (HVAC)	T00-03	Yes/No	N/A
				Electrical Engineer (MV, LV, Substations)	T00-03	Yes/No	N/A
				Electronics Engineer (Control/Software - PLC/SCADA)	T00-03	Yes/No	N/A
				Civil Engineer	T00-03	Yes/No	N/A
				Structural Engineer (Buildings, Substations Infrastructure)	T00-03	Yes/No	N/A
Management & CV's of Key Personnel = 20 Points	General experience, Knowledge Pertinent to Project (=10 points)	Site Management = 15%	Project Manager = 35%	**(score 0)** - The Tenderer has submitted no information to determine a score. **(score 20)** - Key staff do not have relevant levels of experience and knowledge pertinent to the project. **(score 40)** - Key staff has limited levels of relevant experience and knowledge pertinent to the project. **(score 60)** - Key staff has the required minimum levels of experience and knowledge pertinent to the project.. **(score 80**) - Key staff has extensive levels of relevant experience and knowledge pertinent to the project. **(score 100)** - Key staff has outstanding levels of relevant experience and knowledge pertinent to the project.	T00-05	2,63%	0,526
			Project Planner = 20%			1,50%	0,3
			Document Controller = 10%			0,75%	0,15
			Quantity Surveyor = 35%			2,63%	0,526
		Engineers = 80%	Electrical Engineer (HV,LV, Substation & Distribution) = 30%			12,00%	2,4
			Mechanical Engineer (HVAC) = 20%			8,00%	1,6
			Electronics Engineer = 20%			8,00%	1,6
			Civil Engineer = 20%			8,00%	1,6
			Structural Engineer = 10%			4,00%	0,8
		Safety and Environment = 5%	Health and Safety Officer = 100%			2,50%	0,5
		Site Management = 15%	Project Manager = 35%	**(Score 0)** - The Tenderer has submitted no information to determine a score. **(Score 20) -** Key staff does not have project specific education, skills and training. (S**core 40) -** Key staff has limited levels of project specific education, skills and training. **(Score 60) -** Key staff has the required minimum levels of project specific education, skills and training. **(Score 80) -** Key staff has extensive levels of project specific		2,63%	0,526
			Project Planner =20%			1,50%	0,3
			Document Controller = 10%			0,75%	0,15
			Quantity Surveyor = 35%			2,63%	0,526

	Education, training and skills (=10 points)	Engineers = 80%	Electrical Engineer (HV,LV, Substation & Distribution) = 30%	education, skills and training. **(Score 100) -** Key staff has outstanding levels of project specific education, skills and training		12,00%	2,4
			Mechanical Engineer (HVAC) = 20%			8,00%	1,6
			Elctronics Engineer = 20%			8,00%	1,6
			Civil Engineer = 20%			8,00%	1,6
			Structural Engineer = 10%			4,00%	0,8
		Safety Management = 5%	Health and Safety Officer = 100%			2,50%	0,5
Method Statement = 10 Points	Contractor site establishment (=1 point)	Contractor site establishment to be completed by the tenderer taking into consideration all items in the scope of works, office facilities, safety and environmental requirements, connection of services and de-establishment when the project is complete.		**Score 0** - The tenderer has submitted no information to determine a score. **Score 20** - The methodology/approach and work alignment to project schedule is poorly presented and not tailored to address the specific project objectives and methodology. **Score 40** - The methodology/approach is not tailored to address the specific project objectives and methodology. The methodology approach does not deal with the critical characteristics of the project. **Score 60** - Satisfactory response/solution to the particular aspect of the requirement and evidence given that the stated employer's requirements will be met. **Score 80** - The methodology/approach is specifically tailored to address the specific project objectives and methodology and is sufficiently flexible to accommodate changes that may occur during execution. The methodology/approach to manage activities is specifically tailored to the critical characteristics of the project. **Score 100** - Besides meeting the "80" rating, the important issues are approached in an innovative and efficient way, indicating that the tenderer has outstanding knowledge of state-of-the-art approaches. The methodology approach details ways to improve the project outcomes and the quality of the outputs.	T00-07	10%	1
	Design, Site Installation and Commissioning (=7 points)	The tenderer to issue a Method Statement on the required engineering, component procurement, component fabrication, installation and commissioning stages for the total scope of works which will include; 1. Main Intake Substation 2. Substation M 3. Substation N 4. Ystervark Yard 5. Electrical and Comms Cabling 6. PLC/SCADA Works 7. Iscor Substation 8. Blouwater Substation 9. 132/66kV Overhead lines				70%	7
	Project handover (=2 points)	Handover of the project needs to include all training requirements, manual and data packs				20%	2
Previous Experience = 30 Points	Previous Experience (=15 points)	**0** - The Tenderer failed to address the question / issue. Has not submitted any information. **20% -** The Tenderer's previous experience presented has no relevance to the scope of this project and did not address any of the required categories. **40% -** The Tenderer's previous experience presented has some relevance to the project but lacks detail i.e. Description of previous projects, value and references. **60% -** The Tenderer's previous experience presented demonstrates knowledge and experience to successfully execute this project scope. **80% -** The Tenderer's previous experience presented demonstrates a real understanding and substantial evidence of the ability meet the stated project requirements. The tenderer has extensive previous experience in relation to the works **100% -**The Tenderer's previous experience presented demonstrates real confidence extensive understanding in all of the categories as required.			T00-06	50%	15
	References: Specific to the Design, Manufacture, Installation and Commissioning of Bulk Power (= 15 points)	**0** - The Tenderer failed to address the question / issue. Has not submitted any information. **20%** - One (1) reference letters from companies where the Respondent has provided a similar service with details of SOW **40%** - Two (2) reference letters from companies where the Respondent has provided a similar service with details of SoW **60%**- Three (3) reference letters from companies where the Respondent has provided a similar service with details of SoW **80%** - Four (4) reference letters from companies where the Respondent has provided a similar service with deatails of SoW **100%** - Five (5) reference letters from companies where the Respondent has provided a similar service with deatails of SoW				50%	15

Programme = 40 Points	Meet the required timeframes (= 16 points)	Ability to provide the services in terms of the Employer's requirements within the required timeframe as stated in the Works Information (Also Listed Below) and Tender Data by indicating, in a logical sequence, the order, the timing, and the duration of the works that will take place in order to Provide the Works. **Timeframe to be acheived:** 1. Completion is to be achieved no later than **160 working days** from award or to which ever period later amended.	**Score 0** -The tenderer has submitted no information or inadequate information to determine a score or a completion timeline of greater than 200 days.. **Score 20** - The programme does not meet (191 to 200 days) the required timeframe. **Score 40** - The programme does not meet (181 to 190 days) the required timeframe.. **Score 60** - The programme does not meet (171 to 180 days) of the required timeframe. **Score 80** - The programme does not meet (161 to 170 days) of the required timeframe. **Score 100** - The programme (160 days) does meet the required timeframe.	T00-04	75%	30
	Programme information (= 8 points)	The Contractor clearly indicates in the schedule all milestones, activities & information related to the following – 1.Float, 2.Time Risk Allowances, 3.Health and safety requirements, 4.Procedures set out in this contract, 5.Work by the Employer and Others, 6.Access to a part of the site if later than its access date, 7.Acceptances, 8.Plant & Materials and other things to be provided by the employer, 9.Information by Others, 10.Starting date, access dates, Key Dates and Completion Date 11.Planned Completion for each Key Date for each option and the complete works 12.Shows how each activity on the Activity Schedule relates to the operations on each programme	**Score 0** - The tenderer has submitted no information or inadequate information to determine a score. **Score 20** - The tenderer has addressed some but not all requirements as listed in this returnable (4 or less of 12 addressed) **Score 40** - The tenderer has addressed some but not all requirements as listed in this returnable (5 or 6 of 12)addessed **Score 60** - The tenderer has addressed most but not all requirements as listed in this returnable (7 or 8 of 12 addressed) **Score 80** - The tenderer has addressed most but not all requirements as listed in this returnable (9 or 10 of 12 addressed) **Score 100** - The tenderer has addressed all requirements as listed in this returnable (11 or 12 of 12 addressed)	T00-04	10%	4

	Resourcing & Equipment (= 16 points)	The Contractor indicates for each operation, how the Contractor plans to do the work identifying the principal Equipment and other resources which he plans to use. Resources & equipment are loaded against activities with their to the programme for evaluation.	**Score 0** - The tenderer has submitted no information or inadequate information to determine a score. **Score 20** - The tenderer has addressed some but not all resource requirements and the submission is missing critical both resources & equipment which renders it unrealistic / unachievable. **Score 40** - The tenderer has addressed some but not all resource requirements and the submission is missing either critical resources or equipment which renders it unrealistic / unachievable. **Score 60** - The tenderer has addressed some but not all resource requirements and the submission is missing some resources & equipment, but not critical providing the works, which renders it at risk of being unrealistic / unachievable. **Score 80** - The tenderer has addressed all resource requirements correctly and the submission contains resources & equipment, which is accurate, and renders the submission realistic and achievable. **Score 100** - The tenderer has addressed all resource requirements correctly and the submission contains resources & equipment, which is accurate, and renders the submission realistic and achievable and is fully aligned to the method statements	T00-04	15%	6
	TOTAL RATING					100,00
Technical Qualification Threshold = 70%						

Project Name: **Iron Ore Tippler 3 and Associated Infrastructure**

Project No.: **1924701**

Scope of Work Title: **Supply and Install Bulk Electrical Supply including Transformers, Switchgear, MCC and Sub-Station Buildings**

Scope of Work No.: **1924701-E004-SOW-0001_03**

Prepared by: TFR	 Sifiso Buthelezi – Engineering Manager	2023/12/06 Date
Reviewed by: TPT	 Willie Van Dyk – Principal Project Manager	7 Dec 2023 Date
Approved by: TPT	 Clarence King – Project Director	7 December 2023 Date

Rev No.	Date	Revision Details
3	2023.12.06	Issued for Review

PART C3: SCOPE OF WORK

C3.1 *EMPLOYER'S* WORKS INFORMATION

CONTENTS

1. DESCRIPTION OF *WORKS*

1.1 Introduction

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at Saldanha Port by the addition of a third tippler.

The Site is located at the Port of Saldanha. The *Employer* is Transnet Port Terminal (TPT), and the eventual owners of the *works* will be Transnet Port Terminals (TPT) and Transnet National Ports Authority (TNPA).

As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha. The facilities to be provided by the *Contractor* as part of the *works* will encompass the following main elements:

- New Main Intake Substation.
- New Substations M and N.
- New Eskom 132 kV Control Building and associated high voltage infrastructure at the 'Ystervark' portion of the new Main Intake Substation, which shall be owned, maintained and operated by Eskom.
- Protection equipment upgrades and associated *works* at Eskom's existing Blouwater Substation.
- Installation of new 66 kV circuit breakers, and protection equipment upgrades, at Eskom's existing Iscor Substation.
- Installation of conductors and associated hardware assemblies on the existing Eskom Blouwater to Iscor /Ystervark 66kV overhead lines
- Provision of new 48 core 16 kA/1s underground optical fibre cable from Blouwater Substation to Iscor substation/Ystervark substation.
- Provision of new 48 core separate fibre for each network (ICT and process) for the new and existing identified substations.
- Supply and installation of electrical and fibre optic cable reticulation and associated equipment.
- Supply and installation of 400V encapsulated busbar system in the Tippler 3 building.
- Overall commissioning of electrical components.
- Sleeves for substation M & substation N
- Scissoring & orientation of the masts

The *works* to be performed by the *Contractor*, as covered also in the specifications as referenced under Annexure A, the drawings as referenced under Annexure B and the bills of quantities, includes but is not limited to the following:

- High and medium voltage installations.
- High-voltage overhead lines.
- Low voltage installations.
- Protection and metering installations.
- Monitoring and control installations.
- Structural *works.*
- Architecture *works*.
- Civil *works.*
- HVAC.
- Fire suppression.

Further descriptions of the scope of the *works* are provided below.

1.2 Scope of *Works*

The scope of the *works* to be undertaken by the *Contractor* includes, but is not limited to, the following general items:

- The design (for specific *works* specified in this document and all other associated contract documentation), manufacture, supply, installation, construction and commissioning of all infrastructure and equipment required for the provision of the new facilities for the provision of electrical power and electronic services, as covered in this document, the drawings, bills of quantities, specifications and further documents as referenced in this Works Information.
- All transport, off-loading and storage on Site, rigging where needed and moving equipment into the final positions on Site.
- Obtaining of all permits to work from all applicable local and/or national authorities, including Transnet, Eskom, Sunrise Energy and all other 3rd party stakeholders. The servitude agreements and wayleave agreement shall be arranged by the Employer.
- Dealing with, removal and relocation of existing services as required or as specified.
- Site facilities required for the *works*, including offices, storage, temporary (builders) power, transport and the like.
- All quality control activities and supervision of the *works* during all phases of the project implementation period.
- The programming and integration of all local protection and metering, including electrical interlocking, associated monitoring and control systems, building access control and intruder alarm, fire detection, UPS, VOIP telephone systems, HVAC, fire suppression and the like as required. The programming of the main remote I/O device inside each respective substation, including the overall port SCADA systems, to incorporate the aforementioned local systems shall be undertaken by Others.
- The programming and integration of all the respective equipment shall include the development, in conjunction with the *Employer*, of the final requirements and functionality for monitoring, control, logic and integration of the entire systems. The *Contractor* shall make due allowances for these *works* in the tender rates. Additional payments will not be made for costs resulting from any omissions, additions or time required for programming, integration and subsequent re-iterations, as described in the contract.
- Cold and hot commissioning of all new infrastructure.

The *Contractor* shall appoint specialist subcontractors and/or OEMs, to be approved by the *Employer*, to execute the following *works*:

- Installations of outstanding infrastructure (including 6.6 km of underground optical fibre) and commissioning of 66 kV overhead line from Eskom Blouwater substation to Iscor substation and Ystervark /new Main Intake Substation. The foundations and masts have already been installed on-site.
- Detailed designs, supply and installation of new protection and metering infrastructure at the new substations, including calculation of protection settings (settings study), all electrical interlocking and complete integration with other associated systems, excluding the detailed designs of the new protection and metering infrastructure at Eskom's new 'Ystervark' 132 kV control building and existing Blouwater and Iscor substations, which will be in accordance with established Eskom standards and using Eskom National Contract Schemes (ENCs).
- Detailed designs, supply and installation of the respective new main electronic monitoring and control infrastructure, with associated equipment, including complete integration with other associated systems. Any monitoring and control/SCADA infrastructure required at Eskom's new 'Ystervark' 132 kV control building or Blouwater or Iscor substations shall

not require any detailed designs but shall be in accordance with Eskom's standards and using Eskom National Contract Schemes (ENCs).

- Detailed design, supply and installation of the VOIP telephone systems. The *works* shall be undertaken by the same specialist subcontractor/OEM responsible for the main electronic monitoring and control infrastructure.
- Detailed design, supply and installation of all electronic security systems. The *works* shall be undertaken by the same specialist subcontractor/OEM responsible. Any electronic security systems that may be required at Eskom new 'Ystervark' 132 kV control building and/or outdoor yard shall be to their requirements.
- Detailed designs, supply and installation of the new substations buildings access control and intruder alarm systems. This shall also include integration with other associated infrastructure/systems. Any electronic security systems that may be required at Eskom's new 'Ystervark' 132 kV control building shall be to their requirements.
- Detailed designs, supply and installation of the new substations buildings fire detection systems, including integration with other associated systems. Due cognisance shall also be given to the Fire Safety Design Report, forming part of the contract documentation, and any associated requirements thereof. Note: The specialist subcontractor/OEM shall be registered with SAQCC (fire) as an accredited designer, installer, tester, commissioner etc. of fire detection equipment.
- Detailed designs, supply and installation of all new UPS systems at the substations buildings, as well as complete integration with other systems, including the supply and installation of a BTU at the new Eskom 132 kV control building, in accordance with Eskom's requirements and using Eskom National Contract Schemes (ENCs).
- Detailed designs, supply and installation of lightning protection systems for the substations, including testing the entire earthing and lightning protection systems by a SANS accredited/certified specialist subcontractor/ OEM (The specialist subcontractor/OEM should also preferably be a member of the Earthing and Lightning Protection Association (ELPA)). This shall include the undertaking and compilation of a comprehensive lightning risk assessment (to be provided as a report to the *Employer*), as well as taking soil resistivity tests and provision of the results in report format to the *Employer*. Note: The specialist subcontractor/OEM shall be certified by SANS as an accredited designer, fabricator, installer, tester, and maintainer of earthing and lightning protection systems with no exclusions.
- Detailed designs, supply and installation of all electrical and communications infrastructure for the HVAC installations at the new substation buildings, and fire suppression systems.
- Detailed designs, supply and installation of 400V encapsulated busbar system from 3.15MVA 11kV/400V transformer to 400V Low Voltage distribution board in the Tippler 3 building.

All equipment which will be integrated with the port SCADA system shall be fully compatible with this system.

The *Contractor* shall appoint a rehabilitation specialist subcontractor, to be approved by the *Employer*, for the rehabilitation of areas impacted upon through its construction related activities, as prescribed in the environmental management programme. Consequently, the *Contractor's* attention is drawn to its requirement to prevent or reasonably avoid adverse environmental impacts, and strengthen the positive environmental benefits of the development.

This due to Section 28 (1) of the National Environmental Management Act (Act No. 107 of 1998) placing a Duty of Care on those who cause, have caused or may in future cause significant pollution or degradation of the environment.

The *Contractor* shall therefore appoint such specialist subcontractor to undertake a search and rescue operation, prior to the commencement of site clearance, to collect suitable and representative samples of conservation worthy species.

These shall be maintained and propagated by the *Contractor* in a nursery for the duration of construction; where after these shall be planted by the specialist subcontractor within areas identified by the *Employer* for rehabilitation. Areas rehabilitated shall provide for homogenous representativity of the surrounding vegetation.

Further additional *works* shall include the

- Supply and installation of new permanent 400/230 V electrical connections for the New Haul Road Security Building, Existing South Rail Shunt Control Building, New North Rail Shunt Control Building and existing SAX-A cubicle, from the new dedicated field supply distribution kiosks provided by Others, unless otherwise instructed by the *Employer*.
- Supply and installation of complete new fibre optic connection link between the new CV 309 Drive Station's respective patch panel (by Others) and the new Haul Road Security Building.

The scope of information to be provided by the *Contractor* shall include, but is not limited to:

- Type and routine tests, including provision of certificates for equipment.
- FAT and SAT tests, including the provision of certificates for the equipment.
- Shop drawings.
- Detailed schematics and any applicable other associated drawings.
- Data sheets and associated detailed specifications of equipment.
- Operations and maintenance manuals.
- Detailed designs and calculations. The native software files for any detailed design calculations undertaken in software programmes shall also be provided to the *Employer* for verification purposes. Accepted software programmes for detailed designs and calculation purposes shall include, but are not limited to, DigSilent, ReticMaster, Relux (for lighting), CDEGS, CSC Orion, PROKON & Robot Structural Analysis Pro, PLS CADD and PLS Poles. The *Employer* reserves the right to request any additional calculations by the *Contractor* as required, and where instructed by the *Employer* to be done in other, additional software programmes for verification of detailed designs and calculations. The *Contractor* shall allow for the aforementioned in the tender rates.
- As-built drawings in hard and soft copies ('rvt', 'dgn', 'dxf', 'dwg' and 'PDF' formats.)
- Any other as-built documentation as required by the *Employer*.
- Other information required for the completion of engineering design reviews.
- Lighting protection designs and Lightning risk assessment report. [Soil resistivity reports are available]
- Critical and routine spare part lists.
- Equipment guarantees/warrantees.
- Cable schedules.
- Applicable systems software and licenses, including all final programming of equipment on CD-ROMs.
- Testing and measuring equipment calibration certificates.
- All testing and commissioning certificates.
- Detailed designs and method statements for horizontal directional drilling.

In addition to the above, the *Contractor* shall submit and implement designs, method statements, work procedures and the like, in accordance with the requirements of the Works Information, including, but not limited to:

- Project execution plan and detailed method statements, taking into account all applicable Eskom regulations and specifications, including development and implementation of further procedures.
- Health and safety plans and procedures.
- Environmental management plans and procedures.

- Quality management procedures and processes, including inspection and test plans (ITPs) for the off-Site fabrication and on-Site installation of equipment, with nominated “Hold” and “Review” points.
- Document control procedures.
- Engineering management plans for all aspects of the design and engineering *works*.
- Communication procedures, including attendance at meetings and engineering design review processes.
- Procedures for the management, design, fabrication, pre-assembly, transport of the equipment, off-loading, rigging, erection and commissioning.
- Logistics management. The Contractor shall note that some of the materials will be “free-issued”.
- Pre-commissioning and commissioning (‘cold’ and ‘hot’) procedures, including operating manuals and assistance.
- Functional specifications for the operation and control of the equipment.
- Accommodation of traffic.
- Dealing with water on the Site.

Close coordination will be required with Others, including, but not limited to:

- Eskom, for the new 66 kV overhead branch line and the portions of the Main Intake Substation that will ultimately be owned, managed and operated by Eskom, as well as those portions of the *works* to be undertaken at their existing Blouwater and Iscor substations and the new OPGW to be installed on the existing Blouwater-Iscor 66 kV overhead line.
- Sunrise Energy, Eskom and the *Employer*, to coordinate access to the Site for the Main Intake Substation off Main Road MR559 and further *works* along the northern Site boundary.
- Representatives of the ultimate owners of the facilities, including TFR, TPT and TNPA.
- Local authorities, third parties and government officials, engaged in the execution of their statutory obligations.
- Liaison and training of operating staff, as described in the applicable specifications.
- Liaison with independent engineer appointed by the *Employer* to review engineering designs.
- Full cooperation, coordination and furnishing of any technical support and associated information to all Others engaged by the *Employer* as part of the Tippler 3 project. This shall include Others to be appointed by the *Employer* to undertake the overall port SCADA programming, to ensure the required integration of the respective buildings and installations with the centralized monitoring and control systems.

Further detailed descriptions of the *works* and further requirements are provided below.

1.3 HV and MV Installations

1.3.1 General Description : Existing and New Bulk Electrical Systems

Fig 1 overleaf provides a high-level diagrammatical representation of the existing and new bulk electrical systems, which include the following main elements.

i. *Eskom Iscor Substation*

The Eskom Iscor Substation, located immediately north of the port boundaries and to the east of the incoming rail lines and roads, currently provides electrical power at 11 kV to the port. The substation will in future feed the adjoining Sunrise Energy facilities once these are commissioned.

The Iscor substation is currently fed by the two Eskom owned single circuit Blouwater-Iscor 66 kV overhead lines. The high-level scope of work to be undertaken by the contractor as detailed in the bill of quantities allowed for under the PC Amount Section for the 66kV T Off, shall be as follows:

- Installation of 2 x 66kV circuit breakers.
- Installation of 6 x 66kV Voltage Transformers (VT's) in the existing transformer-feeder bays
- Installation of two new 4FZD3920 protection scheme with the 3 terminal differential protection option included.
- Modification of the existing transformer protection schemes for both transformers to ensure the tripping of the new 66 kV circuit breakers.
- Label changes on the protection panels and respective outdoor HV equipment of the 2 x 66 kV feeders, to ensure the current naming convention of 'Blouwater' is changed to Blouwater/Ystervark TEE

The contractor shall refer to Eskom approved final design packages, 1924701-2-300-RPT-007 (Eskom reference number 153272156-0004) revision 1, and Addendum Number 1 Revision 2 pertaining to details of the above-mentioned scope of work.

ii. *Eskom Blouwater Substation*

The Eskom Blouwater Substation currently feeds, amongst other loads, the Iscor Substation via the existing Blouwater-Iscor 66kV overhead lines. Both existing Blouwater-Iscor 66 kV feeder lines have 4FZD3920 protection schemes installed. The line differential protection function within the ABB RED 670 protection relays, installed in the schemes, is used as unit protection for the lines.

The high-level scope of work to be undertaken by the contractor as detailed in the bill of quantities, shall be as follows:

- An additional fibre communication card for each feeder protection panel's ABB RED 670 relay must be installed. ABB have indicated that these additional cards have to be supplied, installed and initialised on site by them.
- Label changes will also be undertaken on the protection panels and respective outdoor HV equipment of the 2 x 66 kV feeders, to ensure the current naming convention of 'Iscor' is changed to Iscor/Ystervark TEE.

The contractor shall refer to Eskom approved final design package, 1924701-2-300-RPT-005 (Eskom reference number 153272156-0002) revision 2, pertaining to details of the above-mentioned scope of work.

iii. *Existing Substations*

The Eskom Iscor substation currently provides 11 kV feeds to Substations A and H within the port area.

Substation A includes step-down transformers (11 kV to 3.3/0.4 kV) and feeds Substations J and K, as well as Substation D at Tippler 1 and the 11 kV Switchgear Room at Tippler 2. This substation also provides power to other downstream installations.

Substation H includes step-down transformers (11 kV to 3.3/0.4 kV) and feeds Substation J and the 11 kV Switchgear Room at Tippler 2, as well as other downstream installations.

iv. *New Substations*

The *works* to be undertaken by the *Contractor* include the provision of a new Main Intake Substation (including new Eskom 'Ystervark' portion), located near existing Substation H, new Substation M, located near the new Tippler 3 buildings, and Substation N, located nearer to the port and iron ore stockpile area.

The Main Intake Substation will include the new incoming 66 kV lines, 132/66/11 kV transformers and all other associated electrical infrastructure. This substation will feed the existing Substations A, H, J and K, as well as new Substations M and N.

Tables 1 and 2 below summarize the reconfiguration of the bulk electrical supply to the existing and new port facilities, as shown in Fig 1. The *Contractor* shall, upon the outset of the *works*, provide a detailed plan of execution for the switch-overs and hook-ups to the existing and new substations, for review and approval by the *Employer.*

This plan shall include detailed safety measures and steps to be taken to minimise or eliminate as far as reasonably possible any disruptions to the ongoing port operations. It shall be noted that some of the associated *works* may only be executed during the annual shutdown, which usually occurs between the months of August and October.

1.3.2 Main Intake Substation

The Main Intake Substation will include all facilities and installations that are required to receive electrical power from the existing Eskom network, initially at 66 kV, but with allowances for future upgrades to 132 kV, and for the downstream distribution of MV power (11 kV) to the new Substations M and N.

Portions of the new Main Intake Substation will be owned, operated and maintained by Eskom and portions of the substation will be controlled by TNPA. The boundary between the two parts of the substation is to be demarcated by fence lines around and within the Site, as shown on the drawings. The substation will include both outdoor facilities and indoor installations.

Parts of the substation that will be owned and operated by Eskom (Ystervark) are designed and shall be constructed in accordance with the applicable Eskom standards and specifications and using Eskom National Contract Schemes (ENCs).

The Site for the New Main Intake Substation is located within the *Employer's* property near the port, to the east of the incoming rail lines and roads to the port area. The northern side of the substation Site extends up to the boundary of an adjoining Sunrise Energy property.

A schematic layout of the HV and MV installations for the Main Intake Substation is shown in Fig 2 overleaf.

The station includes the following main sections, described in further detail below:

- Eskom section, which will include the existing 66 kV incomers and busbars, with provision made for the future 132 kV feeds and other associated electrical infrastructure.
- Transformer yard and other associated electrical systems, which will be owned and operated by the *Employer*.
- 11 kV switchgear and associated systems, located indoors within the switch house, which will also be owned and operated by the *Employer*.

i. *Eskom Section*

Allowance is made for two 66 kV feeds to be installed immediately as part of the *works*. Provision is also made for two future 132 kV feeders. Spatial allowances are made for further electrical infrastructure to be installed in the future.

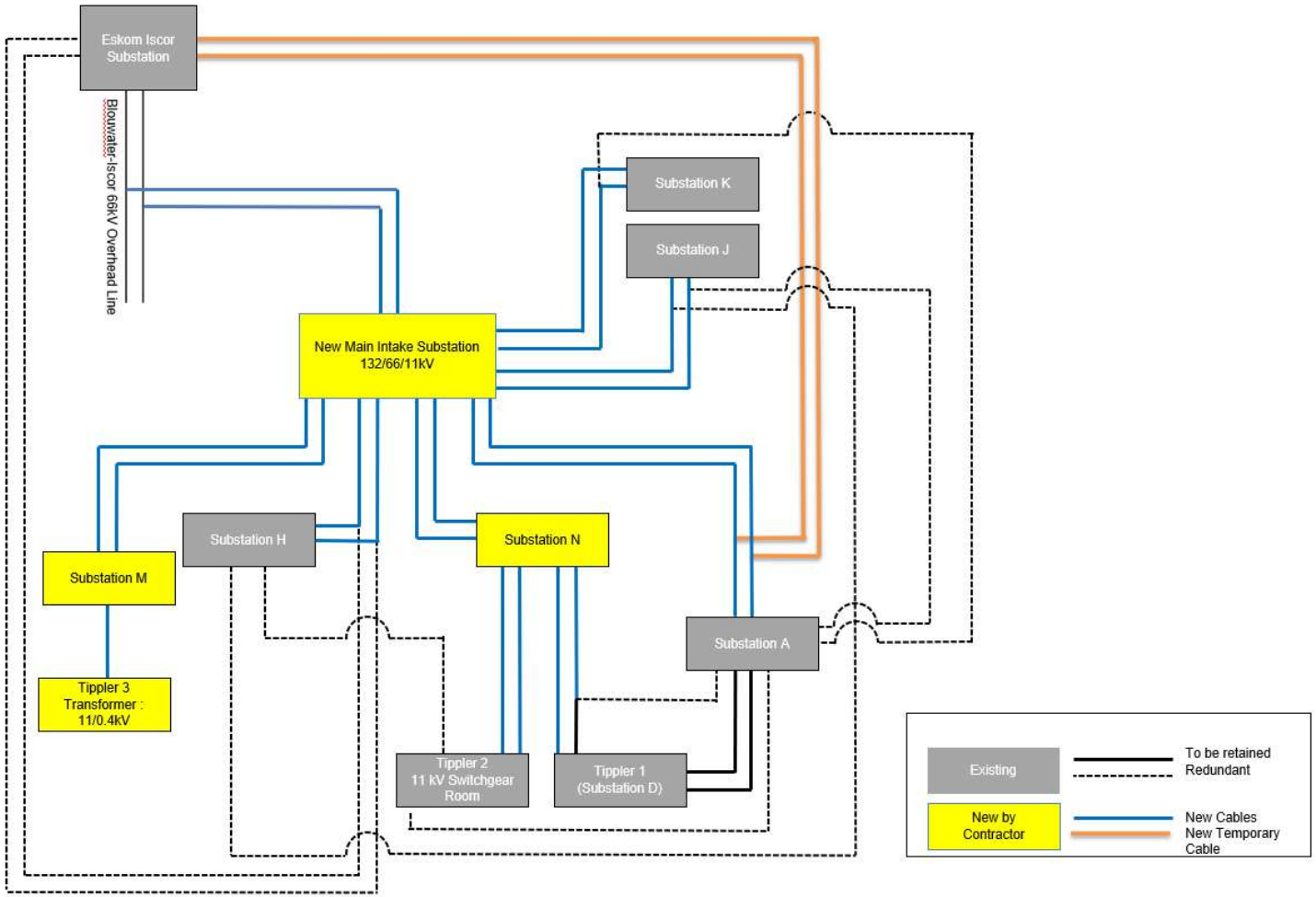

Eskom Iscor Substation
Blouwater-Iscor 66kV Overhead Line
Substation K
Substation J
New Main Intake Substation 132/66/11kV
Substation H
Substation N
Substation M
Substation A
Tippler 3 Transformer : 11/0.4kV
Tippler 2 11 kV Switchgear Room
Tippler 1 (Substation D)
Existing
To be retained
Redundant
New by Contractor
New Cables
New Temporary Cable

TABLE 1 : MV AND LV CABLE LINKAGES : BETWEEN EXISTING SUBSTATIONS/SWITCHGEAR ROOMS

From	To	Existing Cables	Notes
Iscor Substation	Substation A	2 No 3 x 3C x 240mm^2 11 kV Cu SWA XLPE	Portions of the existing cables will become redundant once new feeds from the new Main Intake Substation have been commissioned. The *Contractor* will not be required to remove these redundant existing cable portions, unless otherwise instructed by the *Employer* during construction. New 2 No 3 x 3C x 240mm² 11 kV Cu SWA XLPE cables were installed to feed Substation A from Iscor Substation, however, from the portion between Main Intake substation and Iscor substation this installation is "temporary" until MIS is fully complete, then the contractor shall re-route these cables to Main Intake Substation. Upon final commissioning, the New MIS Substation shall supply existing Substation A and the new cables shall be rerouted to NMIS. New 2 No 1 x 3C x 120mm^2 11 kV Cu SWA XLPE cables were installed. All new feeds for the Substations A and H shall be from the new Main Intake Substation.
	Substation H	2 No 1x 3C x 95-120mm^2 11 kV Cu SWA XLPE	
Substation A	Tippler 1 : (Substation D)	1 No 1 x 3C x 120mm^2 11 kV Cu SWA XLPE	Cable to remain in operation
		1 No 5 x 4C x 185mm^2 Cu PVC SWA PVC	Cables to remain in operation
		1 No 4C x 185mm^2 PVC SWA PVC	
	Tippler 2 11 kV Switchgear Room	1 No 1 x 3C x 120mm^2 11 kV Cu SWA XLPE	Cable to remain in operation
	Substation J	1 No 1 x 3C x 120mm^2 11 kV Cu SWA XLPE	Portions of the existing 11 kV feeder cable will become redundant once a new 1 x 3C x 120mm² 11 kV Cu SWA XLPE feeder cable, fed from the new Main Intake Substation, has been commissioned. The *Contractor* will not be required to remove the redundant existing cable portions, unless otherwise instructed by the *Employer* during construction.

TABLE 1 : MV AND LV CABLE LINKAGES : BETWEEN EXISTING SUBSTATIONS/SWITCHGEAR ROOMS

From	To	Existing Cables	Notes
	Substation K	1 No 1 x 3C x 240mm² 11 kV Cu SWA XLPE	Portions of the existing 11 kV feeder cable will become redundant once a new 1 x 3C x 240mm² 11 kV Cu SWA XLPE feeder cable, fed from the new Main Intake Substation, has been commissioned. The *Contractor* will not be required to remove the redundant existing cable portions, unless otherwise instructed by the *Employer* during construction. A separate new 1 x 3C x 240mm² 11 kV Cu SWA XLPE feeder cable from the new Main Intake Substation shall also be provided for 11 kV power supply redundancy purposes.
Substation H	Substation J	1 No 1 x 3C x 240-120mm² 11 kV Cu SWA XLPE	Portions of the existing 11 kV feeder cable will become redundant once a new 1 x 3C x 120mm² 11 kV Cu SWA XLPE feeder cable, fed from the new Main Intake Substation, has been commissioned. The *Contractor* will not be required to remove the redundant existing cable portions, unless otherwise instructed by the *Employer* during construction.
	Tippler 2 (11 kV Switchgear Room)	1 No 1 x 3C x 120mm² 11 kV Cu SWA XLPE	Cable to remain in operation

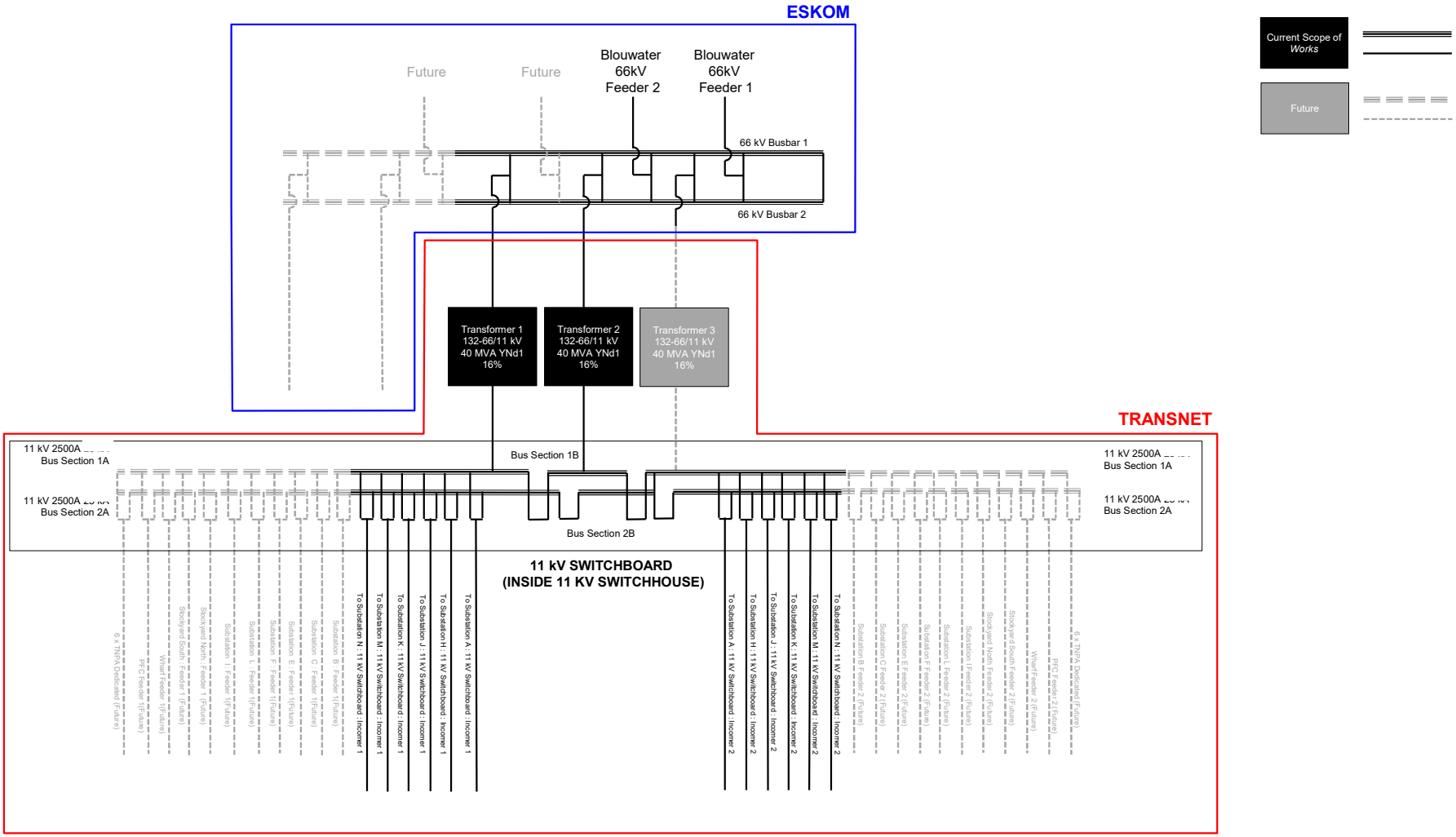
TABLE 2 : NEW MV CABLE LINKAGES : MV BETWEEN NEW SUBSTATIONS/SWITCHGEAR ROOMS

From	To	New Cables	Notes
New Main Intake	Substation A	2 No 3 x 3C x 240mm^2 11 kV Cu SWA XLPE	New 2 No 3 x 3C x 240mm² 11 kV Cu SWA XLPE cables shall be supplied and installed to feed Substation A. Normal fire retardant, self-extinguishing cable type shall be installed for cross-country, below ground. Owing to the fact the new cables were installed between Iscor SS and Substation A, ahead of Main Intake Substation being commissioned, and passing in close proximity thereto, the contractor shall reclaim and re-route these cables into Main Intake Substation. The *Contractor* shall work with the *Employer* in order to develop an appropriate method statement to undertake this change over, with minimal interruption to supply Substation A.
	Substation H	2 No 1 x 3C x 120mm^2 11 kV Cu SWA XLPE	New 2 No 1 x 3C x 120mm² 11 kV Cu SWA XLPE cables shall be supplied and installed to feed substation H. Normal fire retardant, self-extinguishing cable type shall be installed for cross-country, below ground.
	Substation J	2 No 1 x 3C x 120mm^2 11kV Cu SWA XLPE	New 2 No 1 x 3C x 120mm² 11 kV Cu SWA XLPE cables shall be supplied and installed to feed Substation J. Normal fire retardant, self-extinguishing cable type shall be installed for cross-country, below ground. NB: The portion of new cables has been installed from outside substation J building to just before substation N.
	Substation K	2 No 1 x 3C x 240mm^2 11 kV Cu SWA XLPE	New 1 x 3C x 240mm² 11 kV Cu SWA XLPE cable shall be connected at a certain point onto the existing cable feeding Substation K. A separate new 1 x 3C x 240mm² 11 kV Cu SWA XLPE feeder cable shall also be provided for 11 kV power supply redundancy purposes, and connect onto the existing spare incomer circuit breaker at Substation K. NB: The portion of new cables has been installed from outside substation K building to just before substation N. Normal fire retardant, self-extinguishing cable type shall be installed for cross-country below ground cables. A separate normal fire retardant, self-extinguishing below ground cable shall be taken and connected straight onto the spare incomer circuit breaker at Substation K.
	New Substation M	2 No 1 x 3C x 240mm^2 11 kV Cu SWA XLPE	New 2 No 1 x 3C x 240mm^2 11 kV Cu SWA XLPE feeder cables shall be provided for 11 kV power supply redundancy purposes to Substation M. Normal fire retardant, self-extinguishing cable type shall be installed for cross-country, below ground cables. NB: The portion of the cables has been installed from the vicinity of CV035 Dust Suppression plant (at the corner of the fence boundary) to the vicinity of Mini substation No 2.

TABLE 2 : NEW MV CABLE LINKAGES : MV BETWEEN NEW SUBSTATIONS/SWITCHGEAR ROOMS

From	To	New Cables	Notes
	New Substation N	2 No 1 x 3C x 185mm^2 11 kV Cu SWA XLPE	New 2 No 1 x 3C x 185mm^2 11 kV Cu SWA XLPE feeder cables shall be provided for 11 kV power supply redundancy purposes to Substation N. Normal fire retardant, self-extinguishing cable type shall be installed for cross-country, below ground cables.
Substation M	Tippler 3 Transformer Room	1 No 1 x 3C x 120mm^2 11 kV Cu SWA XLPE	New 1 No 1 x 3C x 120mm^2 11 kV Cu SWA XLPE feeder cable shall feed the Tippler 3 local main 11/0.4kV transformer. Normal fire retardant, self-extinguishing cable type shall be installed for cross-country, below ground cables.

FIG 2 : SCHEMATIC : HV AND MV SYSTEMS : MAIN INTAKE SUBSTATION



The Eskom and *Employer* (Transnet) portions of the new Main Intake Substations will be separated by means of an isolator on either side of the fence, with an interface junction box(es) installed to allow for control cabling between the substations. The contractor shall refer to Eskom approved final design package, 1924701-2-300-RPT-0006 (Eskom reference number 153272156-00003) revision 2 pertaining to details of the Ystervark substation scope of work.

All equipment shall be rated for a voltage level of 132 kV, excluding the voltage transformers and surge arrestors, which will be upgraded when the incoming voltage is changed from 66 kV to 132 kV. All applicable outdoor equipment shall have a 31 mm/kV creepage distance.

Standard Eskom design philosophies were used for the design of Eskom's 'Ystervark' portion of the new Main Intake Substation. This includes the safe electrical and working clearances as set forth by Eskom. The substation will make use of low level tubular busbars, which shall consist of a double busbar arrangement with a bus coupler installed.

The main HV equipment to be installed within the Eskom 'Ystervark' portion of the substation, upstream and downstream of the 66 kV Eskom busbars, shall include, but is not limited to, the items as listed below. Only Eskom approved equipment is to be used within the Eskom 'Ystervark' portion of the substation, and at specific areas where so specified.

TABLE 3 : HV EQUIPMENT : ESKOM 'YSTERVARK' PORTION

Item	Description
Tubular Busbars	120mm (outer dia.) x 112mm (inner dia.) x 4mm wall thickness, 12,2m long aluminium tube busbar, with current rating of 2300 A shall be installed.
Centipede Conductors	Centipede conductors are to be installed for the stringing of the 66 kV feeder and transformer bays.
Bull Conductors	2 x Bull conductors are to be installed for the 66 kV bus coupler bay.
132 kV Post Insulators	132 kV Post insulators are to be installed on the HV equipment supports and tubular busbar supports where needed.
132 kV 2500A Isolators	132 kV hand operated, 3-pole, centre rotate double break, 2500 A, 40 kA, isolators are to be installed for the 66 kV line, busbar and bus coupler isolators. The line isolators are to have a surge arrestor bracket mounted on the substation side.
132 kV 2500A Inline Isolators	132 kV hand operated, 3-pole, centre rotate double break, 2500 A, 40 kA, inline isolators are to be installed for the 66 kV busbar isolators where needed.
132 kV 2500A Motorised Isolators	132 kV hand operated/motorised, 3-pole, centre rotate double break, 2500 A, 40 kA, isolators are to be installed for the 132-66/11 kV transformers isolation between the Eskom and *Employer* portions of the substation.
132 kV Circuit Breakers	132 kV, 3150 A, 40 kA, 3-pole circuit breakers are to be installed where indicated.
66 kV Surge Arrestors	66 kV surge arrestors are to be mounted on the line isolators on the substation side.
132 kV Current Transformers	132 kV, 2500 A, 40 kA, current transformers, with 6 cores (2 x Protection: 2400/1 MR, 2 x Buszone:

	1600/1 MR, 2 x Meter: 2400/1 MR) shall be installed where indicated.
66 kV Power Voltage Transformers (PVT)	66/0.4 kV Power voltage transformers with a 2500 VA rating are to be installed on the 66 kV busbars.
66 kV Voltage Transformers (VT)	66/0.11 kV VTs with a 100/50 VA and class 3P/0.2 rating are to be installed on the 66 kV busbars.

ii. *Transformer Yard (Employer)*

The *Employer's* transformer yard will consist of two fully equipped transformer bays and space allocation for one future transformer bay. The following, but not limited to, main HV and MV equipment is to be installed within the outdoor transformer yard, which will be owned and operated by the *Employer*.

TABLE 4: HV & MV EQUIPMENT : TRANSFORMER YARD

Item	Description
Centipede Conductors	Centipede conductors are to be installed for the stringing of the 66 kV transformer bay sides.
Bull Conductors	2 x Bull conductors are to be installed for the 11 kV transformers bay sides.
132 kV 2500 A Isolators	132 kV hand operated, 3-pole, centre rotate double break, 2500 A, 40 kA, isolators are to be installed for the 66 kV transformer side isolators.
132 kV Outdoor Type Circuit Breakers	132 kV, 3150 A, 40 kA, 3-pole circuit breakers are to be installed in the 66 kV transformer bays.
132 kV Current Transformers (CT)	132 kV, 2500 A, 40 kA, current transformers, with 6 cores (2 x Protection: 2400/1 MR, 2 x Buszone: 1600/1 MR, 2 x Meter: 2400/1 MR) shall be installed where indicated.
66 kV Surge Arrestors	66 kV surge arrestors are to be mounted on the transformers.
66 kV Post Insulators	66 kV Post insulators are to be installed on the 11 kV equipment supports and cable sealing end supports where needed.
132-66/11 kV 40 MVA type YNd1 Transformers	132-66/11 kV 40 MVA YNd1, 16% impedance, dual primary winding outdoor transformers with vacuum OLTS's.
11 kV NEC/NER Auxiliary Transformers.	11 kV, 360 A, combined three phase electro-magnetic couplers with neutral earthing resistors as well as 11/0.4 kV 315 kVA Dyn11 auxiliary transformers.
11 kV Surge Arrestors	11 kV surge arrestors are to be mounted on the transformers.

iii. *11 kV Switchgear*

The feeds from the transformers pass into the 11 kV Switch House to the indoor 11 kV switchboard incomer circuit breakers. The following, but not limited to, MV equipment is to be installed within the building.

TABLE 5: 11 KV SWITCHGEAR

Item	Description
11 kV Busbars	2500 A Double busbar SF_6 gas insulated system. All switchgear shall have a fault rating of 40 kA rating for 3 seconds and shall be internally arc type tested AFLR 40 kA for 1 second.
11 kV Circuit Breakers	11 kV fixed vacuum circuit breakers with a normal rated current of 2500 A for incomer and bus coupler (section) switchgear and 2000 A for feeder switchgear. All switchgear shall have a fault rating of 40 kA rating for 3 seconds and shall be internally arc type tested AFLR 40 kA for 1 second.
11 kV Three-way Switches	11 kV Three-way switches with normal rated current of 2500A for incomer and bus coupler (section) switchgear and 2000A for feeder switchgear. All switchgear shall have a fault rating of 40 kA rating for 3 seconds and shall be internally arc type tested AFLR 40 kA for 1 second.
11 kV Voltage Transformers (VT)	11/0.11 kV busbar 3-phase voltage transformers to be mounted on respective bus coupler (section) and feeder panels (if so required).

Provision is made for the immediate installation of dual 11 kV feeds to the following substations:

- Substation A.
- Substation H.
- Substation J.
- Substation K.
- Substation M.
- Substation N.

Allowances are also to be made for the following future dual 11 kV feeds:

- Substation B.
- Substation C.
- Substation E.
- Substation F.
- Substation L.
- Substation I.
- Stockyard North.
- Stockyard South.
- Wharf Feeder.

- Power Factor Correction.
- Dedicated feeds for other, future TNPA installations.

The switch-overs and hook-ups to the respective existing substations and buildings shall be executed as described in Section 1.3.1 and further outlined in Table 2.

The *Contractor* shall be responsible for the detailed design, supply and installation of MV equipment, including transformers, switchgear, isolators, post insulators, CTs, VTs and associated equipment at the new substations. The MV equipment shall be suitable for indoor and outdoor environments, as applicable.

iv. *Conductors and Insulators : Main Intake Substation*

All 132-66 kV feeder and primary transformer sides conductors shall will be centipede conductor. The busbars are to be 120mm (outer dia.) x 112mm (inner dia.) x 4mm wall thickness, 12,2m long aluminium tubes with centipede conductor installed 2/3 of the length of the tubes for anti-vibration purposes.

The 66 kV bus coupler and the transformer secondary 11 kV sides will make use of twin bull conductors. From the cable end supports, 24 x 1C x 630mm² Cu AWA XLPE will feed the 11 kV Switch House 11 kV indoor switchgear.

v. *Steel Supports: Main Intake Substation Yard*

Steel supports, fixed to concrete foundations, shall be provided for above-ground outdoor MV equipment and installations as shown on the drawings. Allowance has been made for various types of steel supports, as listed in Table 6 below.

TABLE 6 : EQUIPMENT SUPPORT TYPES

Equipment	Support Type
132 kV Incomers at entry point to substation	132 kV Gantries (columns and beam)
66 kV Voltage Transformers 132 kV Current Transformers	2.5m Lattice Steel Support with M1 Cap
132 kV Post Insulators	2.5m Lattice Steel Support with M3 Cap
66 kV Post Insulators	2.5m Lattice Steel Support with M2 Cap
132 kV Busbars	132 kV Twin Tubular Busbar Supports
132 kV Isolators	132 kV Isolator Lattice Support
132 kV Circuit Breakers	132 kV Circuit Breaker Tubular Support
11 kV NECRT	NECRT Support
11 kV Cable End	11 kV Cable End Support

The following further requirements shall apply:

- All steel to be Grade S355JR/350WA, except angles less than 45mm, which shall be mild steel.
- Structural use of steel shall conform to SANS 10162.
- All steelwork shall be fabricated, erected and levelled to a tolerance of ± 1.5mm.
- All welding and welding symbols shall conform to SANS 10044 Parts 1 to 5. All welds shall be seal welded.

- All steelwork shall be hot-dip galvanized to SANS 121.

The steel supports are to be founded on concrete footings, with the steel structures tied down with cast-in steel holding bolts. The holding-down bolts shall be tied to the earthmat, as shown on the drawings.

A concrete base shall also be provided for the transformers, which shall include drainage sumps, to be connected to the oil dam and trap, as shown on the drawings. A low-level bund wall is to be provided along the perimeter of the transformer area.

1.3.3 Substation M

Substation M, as shown schematically in Fig 3, will include all facilities and installations that are required to receive 11 kV electrical power from the new Main Intake Substation. The substation will serve as the primary source of electrical power to the substation building, the Tippler 3 building, Conveyors CV-308 and Transfer Tower TT-301, which form part of the overall Tippler 3 project, and other ancillary loads.

The 3.3 kV feed for the conveyor and transfer tower will be connected to VSDs, which are to be installed by Others within the substation building. Fig 4 indicates the battery limits between the installations to be undertaken by the *Contractor*, as part of the *works*, and installations to be done by Others, responsible for the conveyors and Tippler 3 building installations.

The scope of *works* also includes a new 11/0.4 kV transformer, to be installed by the *Contractor* within the new Tippler 3 building, together with the associated electrical and data/control cabling. The further downstream low voltage distribution boards within the Tippler 3 building will be installed and supplied by Others.

Allowance is made for a dedicated 11/0.4 kV transformer within the substation, to supply 400 V power supplies to the substation building, Conveyor CV-308 and Transfer Tower TT-301 low voltage infrastructure.

The substation will be operated and maintained by the *Employer*. The Site for the substation is located within the *Employer's* properties near the Tippler 3 building, on the eastern side of the corridor between the Haul Road and the ArcelorMittal conveyor to the port.

Table 7 provides a listing of the major MV equipment to be installed at Substation M. All of the equipment as listed will be installed indoors.

1.3.4 Substation N

Substation N, as shown schematically in Fig 5, will include all facilities and installations that are required to receive 11 kV electrical power from the Main Intake Substation. The substation will serve as the primary source of electrical power to the substation building, Conveyors CV-309 and CV-310 and Transfer Tower TT-302, which form part of the overall Tippler 3 project, and other ancillary loads.

The 3.3 kV feed for the conveyor and transfer tower will be connected to VSDs, which are to be installed by Others within the substation building. Fig 6 indicates the battery limits between the installations to be undertaken by the *Contractor*, as part of the *works*, and installations to be done by Others, responsible for the conveyors.

Allowance is made for a dedicated 11/0.4 kV transformer within the substation, to supply 400 V power supplies to the substation building, Conveyors CV-309 and CV-310 as well as Transfer Tower TT-302 low voltage infrastructure.

The substation will be operated and maintained by the *Employer*. The Site for the substation is located within the existing port boundaries, opposite Tipplers 1 and 2 and to the east of existing ArcelorMittal Conveyor CV-305.

Table 8 includes a listing of the major MV equipment to be installed at Substation N. All of this equipment will be installed indoors.

FIG 3 : SCHEMATIC : MV SYSTEMS : SUBSTATION M

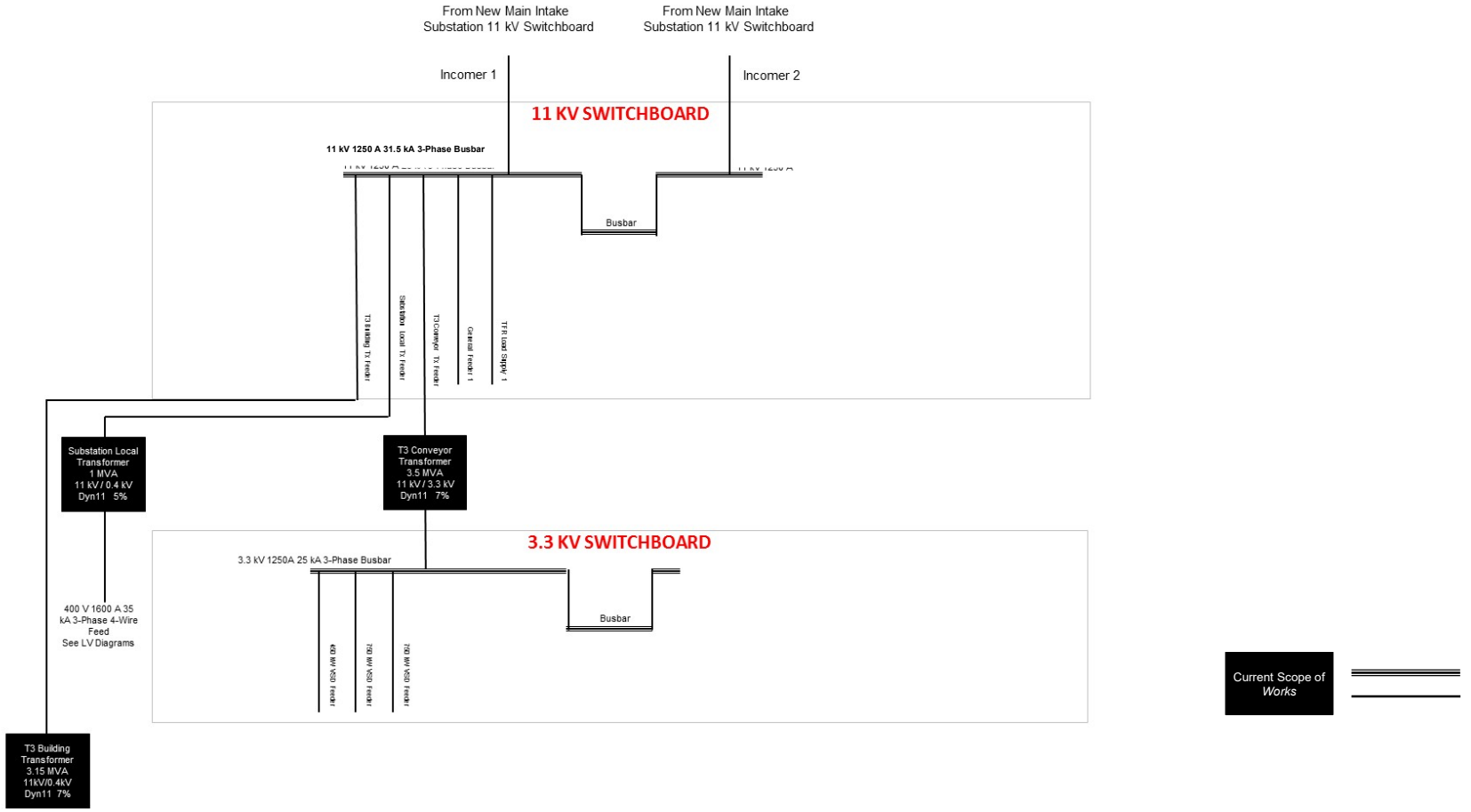


FIG 4 : BLOCK DIAGRAM : SUBSTATION M POWER SUPPLY BATTERY LIMITS BETWEEN *CONTRACTOR* AND OTHERS

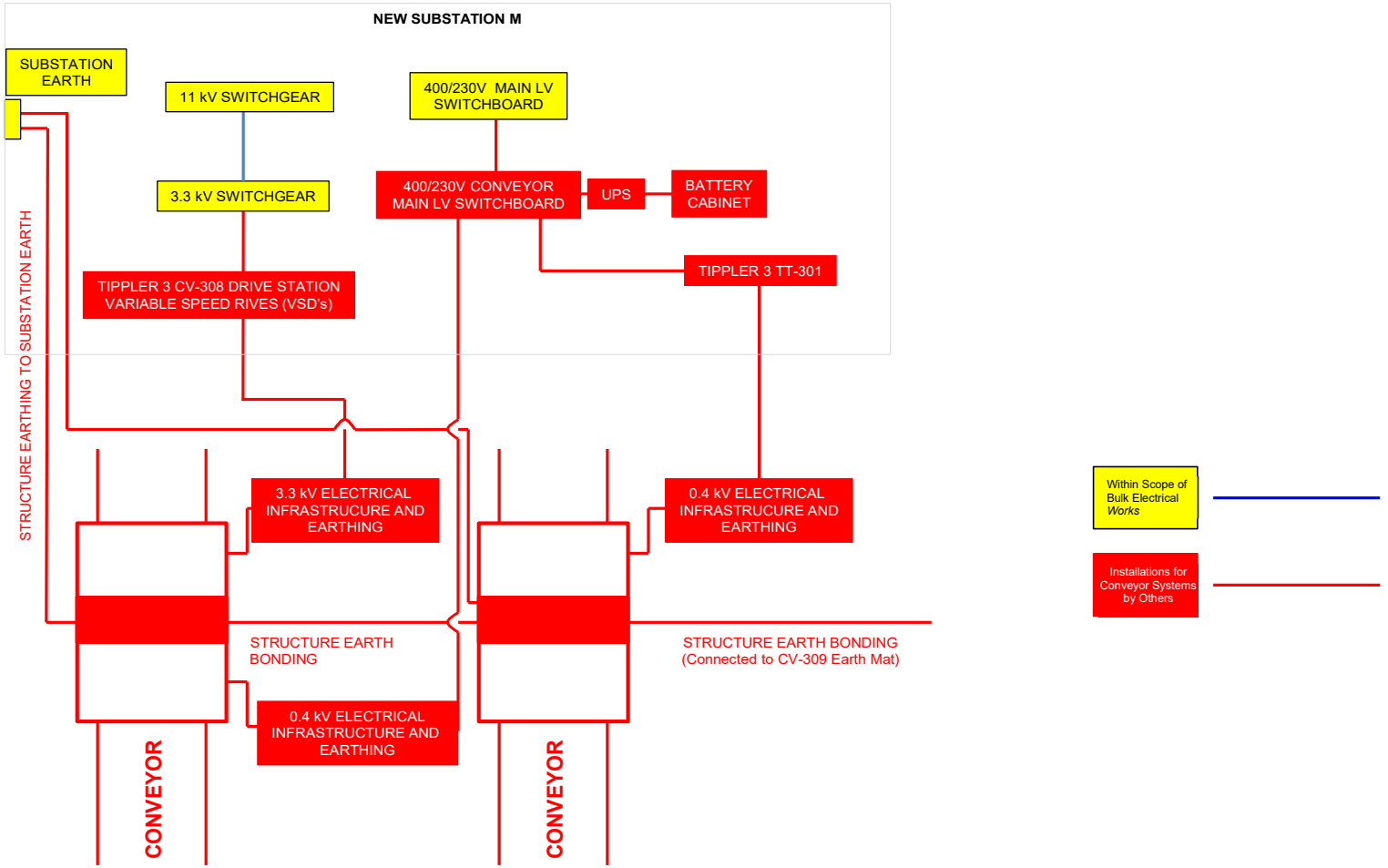


FIG 5: SCHEMATIC : MV SYSTEMS : SUBSTATION N

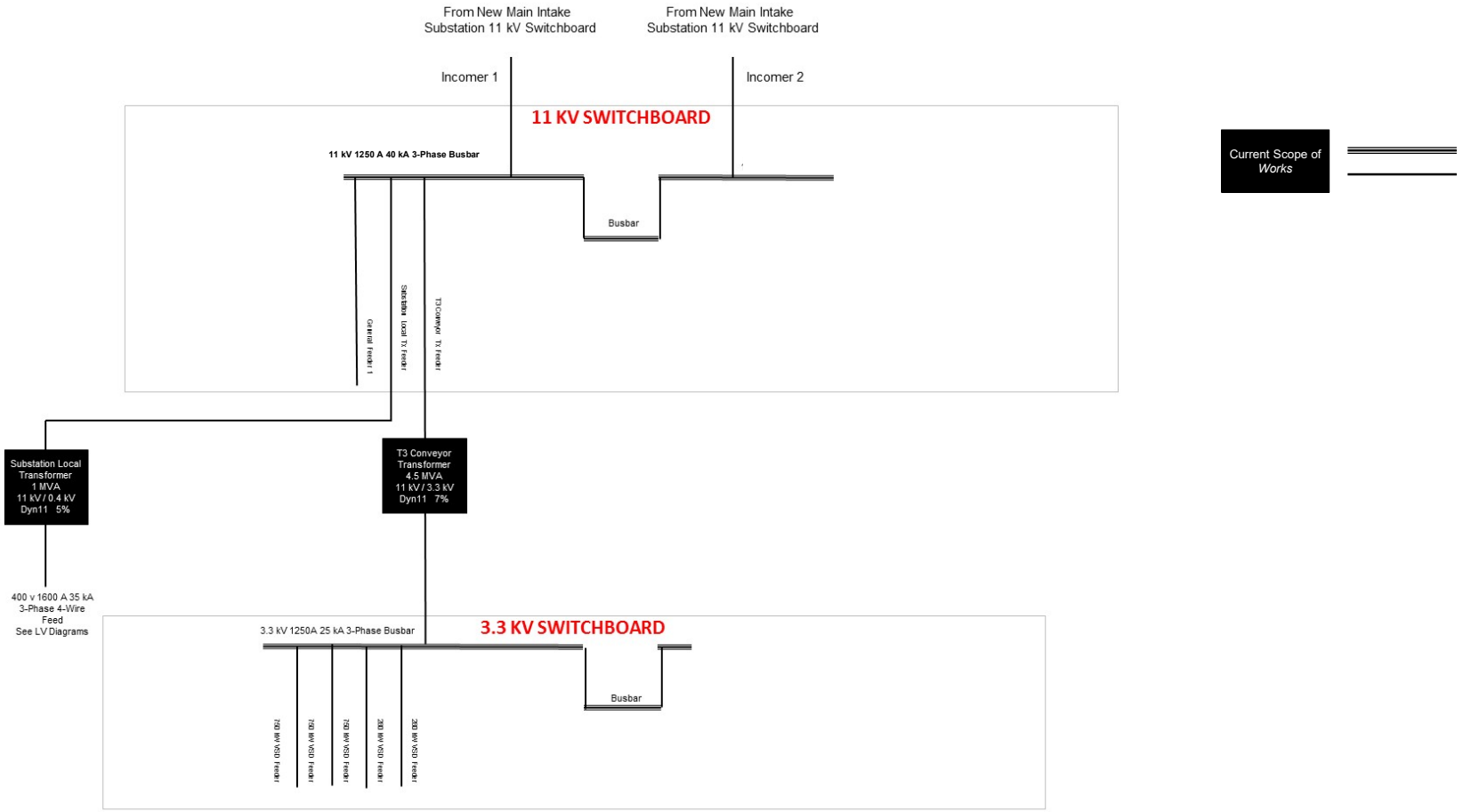


TABLE 7: SUBSTATION M - MV SWITCHGEAR AND TRANSFORMERS

Item	Description
SUBSTATIONS M: SWITCHGEAR	
11 kV Busbars	1250 A Single busbar SF_6 gas insulated system. All switchgear shall have a fault rating of 31.5 kA for 3 seconds and shall be internally arc type tested AFLR 31.5 kA for 1 second.
11 kV Circuit Breakers	11 kV Fixed vacuum circuit breakers with a normal rated current of 1250 A for incomer and bus coupler (section) switchgear and 630 A for feeder switchgear. All switchgear shall have a fault rating of 31.5 kA for 3 seconds and shall be internally arc type tested AFLR 31.5 kA for 1 second.
11 kV Three-way Switches	11 kV Three-way switches with normal rated current of 1250 A for incomer, bus coupler (section) and riser panel switchgear and 630 A for feeder switchgear. All switchgear shall have a fault of rating 31.5 kA for 3 seconds and shall be internally arc type tested AFLR 31.5 kA for 1 second.
3.3 kV Busbars	1250 A Single busbar SF_6 gas insulated system with a 25 kA fault rating for 3 seconds. All switchgear shall have a fault rating 25 kA for 3 seconds and shall be internally arc type tested AFLR 25 kA for 1 second.
3.3 kV Circuit Breakers	11 kV fixed vacuum circuit breakers with a normal rated current of 1250 A for incomer and bus coupler (section) switchgear and 630 A for feeder switchgear. All switchgear shall have a fault rating of 25 kA for 3 seconds and shall be internally arc type tested AFLR 25 kA for 1 second.
3.3 kV Three-way Switches	Three-way switches with normal rated current of 1250 A for incomer, bus coupler (section) and riser panel switchgear and 630 A for feeder switchgear. All switchgear shall have a fault rating of 25 kA for 3 seconds and shall be internally arc type tested AFLR 25 kA for 1 second.
11 kV Voltage Transformers	11/0.11 kV busbar 3-phase voltage transformers to be mounted on respective bus coupler (section) and riser panels.
3.3 kV Voltage Transformers	3.3/0.11 kV busbar 3-phase voltage transformers to be mounted on respective bus coupler (section) panel.
SUBSTATION M: TRANSFORMERS	
T3 Conveyor Transformer	11/3.3 kV, 3.5 MVA, Dyn11, 7% dry-type transformer with enclosure. OCTS +5% -5% with 2.5% voltage per tap.
Substation Local Transformer	11/0.4 kV, 1 MVA, Dyn11, 5% dry-type transformer with enclosure. OCTS +5% -5% with 2.5% voltage per tap.

TABLE 7: SUBSTATION M - MV SWITCHGEAR AND TRANSFORMERS

Item	Description
T3 Building Transformer	11/0.4 kV, 3.15 MVA, Dyn11, 7% dry-type transformer with enclosure. OCTS +5% -5% with 2.5% voltage per tap. Note: Additional requirements pertaining to transformer unit protection and local LV supply apply. Refer to specifications, drawings and/or BoQ for further details.

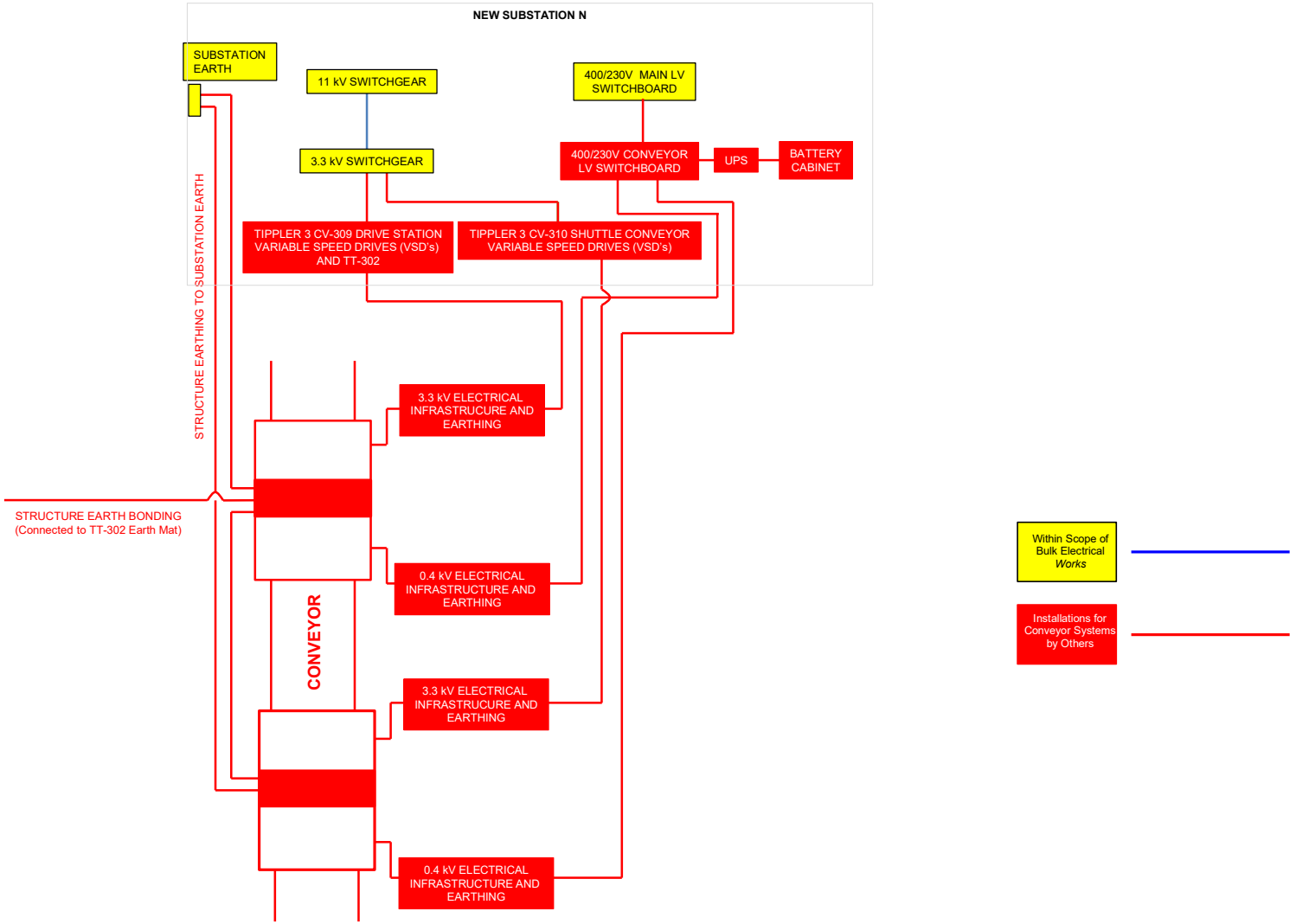
TABLE 8 : SUBSTATION N MV SWITCHGEAR AND TRANSFORMERS

Item	Description
SUBSTATIONS N: SWITCHGEAR	
11 kV Busbars	1250 A Single busbar SF_6 gas insulated system. All switchgear shall have a fault rating of 40 kA for 3 seconds and shall be internally arc type tested AFLR 40 kA for 1 second.
11 kV Circuit Breakers	11 kV fixed vacuum circuit breakers with a normal rated current of 1250 A for incomer and bus coupler (section) switchgear and 630 A for feeder switchgear. All switchgear shall have a fault rating of 40 kA for 3 seconds and shall be internally arc type tested AFLR 40 kA for 1 second.
11 kV Three-way Switches	11 kV Three-way switches with normal rated current of 1250 A for incomer, bus coupler (section) and riser panel switchgear and 630A for feeder switchgear. All switchgear shall have a fault rating of 40 kA for 3 seconds and shall be internally arc type tested AFLR 40 kA for 1 second.
3.3 kV Busbars	1250 A Single busbar SF_6 gas insulated system with a 25 kA fault rating for 3 seconds. All switchgear shall have a fault rating of 25 kA for 3 seconds and shall be internally arc type tested AFLR 25 kA for 1 second.
3.3 kV Circuit Breakers	11 kV fixed vacuum circuit breakers with a normal rated current of 1250 A for incomer and bus coupler (section) switchgear and 630 A for feeder switchgear. All switchgear shall have a fault rating of 25 kA for 3 seconds and shall be internally arc type tested AFLR 25 kA for 1 second.
3.3 kV Three-way Switches	Three-way switches with normal rated current of 1250 A for incomer, bus coupler (section) and riser panel switchgear and 630 A for feeder switchgear. All switchgear shall have a fault rating of 25 kA for 3 seconds and shall be internally arc type tested AFLR 25 kA for 1 second.
11 kV Voltage Transformers	11/0.11 kV busbar 3-phase voltage transformers to be mounted on respective bus coupler (section) and riser panels.

TABLE 8 : SUBSTATION N MV SWITCHGEAR AND TRANSFORMERS

Item	Description
3.3 kV Voltage Transformers	3.3/0.11 kV busbar 3-phase voltage transformers to be mounted on respective bus coupler (section) panel.
SUBSTATION N : TRANSFORMERS	
T3 Conveyor Transformer	11/3.3 kV, 4.5 MVA, Dyn11, 7% dry-type transformer with enclosure. OCTS +5% -5% with 2.5% voltage per tap.
Substation Local Transformer	11/0.4 kV, 1 MVA, Dyn11, 5% dry-type transformer with enclosure. OCTS +5% -5% with 2.5% voltage per tap.

FIG 6 : BLOCK DIAGRAM : SUBSTATION N POWER SUPPLY BATTERY LIMITS BETWEEN *CONTRACTOR* AND OTHERS



1.4 66 kV Feed to Main Intake Substation

1.4.1 General

A new 66 kV tee-off from the existing Eskom two single circuit Blouwater-Iscor 66 kV overhead lines is to be installed by the *Contractor* as an integral part of the *works.* In addition to the aforementioned, a new 48 core 16 kA/1s underground optical fibre conductor from Blouwater Substation to Iscor substation, and from Iscor substation to Yastervark substation, has to be installed.

The detailed designs for these *works* had been reviewed and approved by Eskom under Branch lines final design package,1924701-2-300-RPT-0004 (Eskom reference number 153272156-00001) revision 2, volume 1-3. The full scope of work for the branch line is indicated clearly in section 5.2 of the branch lines final design package. The contractor shall undertake the outstanding works, testing and commissioning of the entire 66kV overhead line from Blouwater substation to Iscor substation / Ystervark substation, including for the new ± 6.6 km sleeve / manhole system, with fibre optic cabling inside, from Blouwater Substation to Iscor / Ystervark Substations for communications purposes. The *works* to be undertaken by the *Contractor* will include but not be limited to the following:

- Installation of new ± 6.6 km underground sleeves & associated manholes, for HDD FO cabling housing, from Blouwater Substation to Iscor / Ystervark Substations, along the route of the existing Blouwater-Iscor 66 kV OHL and new 66kV branch line.
- Installation of associated hardware assemblies of self-supporting single circuit T-off structures 1 BLO / ISC 32 and 2 BLO / ISC 32.
- Installation of associated hardware assemblies (vibration dampers) of the self-supporting strain double circuit structure 1 & 2 BLO / ISC 32/1.
- Installation of associated hardware assemblies (vibration dampers) of the self-supporting single circuit terminal structures 1 BLO / ISC 32/2 and 2 BLO / ISC 32/2 at the new Ystervark substation.
- Re-labelling of the existing terminal structures at ISCOR substation
  - 1 BLO / ISC 30 - (New Label: 1 BLO / ISC 33).
  - 2 BLO / ISC 30 - (New Label: 2 BLO / ISC 33)
- Disconnection of the existing 12 kA/1s 24 core OPGW at the dome joint on the existing structure 12 of the Duferco 66 kV OHL line.
- Removal of redundant OPGW between 2 BLO / ISC 13 and structure 12 of the Duferco 66 kV line, including redundant hardware assemblies, and make electrical connection on OPGW / shield wire at both sides of 2 BLO / ISC 13.
- Re-establish existing OPGW fibre optic connections at existing dome joint at structure 12 of the Duferco 66 kV OHL line.
- Remove existing Chicadee ACSR phase conductors on both circuit 1 and 2, from the Iscor Substation gantry to structures 1 BLO / ISC 31 and 2 BLO / ISC 31 respectively.
- Remove on circuit 2 existing 12 kA/1s 24 core OPGW, from Iscor Substation gantry to structure 2 BLO / ISC 31.
- Removal of existing phase hardware assemblies on eastern side of structures 1 BLO / ISC 31 and 2 BLO / ISC 31 respectively, including on Iscor Substation gantry.
- Installation of new phase hardware assemblies on eastern side of structures 1 BLO / ISC 31 and 2 BLO / ISC 31 respectively, including on structures 1 BLO / ISC 32 & 2 BLO / ISC 32 as well as on Iscor Substation gantry.
- Removal of existing ADSS FO cable from the above-mentioned gantry dome joint up until patch panel inside Iscor Substation relay house.

- Removal of, on circuit 1, the existing OPGW hardware assemblies (for 16 kA/1 s 48 core OPGW) on both sides of structure 1 BLO / ISC 31 with corresponding assembly on Iscor Substation gantry.
- Installation of new OPGW hardware assemblies on both sides of structure 1 BLO / ISC 31.
- Installation of new OPGW & Oak AAAC shield wire hardware assemblies on structure 1 BLO / ISC 32.
- Installation of new OPGW hardware assemblies on Iscor Substation gantry and ISCOR terminal structures.
- Installation of new Oak AAAC shield wire hardware assemblies on both sides of structure 2 BLO / ISC 31. Note: One side to cater for existing 12 kA / 1 s 24 core OPGW which acts as shield wire only.
- Installation of new Oak AAAC shield wire hardware assemblies on structure 2 BLO / ISC 32.
- Installation of new Oak AAAC shield wire assemblies on Iscor Gantry.
- Installation of new greased Chicadee ACSR phase conductors on circuit 1, from structure 1 BLO / ISC 31 onto T-off structure 1 BLO / ISC 32, then onto structure 1 BLO / ISC 33 and terminate at the Iscor Substation gantry.
- Installation of new greased Chicadee phase conductors on circuit 2, from structure 2 BLO / ISC 31 onto T-off structure 2 BLO / ISC 32 then onto 2 structure BLO / ISC 33 and terminate at the Iscor Substation gantry.
- Installation of new Oak AAAC shield wire on circuit 2, from structure 2 BLO / ISC 31 onto T-off structure 2 BLO/ ISC 32 then onto 2 BLO / ISC 33 and terminate at the Iscor Substation gantry.
- Removal of second existing gantry point OPGW/fibre optic connection and termination infrastructure at Iscor Substation gantry, including associated equipment.
- Installation of new HDD FO cables from Blouwater Substation relay house, in new sleeve / manhole system, into Iscor Substation relay house, & in turn to Ystervark Substation relay house (control building) and terminate at all three Substations' respective patch panels.
- Installation of phase jumpers at the terminal towers, 1BLO/ISC32/2 and 2BLO/ISC32/2.
- Installation of new Oak AAAC shield wire on circuit 1, from terminal structure 1 BLO / ISC32/2 onto Ystervark Substation gantry. Bifurcation of shield wires to be implemented at terminal structure 1 BLO/ISC 32/2 onto Ystervark Substation gantry to ensure adequate lightning protection.
- Installation of new Oak AAAC shield wire on circuit 2, from terminal structure 2 BLO / ISC32/2 onto Ystervark Substation gantry. Bifurcation of shield wires to be implemented at terminal structure 2 BLO/ISC 32/2 onto Ystervark Substation gantry to ensure adequate lightning protection
- Join the 3x50mm earth conductor to the crow foot of 2BLO/ISC32/2 and the Ystervark Earthmat substation grid.
- Join the 3x50mm earth conductor to the crow foot of 1BLO/ISC32/2 and the Ystervark Earthmat substation grid.
- Removal of HV line earthing kits from both lines at Ystervark gantry prior to commissioning of the lines.

The *Contractor* shall supply all materials required for the *works*, including, but not limited to, the following:

- New phase conductors, shield conductors and OPGW.
- Silicone rubbber insulator and hardware for masts.

All detailed designs, installations, materials, and the like shall be to Eskom requirements and specifications. The line is close to the coast and high creepage insulators must be used, with a minimum 31mm/kV creepage distance rating.

1.4.2 Design and construction of Permanent *Works*

Design and construction (structural elements) of the monopoles including foundation is complete and signed off by the previous contractor's engineer according to 1924701-E004-SQ-0169_04 and 1924701-E004-SQ-0170_03. The remaining scope (electrical) is captured in the section 1.4 above.

1.4.3 Further Services to be Provided by the *Contractor*

Further additional services to be provided by the *Contractor* in accordance with this Works Information, the specifications, bill of quantities and the relevant Eskom standards/ specifications as referenced in the specifications shall include, but are not limited to, the following.

- Any supplementary geotechnical investigations and/or soil resistivity testing, additional to the scope of investigations already conducted and documented in the reports referenced under the Site Information, if this is deemed necessary by the *Contractor* and/or the *Employer.* A provisional sum has been included in the bill of quantities for such further investigations.
- Detailed design and drawings of temporary steel/wood structures, for the protection of existing overhead power and/or communication lines, during erection and stringing of conductors, if the aforementioned protective measured are deemed necessary.
- Provision, construction and removal of temporary steel/wood structures, for protection of existing overhead power and/or communication lines during stringing *works*.
- Particular attention shall be given to *works* undertaken in close proximity to live power lines, as well as roads and any communication lines, taking into account the permitting requirements of the responsible authorities, *Employer* and other 3rd parties. The *Contractor* shall also appoint a full-time Eskom registered 'close proximity working' specialist for this project.
- Plan of execution for switch-over from existing to new systems.
- Dismantling existing systems.

1.4.4 Switch-Overs

The *Contractor* shall be responsible for making the switch-over from the existing to the new systems, including compiling of the final procedures and activity lists, which will be undertaken in conjunction with and under the supervision of the *Employer* and Eskom.

The *Contractor* shall also provide a detailed work plan and safe work methods for the dismantling, removal and disposal of the elements of the existing system that are to be removed from Site and disposed of at the Eskom Brackenfell premises, including in particular topping over of redundant pylon structures.

1.5 Main Low Voltage (LV) Infrastructure and Associated Communication Links

1.5.1 Main Intake Substation

The LV installations and associated communication links to be provided within the 11 kV Switchgear Building are shown in Fig 7, and include, but are not limited to, the following main items:

i. *Small Power*

Small power connections and internal/external (building and yard) lighting installations are to be provided for the new Main Intake Substation, as described in further detail below.

The small power infrastructure shall comprise of, but not be limited to a main distribution board, which in turn will be fed from the 400/230 V supply from the auxiliary NECRT transformers, located within the transformer yard. This distribution board also includes the UPS supply section, which will be fed in turn from the building UPS and associated battery bank in order to feed defined critical loads.

The main distribution board (normal and UPS supplies as applicable) shall provide power to circuits, such as, HVAC systems (Chiller plant, air handling units, fresh air supply fans, controller etc.), the dedicated MV equipment UPS and associated battery bank, normal and dedicated socket outlets, isolators, transformer auxiliary power supplies, indoor and outdoor lighting, Eskom's 132 kV control building and the like. It is to be noted that the 132 kV control building will also be able to receive LV power supplies from the 66/0.4 kV 2.5 kVA power voltage transformers connected to the 'Ystervark' portion 66 kV outdoor busbar system, to be operated and maintained by Eskom.

The building UPS will supply the following, but not necessarily limited to, the following main critical systems located in various rooms inside, and where applicable externally at, the 11 kV Switchgear Building:

- Access control infrastructure.
- Intruder alarm infrastructure.
- Fire detection systems.
- Dedicated socket outlets.
- Certain HVAC loads.
- The building management ET200 panel and dedicated ICT panel(s) (if applicable).
- Internal and external building lighting.

The building's UPS will be able to provide 400/230 V and be rated to supply full load for 2 hours during a power outage.

The dedicated MV equipment UPS will supply the metering and transformer panels, including the IEDs on the 11 kV switchgear plus other associated equipment respectively. The dedicated MV equipment UPS will be able to provide 110 V DC, 24 DC and 230 V AC respectively for the aforementioned equipment and shall be rated to supply full load for 2 hours during a power outage.

Distribution boards installed indoors shall be of the 3CR12 IP54 type and those externally or directly exposed to the environment of the 316L stainless steel IP65 type.

The sockets and dedicated socket outlets, isolators and the like shall be a combination of flush and surface/wall mounted and, where applicable, power skirting/trunking types, with each piece of equipment having the appropriate electrical and IP ratings, as specified.

All low voltage and small power infrastructure for the Eskom 'Ystervark' portion of the new Main Intake Substation, including equipment to be installed at Eskom's existing Blouwater and Iscor substations, shall comply fully to their requirements.

Further reference shall be made to the specifications, bill of quantities and drawings.

ii. *Communication Links*

The communications linkages, for monitoring and control purposes, that are to be provided, includes but are not limited to the following:

- The access control, intruder alarm, fire detection panels, HVAC controller and UPS' shall be daisy chained and linked to the BMS ET200 panel via Profibus DP, and where required I/O hardwired interfacing cables.
- The access control, fire detection panels and if applicable HVAC controller shall also be I/O hardwired linked as needed.
- MV switchgear breaker status I/O hardwired linked with BMS ET200 panel.
- MV metering, via combination of copper Ethernet, dedicated network switches and fibre optic cables to main Ethernet communications network.
- MV switchgear IED linkages for communications to one another and different substations plus associated plant via fibre optic cables, network switches etc.
- BMS ET200 panel to main network switch via copper CAT 6A communications cable.
- BMS ET200 panel, via OLM, linkage to Profibus over fibre plant communications network.
- The CCTV shall be connected to the ICT network switch via copper CAT 6A communication cables.
- Network switch connections to patch panels shall be via fibre optic patch leads.

Further reference shall be made to the specifications, bill of quantities and drawings.

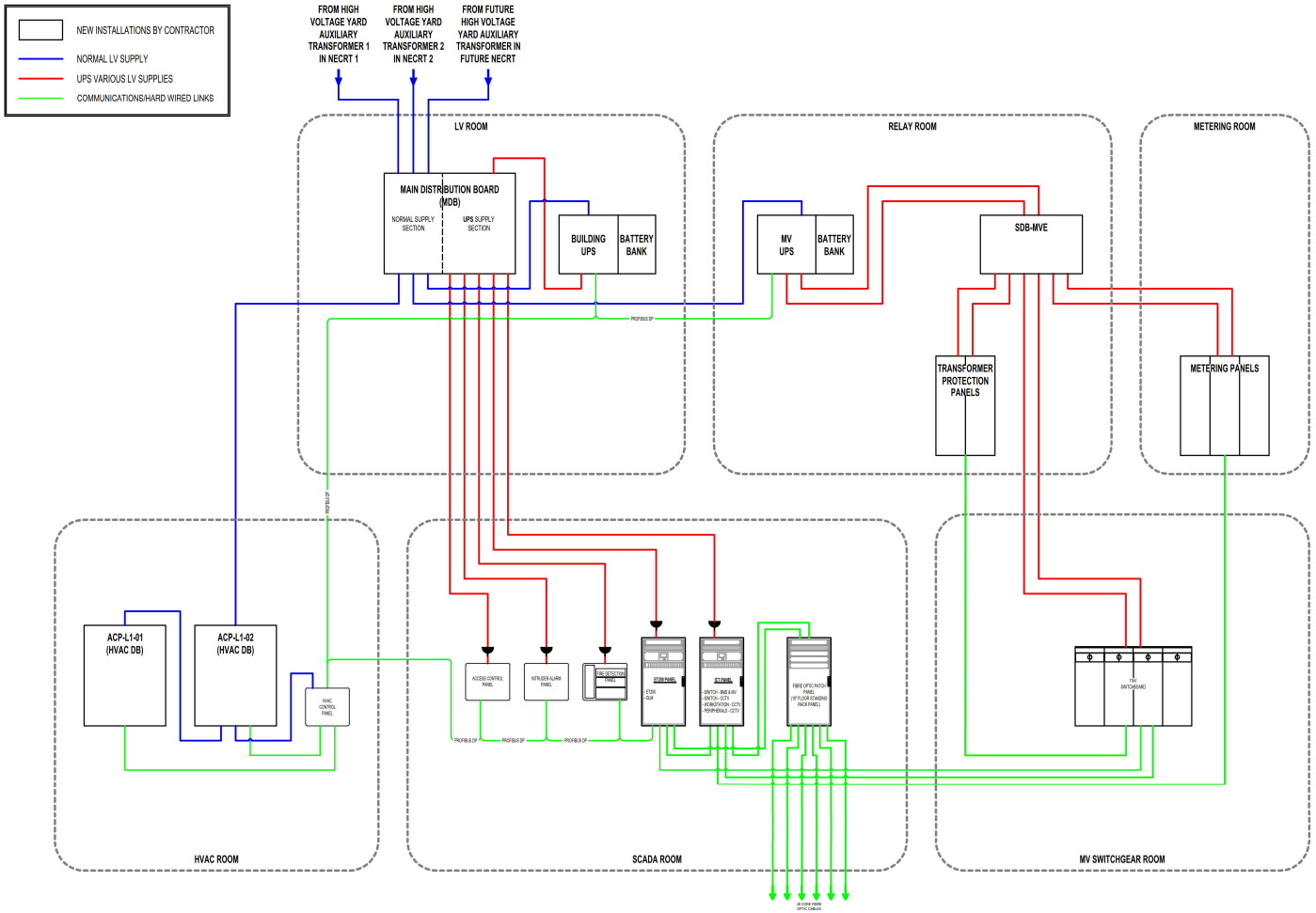
iii. *Lighting*

The lighting to be provided for the new Main Intake Substation shall be as per the specifications, bill of quantities and drawings.

The building internal lighting shall also provide emergency lighting. Certain of the building external lighting shall also form part of the emergency lighting systems. The type and quantity of luminaires to be installed internally and externally at the Eskom 132 kV Control Building, including the emergency lighting, shall be in accordance with Eskom's requirements.

All luminaires shall have the appropriate IP ratings, as specified. Area lighting at the new Main Intake Substation (including the Ystervark portion) shall be achieved via a combination of LED flood light luminaires mounted at ± 12.5m on the 21m lightning masts, and LED luminaires mounted externally on the 11 kV Switchgear House and Eskom's 132 kV Control Building.

FIG 7 : MAIN INTAKE SUBSTATION : BLOCK DIAGRAM : MAIN LV AND CONTROL INSTALLATIONS



1.5.2 Substation M and N

A block diagram of the LV installations and communication links to be provided for Substations M and N is shown in Fig 8 and includes, but is not limited to, the following main items:

i. *Small Power*

Small power connections and internal/external lighting installations are to be provided for the new Substation M and N respectively, as described in further detail below.

The small power infrastructure shall comprise of, but not be limited to a main distribution board, which in turn will be fed from the 400/230 V supply from the 1 MVA local substation transformer, also situated within the substation building. This distribution board includes a UPS supply section as well, which will be fed in turn from the building UPS and associated battery bank in order to feed defined critical loads.

The main distribution board (normal and UPS supplies as applicable) shall provide power to circuits, such as, HVAC systems (Chiller plant, air handling units, fresh air supply fans, controller etc.), the dedicated MV equipment UPS and associated battery bank, normal and dedicated socket outlets, isolators, transformer auxiliary power supplies, indoor and outdoor lighting and the like.

The building UPS will supply the following, but not necessarily limited to, the following main critical systems located in various rooms inside, and where applicable externally at, the 11 kV Switchgear Building:

- Access control infrastructure.
- Intruder alarm infrastructure.
- Fire detection systems.
- Dedicated socket outlets.
- Certain HVAC loads.
- The building management ET200 panel and dedicated ICT panel(s) (if applicable).
- Internal and external building lighting.

The building's UPS will be able to provide 400/230V and be rated to supply full load for 2 hours during a power outage.

The dedicated MV equipment UPS will supply the metering panels, including the IEDs on the 11 kV and 3.3 kV switchgear plus other associated equipment respectively. The dedicated MV equipment UPS will be able to provide 110 V DC, 24 DC and 230 V AC respectively for the aforementioned equipment and shall be rated to supply full load for 2 hours during a power outage.

Distribution boards installed indoors shall be of the 3CR12 IP54 type and those externally or directly exposed to the environment of the 316L stainless steel IP65 type.

The sockets and dedicated socket outlets, isolators and the like shall be a combination of flush and surface/wall mounted and, where applicable, power skirting/trunking types, whilst each equipment item having the appropriate electrical and IP ratings as specified.

Further reference shall be made to the specifications, bill of quantities and drawings.

ii. *Communication Links*

The communications linkages, for monitoring and control purposes, that are to be provided, includes but are not limited to the following:

- The access control, intruder alarm, fire detection panels, HVAC controller and UPS' shall be daisy chained and linked to the BMS ET200 panel via Profibus DP, and where required I/O hardwired interfacing cables.
- The access control, fire detection panels and if applicable HVAC controller shall also be I/O hardwired linked, if so required.
- MV switchgear breaker status I/O hardwired linked with BMS ET200 panel.
- MV metering, via combination of copper Ethernet, dedicated network switches and fibre optic cables to main Ethernet communications network.
- MV switchgear IED linkages for communications to one another and different substations plus associated plant via fibre optic cables, network switches etc.
- BMS ET200 panel to main network switch via copper CAT 6A communications cable.
- BMS ET200 panel link via Profibus DP cable link to plant ET200/PLC panel.
- The CCTV shall be connected to the ICT network switch via copper CAT 6A communication cables.
- Network switch connections to patch panels shall be via fibre optic patch leads.

Further reference shall be made to the specifications, bill of quantities and drawings.

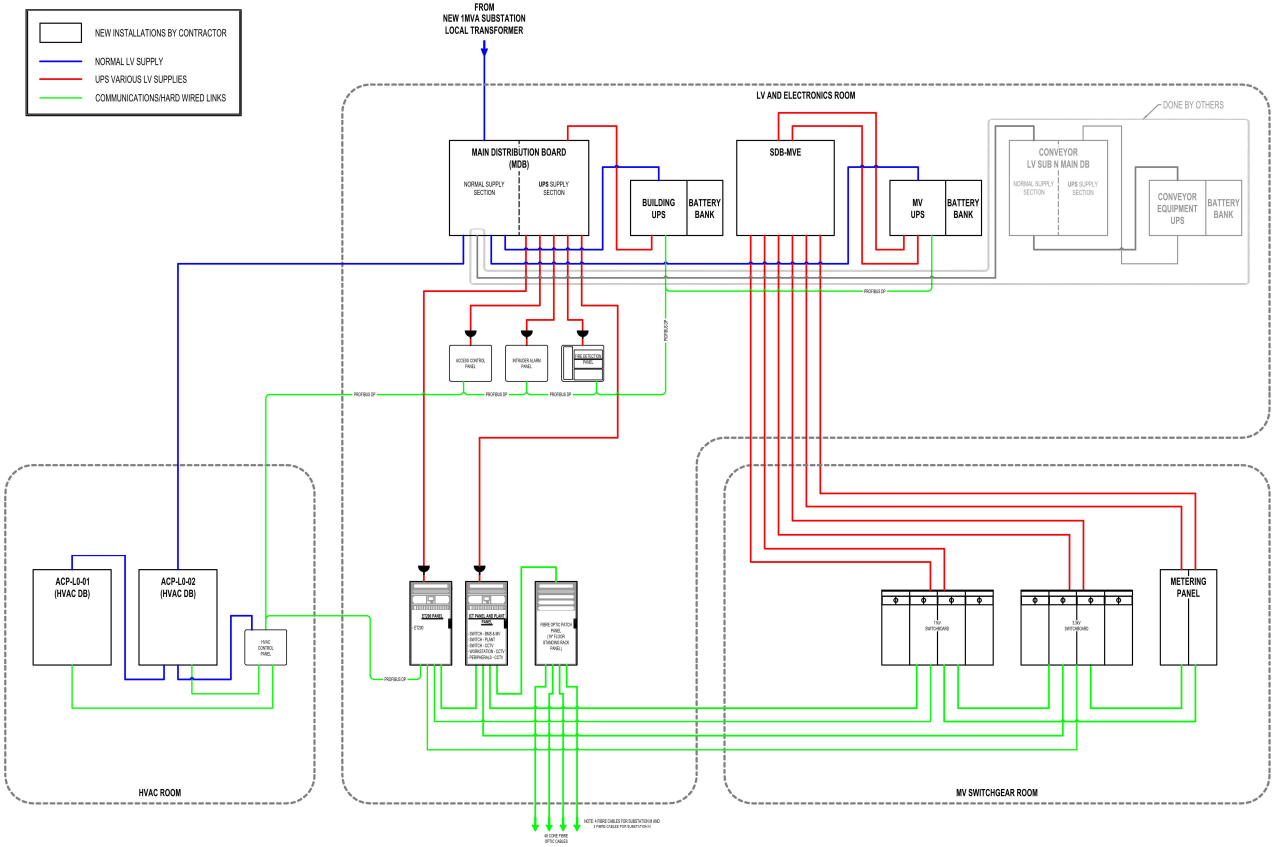
iii. *Lighting*

The lighting to be provided for Substation M and N respectively shall be as per the specifications, bill of quantities and drawings.

The buildings internal lighting shall also provide emergency lighting. Certain of the building external lighting shall also form part of the emergency lighting systems.

All luminaires shall have the appropriate IP ratings, as specified.

FIG 8 : SUBSTATION M AND N : BLOCK DIAGRAM : MAIN LOW VOLTAGE (LV) INFRASTRUCTURE AND ASSOCIATED COMMUNICATION LINKS



1.6 Fire Detection Systems

A comprehensive fire detection system shall be installed at the new Main Intake Substation as well as Substations M and N, which shall be in accordance with applicable legislation and regulations, as well as the specifications, bill of quantities and drawings as well as the fire safety design report.

Each fire detection system shall comprise of, but not be limited to, the following:

- Main multi-zone programmable fire alarm panel.
- Local multi-zone programmable fire control panels.
- Internal battery back-up batteries for the alarm/control panels. These shall be fully sealed, maintenance free and rated to maintain operation for a minimum of 24 hours, of which at least 2 hours is at alarm status. The batteries shall have a minimum guaranteed life span of 15 – 20 years.
- Addressable and non-addressable smoke/heat multi-sensors.
- Manual red glass resettable call point units.
- Green emergency door release units.
- PH120 communications cable.
- Fire alarm visual and audible indicators.
- Fire suppression alarm visual and audible indicators.
- Input/Output interface units.
- Emergency stop push buttons, for cancelation of suppression system activation sequence.
- Profibus DP and/or I/O hardwired interfacing cabling connections, as applicable, between all equipment, including to applicable HVAC and fire suppression equipment.

All cabling for the systems shall be of the fire retardant, self-extinguishing, zero toxic emissions type, 120 minute duration, unless otherwise specified or shown. All equipment shall have the correct type IP rating as specified, taking account also of the location of the installations, including in particular the harsh and dusty environments.

At this stage no allowances have been made for a fire detection system at Eskom's 132 kV Control Building. Should Eskom however instruct otherwise during the construction phase of the project, such systems shall have to be provided as well.

1.7 Electronic Security Systems

Comprehensive electronic security systems (access control, CCTV and indtruder detection) shall be installed at the new Main Intake Substation as well as Substations M, Substation N and the Tippler building which shall be in accordance with applicable legislation and regulations, as well as the specifications, bill of quantities and drawings.The electronic security systems sha;; be monitored in the existing TPT security control room, this includes but not limiited to the CCTV, access control and intruder detection systems.

Each access control system shall comprise of, but not be limited to, the following:

- Main programmable control panel.
- Laptop PC setup and monitoring station, with required software.
- Door controllers.
- Biometric readers compatible with the access control system, with LED and tone indication.
- Release buttons compatible with the access control system, with LED and tone indications.
- 500kg magnetic door locks complete with LED and tone indication.
- Door position (open or closed) indication magnets.

- Buzzer buttons compatible with the access control system, complete with LED indication.
- Conventional green break glass resettable manual call point units with and without additional I/O, all with LED indication.
- Visual and audible indication installations.

The CCTV systems shall comprise of, but not be limited to, the following:

- Indoor/outdoor, ceiling/wall mounted POE fixed HD dome CCTV units with built-in motion detection.
- POE Network switch(es), onto which CCTV cameras connect directly via CAT 6A cabling. The network switches shall in turn be connected via the fibre optic patch panels onto the main port ICT network.

All equipment shall have the correct type IP rating as specified, taking account also of the location of installation, including in particular the harsh and dusty environments.

No allowances have been made for access control and CCTV systems at Eskom's 132 kV Control Building. Should Eskom however instruct otherwise during the construction phase of the project, account shall have to be taken of their requirements as well.

Each respective intruder alarm system shall comprise of, but not be limited to the following:

- Programmable control panel with software.
- Keypads with LED backlight and cover.
- False alarm immune passive infrared intruder detectors.
- Door (open or closed) sensors installed onto normal access or roller shutter doors.

Intruder alarm systems shall be interconnected with each substation's respective BMS system via Profibus DP and/or I/O hardwired interfacing cabling connections.

All equipment shall have the correct type IP rating as specified, and also taking into account the location of installation especially pertaining to harsh and dusty environments.

No allowance have been made for an intruder alarm system at Eskom's 132 kV Control Building, however should Eskom instruct otherwise during the construction phase of the project, it shall take into account their requirements as well.

1.8 VOIP Systems

The telephone system to be employed at the new Main Intake Substation and Substations M and N respectively shall be of the Voice over IP (VOIP) type. Final details of the telephone system are still to be confirmed. A provisional sum has been included in the bill of quantities for these installations.

1.9 Uninterruptable Power Supplies (UPS) and Battery Terminal Units (BTU)

At the new Main Intake Substation and Substations M and N respectively, emergency/back-up power supplies shall be in the form of UPS'. The locations of the units are shown on the drawings, and as described elsewhere in this document. All UPS' shall have a 400 V AC 3 phase input, with the different voltage outputs as specified.

All back-up batteries, contained in suitable sized battery cabinet(s) shall be of the fully sealed, deep cycle, maintenance free gel type, with a minimum guaranteed life span of 15 - 20 year

and/or 3000 operating cycles. Back-up battery capacity shall be 100% full load for the hours specified on the drawings and bill of quantities for each respective UPS.

The UPS' and battery cabinet(s) shall be floor standing, and be of the 3CR12 IP54 type. The UPS systems shall be interconnected with each substation's respective BMS system via Profibus DP and/or I/O hardwired interfacing cabling connections. Additional 'UPS Live' visual and audible units shall form part of the systems.

All equipment shall have the correct type IP rating as specified, and also taking into account the location of installation especially pertaining to harsh and dusty environments.

The BTUs with all associated equipment such as cabling etc., to be provided at Eskom's 132 kV Control Building and Iscor Substation as applicable, shall comply fully with their standards and specifications etc.

1.10 Main Electronic Monitoring and Control Infrastructure

The main monitoring and control infrastructure to be provided by the *Contractor* will include, but not be limited to, the following main elements, to ensure complete integration of all applicable local installations and the overall port SCADA system:

MAIN ELEMENTS

- Fibre optic reticulation cables between new substations and existing infrastructure.
- Fibre optic patch leads.
- Copper communications/signalling cables.
- ET200s.
- 19" Rack enclosures, floor and/or surface mounted type.
- Managed (Layer 3) and un-managed network switches.
- Patch panels and brush trays.
- Remote pendent control units.
- GPS time clock unit, with antenna.

The respective equipment, as per the drawings, specifications and bill of quantities, shall be installed at:

- Tippler 3 building.
- New Substation M.
- New Substation N.
- New Main Intake Substation.
- CCR and Electronics Workshop/Engineering Station.

Fibre optic cables, patch panels, network switches, and all associated communication equipment as per the drawings, specifications and bill of quantities, shall be installed at:

- Tippler 3 building.
- New Substation M.
- New Substation N.
- New Main Intake Substation.
- CCR and Electronics Workshop/Engineering Station.
- Substation A.
- Substation B.
- Substation H.
- Substation J.

- Substation K.

Reference is also made to Figures 9 and 10, indicating the overall and Tippler 3 communications infrastructure with associated battery limits. The system shall make provision for connection and interfacing with the further MEIP, Tippler, Conveyor and associated installations to be installed by Others.

As described previously and further in this document, local equipment interconnections at the new substations, with the monitoring and control systems shall be UPS, Fire Detection, HVAC, , Protections systems (switchgear electrical equipment status signals)etc.
The metering of electrical equipment shall be linked to the existing port metering system.

At the Tippler 3 building, the *Contractor* shall be required to install the main building managed network switch (layer 3), with associated rack enclosure, patch panels, brush trays, patch leads and associated installations, including the communications infrastructure required for the Tippler 3 building transformer protection systems requiring to communicate to Substation M.

The main communications protocol shall be Ethernet (TCP/IP) and where applicable IEC 61850, with local communications protocols being a combination of Profibus and hardwired I/O where necessary, unless otherwise specified or shown. The typical wiring/cabling to be used shall be, but not limited to fibre optic, CAT 6A Cu, conventional low voltage Cu control and Profibus DP types.

All equipment shall have the correct type IP rating as specified, and also taking into account the location of installation especially pertaining to harsh and dusty environments.

The associated equipment such as cabling etc., to be provided at Eskom's 132 kV Control Building shall comply fully with their standards and specifications etc.

FIG 9 : BLOCK DIAGRAM : OVERALL COMMUNICATIONS NETWORK

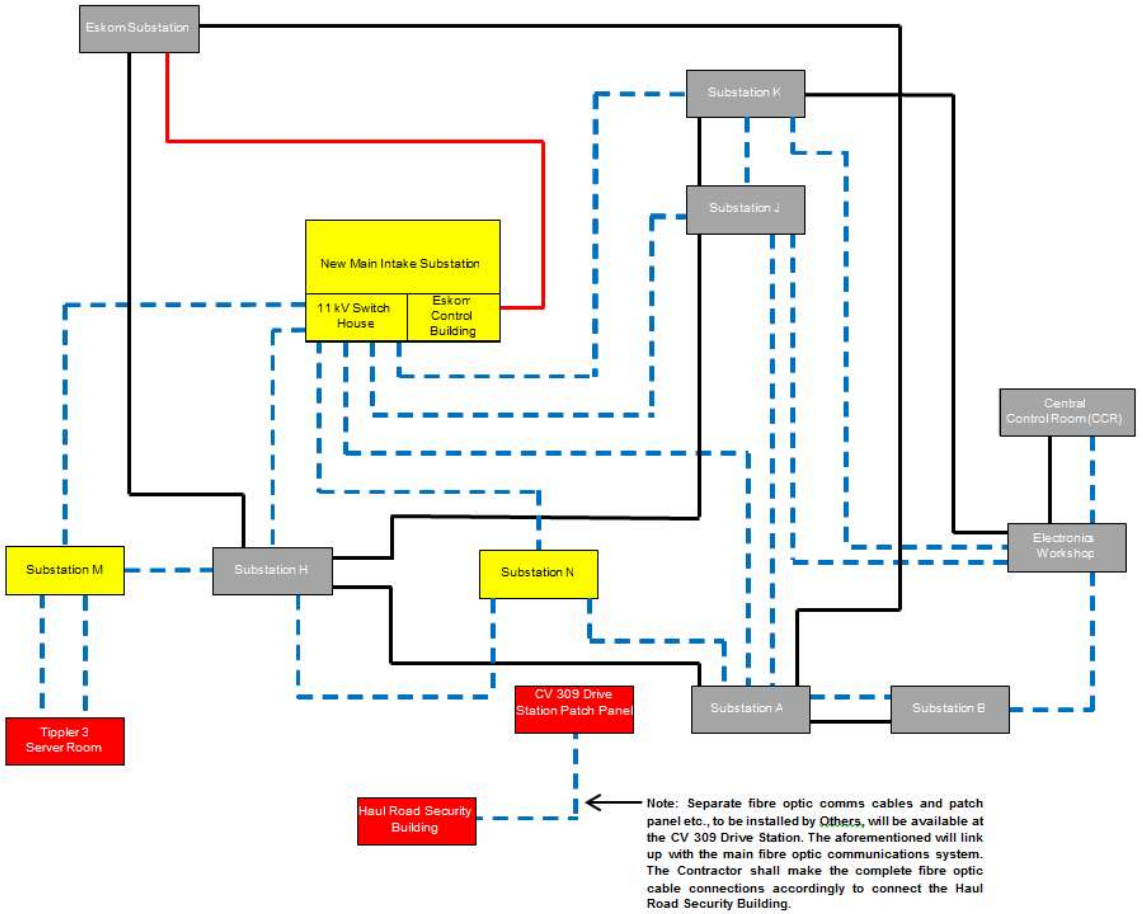
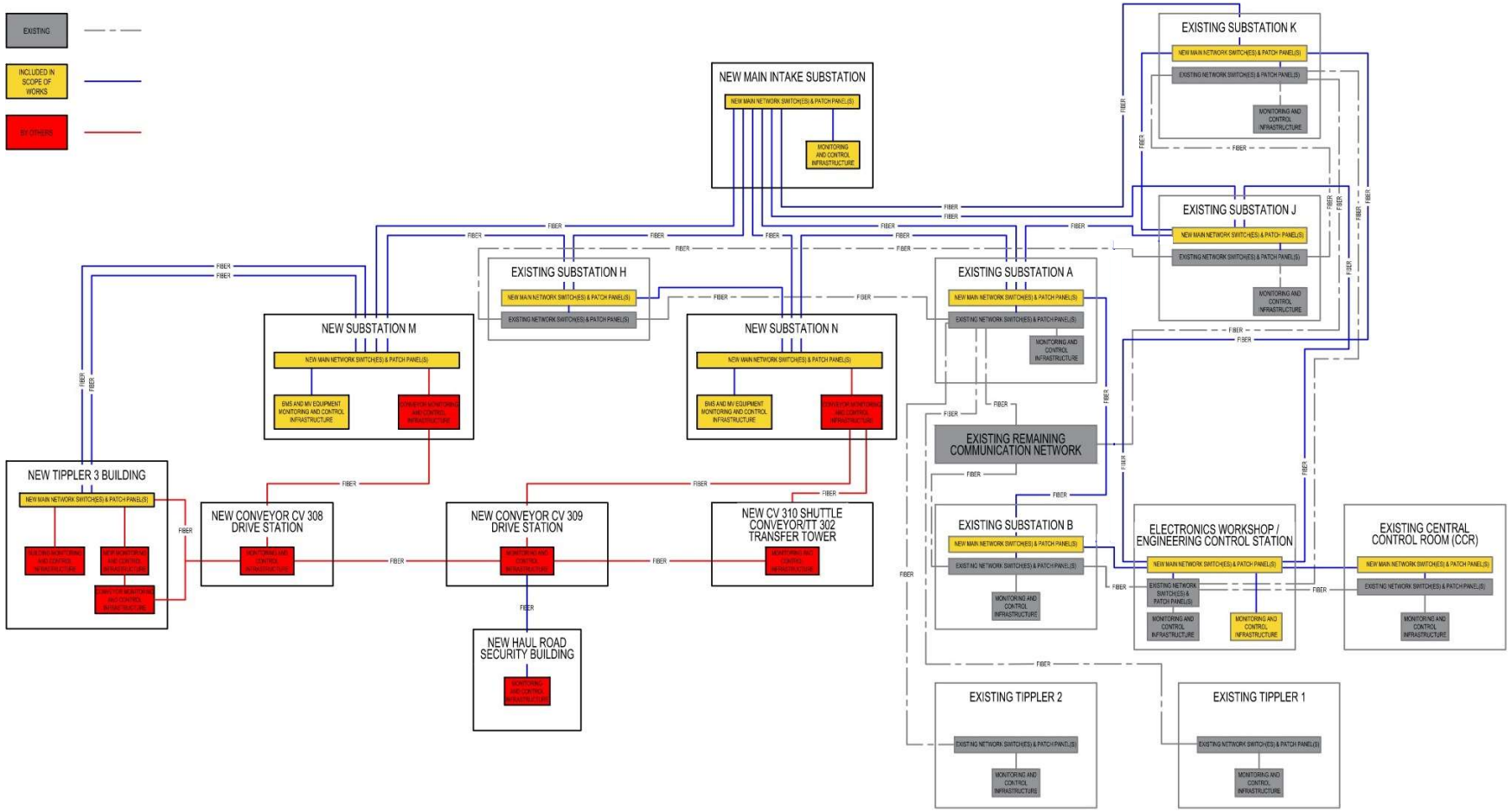


FIG 10 : BLOCK DIAGRAM : COMMUNICATION NETWORK FOR TIPPLER 3 PROJECT



1.11 Protection Systems

Comprehensive new electrical protection infrastructure shall be provided by the *Contractor*, which shall include, but not be limited to, the following main elements:

i. *New Main Intake Substation*

- 132-66/11 kV transformer and 11 kV reactor (if required) protection schemes.
- 11 kV busbar (Arc) protection for all air insulated compartments.
- 11 kV cable feeder, with Solkor-N, protection schemes.
- Bus coupler (section) schemes.
- Automatic load management system to ensure load is evenly distributed between the two busbars of the double busbar systems.

ii. *Eskom new 'Ystervark' and existing Blouwater and Iscor substation*

- High-voltage feeder protection schemes (4FZD3920).
- Buszone protection scheme (4BZ5700).
- AC/DC panels.
- Battery panels and accessories.
- Junction boxes (current, voltage, isolator, interface).
- Telecontrol equipment.
- Substation automation installations.

The new installations and *works* at Blouwater and Iscor substations are required for the upgrades that are necessary to normalise the existing protection schemes on the transformer/feeder systems and allow for new 3-current terminal differential protection schemes.

iii. *Substations M and N*

- 11/3.3 kV transformer protection schemes.
- 11/0.4 kV transformer protection schemes.
- 11 kV and 3.3 kV busbar (Arc) protection for all air insulated compartments.
- 11 kV cable feeder, with Solkor-N, protection schemes.
- Bus coupler (section) protection and control schemes.

iv. *Tippler 3*

- 11/0.4 kV transformer protection schemes.

v. *Substations A, H, J and K*

- Decommission and remove existing Solkor-R/Rf relays of bays connecting to new Main Intake Substation.
- Cut the existing switchgear face-plates (if necessary) of the panel to fit the new Solkor-N relays, including new wiring and modifications to the existing wiring to cater for the new protection schemes.

Reference shall also be made to the specifications, drawings and bill of quantities for additional information, including the required functionality of each respective protection scheme. Stringent electrical and mechanical interlocking, as well as inter-tripping on all levels, shall be incorporated into all new systems.

Protection systems for all HV/MV electrical power systems will be fully integrated with the new and existing monitoring and control systems at the port.

All equipment shall have the correct type IP rating as specified, taking account of the location of the installations, including in particular the harsh and dusty environments.

Associated equipment, such as cabling and the like, to be provided at Eskom's 132 kV Control Building, as well as Blouwater and Iscor substations, shall comply fully with Eskom standards, specifications and the like and shall take account of the associated interlocking and intertripping requirements.

1.12 Metering Systems

At the new Main Intake Substation energy/tariff meters shall be provided at the following locations, unless otherwise shown or specified:

- On all 11 kV indoor switchgear incomers and feeders.

At Substations M and N energy/tariff meters shall be provided at the following locations, unless otherwise shown or specified:

- On all 11 kV indoor switchgear feeders.
- On all 3.3 kV indoor switchgear feeders.

The meters shall be housed inside their own dedicated meter panels. These meters shall have an accuracy class of 0.2S and shall, as a minimum, provide the following electrical data outputs and associated functionalities:

i. *Instantaneous RMS Values:*

- Current, voltage and frequency.
- Active, reactive and apparent power (total and per phase).
- Power factor (total and per phase).
- Current measurements range (low and high).
- Energy values.
- Active, reactive and apparent energy.
- Settable accumulation modes.

ii. *Power Quality Measurements*

- Detection of voltage sags and swells.
- Symmetrical components: zero, positive and negative.
- Transients detection.
- Harmonics: individual, odd and even up to 63rd value.
- Harmonics: magnitude, phase and inter-harmonics up to 50th value.
- Flicker.

iii. *Data Recordings*

- Minimum/maximum for any parameter.
- Historical logs: maximum number of cycles up to 800.
- Waveform logs: maximum number of cycles up to 96.
- Timestamp resolution in seconds (0.001 seconds).
- Setpoints with Minimum Response Time of half a cycle.

- Number of setpoints: 65.
- GPS time synchronisation.
- Expandable memory up to 10 megabytes.

iv. *Display and I/O*

- Front panel display.
- Active/reactive energy pulser, LED and IEC1107 style.
- Digital pulse outputs: 8 – solid state Form A.
- Digital pulse outputs: 4 – solid state Form C.
- Alarm relay outputs: 1 – Form C.
- Digital input: 3.

The above meters shall be fully programmable and shall consist of RS 232/485 Modbus, Profibus (additional protocol card required if applicable) and RJ45 Ethernet (IEC 61850) communications ability.

For the main LV distribution boards, energy/power quality meters shall be provided. The meters shall be housed inside the distribution panels with the local visible displays and operable mechanisms present at the front. The aforementioned meters shall have an accuracy class of 0.5 or better and, as a minimum, provide the following electrical data outputs and associated functionalities:

i. *Instantaneous RMS Values*

- Current, voltage and frequency.
- Active, reactive and apparent power (total and per phase).
- Power factor (total and per phase).
- Current measurements range (auto-ranging)

ii. *Energy Values*

- Active, reactive and apparent energy.
- Settable accumulation modes.

iii. *Demand Values*

- Current: present and maximum values.
- Active, reactive and apparent power: recent and maximum values.
- Predicted active, reactive and apparent power.
- Synchronisation of window measurement.
- Setting of calculation mode.

iv. *Power Quality Measurements*

- Detection of voltage sags and swells.
- Transient detection and capture.
- Harmonic distortion: current and voltage.
- Individual harmonics up to 127th value.
- Fast acquisition of data.

v. *Data Recordings*

- Minimum/maximum of instantaneous values.
- Data logs.
- Event logs.
- Trending/forecasting.
- Sequence of event recording.
- Time stamping.
- GPS synchronisation (1ms).
- Expandable memory up to 10 megabytes.

vi. *Display and I/O*

- Front panel display.
- Wiring self-test.
- Pulse output (1).
- Digits or analogue inputs (20).
- Digits or analogue outputs (12 – maximum including pulse output).

The above meters shall be fully programmable and shall consist of RS 232/485 Modbus, Profibus (additional protocol card required if applicable) and RJ45 Ethernet (IEC 61850) communications ability.

All equipment shall have the correct type IP rating as specified, taking account also of the location of installation, including in particular the harsh and dusty environments.

The associated metering equipment, such as meters, cabling and the like, to be provided at Eskom's 132 kV Control Building, shall comply fully with their standards and specifications.

Reference shall be made to the specifications, drawings and bills of quantities for further details.

1.13 Cable Management Systems

The *works* include all necessary cable management systems, which shall comprise of cable trays, conduits, ducting/trunking and the like. Suitable fire-stopping methods shall be provided where necessary, in accordance with the applicable specifications.

All cable management systems shall be either of the plastic fire retardant, self-extinguishing, zero toxic emissions or 316L stainless steel type, irrespective of whether they are used for electrical or electronic services, as per the technical specifications, drawings and bill of quantities, unless specified or instructed otherwise.

Specific cable management systems for Eskom's new and existing owned and operated infrastructure shall comply fully to their requirements.

1.14 Substation Earthing and Lightning Protection

The *Contractor* shall appoint a SANS accredited/certified specialist subcontractor/OEM, to be approved by the *Employer*, to undertake the complete detailed designs, supply, installation lightning protection systems and commissioning of the entire new earthing and lightning protection systems at all three new substations.

This shall also include a comprehensive lightning risk assessment . The results and findings are to be included in a report, to be reviewed and approved by the *Employer*. The report format is

described in the specifications. The detailed designs, installations and commissioning shall take account of Eskom's requirements where applicable.

The *Contractor* shall ensure that the specialist subcontractor/OEM fully cooperates, coordinates and furnishes all technical support and associated information to Others, as required, to ensure that the new earthing and lightning protection systems are fully and correctly integrated.

Allowance has been made for a Class IV earthing and lightning protection system, as per the applicable legislation, regulations and standards. The earthing and lightning protection systems shall also take account of and cater for all electronic and instrumentation systems.

The selection of lightning protection materials shall take into account the harsh corrosive environment within which the systems will be operated, as well as the risk of galvanic corrosion.

The earthing and lightning installations shall conform to Specification 1924701-2-300-E-SP-0008, as referenced under Annexure A, including the drawings and bill of quantities. The entire earth mat/grid, fencing, other *Employer* owned/operated outdoor infrastructure and portions of the Main Intake Substation that will ultimately be operated and maintained by Eskom shall comply with the relevant Eskom specifications.

The specific earthing and lighting protection system requirements of the 11 kV Switch House at the new Main Intake Substation shall comply with the specific requirements of the *Employer*, as indicated in the specifications, bill of quantities and/or drawings.

Typical main earthing and lightning protection equipment will include, but not be limited to:

- Earth mats/grids.
- Earth spikes.
- Earthing straps and tails.
- Insulated copper earth wires for LPS down conductors and general earthing/bonding purposes.
- Earth bars.
- Lightning masts.

The entire earthing systems for Substations M and N and the Tippler building shall be based on a combined MV/LV earth system. The *Employer*-owned and operated earth installations shall also be in accordance with the TN-S earthing principle. The final earth resistance value shall not be more than 1 Ohm. The *Contractor* shall also provide the main transformer earth bar at the Tippler 3 building for, amongst others, earthing interconnections between the Tippler 3 building and Substation M.

For the Main Intake Substation, the earthing system shall be designed to ensure aspects such as step and touch potential, grid potential rise and the like are within statutory and Eskom required safe limits, taking into account the specific requirements of the 11 kV Switch House and 132 kV Control Building, as well as Eskom's standards and specifications. Eskom's applicable TNC-S and/or TN-S earthing principles shall apply as per their requirements.

1.15 Buildings

The following buildings are to be completed as part of the *works:*

- Ystervark Substation : Eskom Control Building.
- Main Intake Substation : 11 kV Switch House.
- Substation M Building.
- Substation N Building.

Further descriptions are provided below.

1.15.1 Ystervark Substation : Eskom Control Building

A separate building, for the sole use of Eskom's operating and maintenance personnel, is to be provided within their (Ystervark) portion of the Main Intake Substation. The building will comprise of a single-storey brick structure with conventional A-frame timber roof trusses and Aluminium roof sheeting. Allowances have been made for the following:

- Control room : 3.6m x 6.8m.
- Store room : 3.6m x 32.6m.
- Reception area : 1.4m x 1.0m.
- Ablution facilities : 1.4m x 1.0m.

Provision is also made for an external loading bay and water storage area. It is intended that a water tank, for rainwater harvesting, be provided to serve the ablution facility inside the building consisting of a wash hand basin and toilet. Wherever the required quality databooks are not available, the required inspections and tests need to be conducted on all infrastructure completed by previous contractor to ensure proper and safe commissioning.

1.15.2 Main Intake Substation : 11 kV Switch House

The substation is a rectangular building, with a footprint of approximately 59m x 17m and a height of 11m. The building encloses complex service systems for electric cabling, data feeds and air-conditioning systems and is split into three distinct zones, ie:

- Service zone, located on the ground floor (Level 00), which will contain the main incoming cabling to the upper floor (Level 01), as well as the outgoing cables to the downstream substations. Access within the service zones is independent of access from within the main equipment zones. The service zone on Level 00 will be spilt by a 230mm brick wall, to provide two enclosed open spaces with a storeroom on the ~~north-eastern~~ South Western corner.

- Equipment space, located on the first and second floors (Level 01 and Level 02). Level 01 will accommodate the following installations:

  i. MV switchgear room, located on the ~~north-western~~ North Eastern side of the building and extending over the full length of the building.
  ii. HVAC, Relay, Metering, SCADA and LV room, along the ~~south-eastern~~ South Western part of the building.
  iii. The two sets of rooms are separate by a 3.28m wide access hall, extending along the full length of the building.
  iv. A further storeroom will be located on the ~~north-eastern~~ South Western corner of the building.
  v. A loading deck will be provided on the ~~northern~~ Southern side of this floor, beneath the crawl beam to be installed above the deck.

  Level 02 extends only over a portion of the ~~south-eastern~~ North Western corner of the building and will accommodate the chiller plant for the HVAC systems and access thereto.

- Circulation space, which provides for horizontal and vertical circulation of people and equipment throughout the buildings, connecting the service and equipment zones. The building is serviced at either end by a staircase linking both floors, and acting as alternative fire escape routes.

TABLE 9 : MAIN INTAKE SUBSTATION APPROXIMATE ROOM DIMENSIONS

Room	(m^2)
MV Switchgear Room	315
Relay Room	38
Metering Room	38
SCADA Room	39
LV Room	39
HVAC Room	78
Chiller Plant Area	29

The building will not have any rest room or ablution facilities.

The building will consist of a concrete framed structure with brick intermediate walls and an external face-brick cavity wall. The roof consists of colour-coated aluminium sheeting with an integral insulation sandwich panel, all supported by a steel portal frame. Internal wall finishes are generally of plaster and paint.

The building consists of a reinforced concrete raft foundation, with a floor thickness of 250mm, and thickened perimeter and intermediate beams, founded on a compacted engineering fill. Concrete columns around the perimeter and centre of the structure will support the elevated concrete decks.

The external walls will comprise of a 280mm cavity wall, with face-brick on the exterior and bagged clay brick on the internal side. Interior walls will be a combination of concrete (between MV switchgear room and access hall) and brickwork. Level 01 will be double-volume, with a false ceiling height of 5.0m off the floor level, unless otherwise shown on the drawings. HVAC ducting will be located between the ceiling and the roof.

The MV switchgear room floor will have a 900mm wide opening to Level 00, extending over the full length of the room, to accommodate incoming and outgoing cables.

Cabling along the opposite side of the building, for the Relay, Metering, SACDA and LV rooms, will be accommodated within 110mm ducts beneath a false floor, comprising of *"Solidfeel Access Flooring Airflow 70"* modular interchangeable steel panels supported by a steel under structure, or approved equivalent.

The roof comprises of aluminium sheeting–extending down to the Level 01 floor level, and supported by 406mm x 178mm x 54mm I-profile steel trusses and transverse 180mm x 70mm C-shaped parallel flange channels.

A false ceiling will be installed at the Relay, Metering, SCADA, LV and MV Switchgear Room. The ceiling will be suspended from the roof trusses by 50mm x 50mm x 3mm sag bars. The false ceiling shall be 600mm x 1200mm "Lafarge Gypsum Master" or approved equivalent. HVAC ducting is to be located above this ceiling.

The steel trusses shall be bolted down with steel holding-down bolts, cast into the concrete perimeter beam at the Level 01 floor level. Aluminium flashings, similar colour to roof sheeting will be provided at the gable ends of the roof.

100mm x 100mm x 4000mm SHS gable columns will be installed off Level 02, to provide a frame for the aluminium louvres. Similar support systems will be used on all substations. Roof bracing will comprise of 100mm x 100mm x 8mm equal angles.

Fibreglass gutters are to be provided along the full length of the building, on both sides, with surface mounted downpipes

All floors, apart from rooms with a false floor, will have a “Mastertop 1210 Plus”, or approved equivalent, light grey epoxy floor coating. The chiller plant room will have a fibre-glass waterproof flooring.

All internal doors shall be solid core or fire doors, depending on location, and as specified.

Voids will be provided within the floors and walls as required to accommodate the HVAC ducting.

Stairways will be provided at either end of the building, to provide normal access and for evacuation in the event of fire. 1000mm high polished 316L stainless steel handrails, as detailed on the drawings, shall be provided along stairways, as well as along the external edges of the loading platforms.

Access to the building will be from either end, which will have glazed sections, providing natural lighting to the Level 00 service level area and the access hall on Level 01. All further equipment rooms on Level 01 will have artificial lighting only. There are no doors or windows along the length of the building.

The North Western corner of the building will have aluminium louvres at the gable end, to provide ventilation to the HVAC chiller plant room. The roofing above the chiller plant room will comprise of 316L polished stainless steel mesh, to allow free air flow to and from the chiller plant.

A mechanical louvre opening is also to be installed on the south-western side at the gable end, to accommodate the airflow to the HVAC fresh air fans. Blast ducts with mechanical vents are to be provided on either end of the building to relieve pressure within each room.

A 356mm x 171mm x 67mm I-profile steel crawl beam will be installed at the top of roof level on the southern side of the building, to allow future lifting of equipment from ground level to Level 01. 2.7m x 2.8m roller shutter doors are to be installed at Levels 00 and 01 beneath the crawl beam.

Wherever the required quality databooks are not available, the required inspections and tests need to be conducted on all infrastructure completed by previous contractor to ensure proper and safe commissioning.

1.15.3 Substation M Building

The substation is a rectangular building, with a footprint of approximately 40m x 12m and a height of 8m. The building has dedicated rooms for service systems such as MV switchgear, Electronic, LV, HVAC equipment and the like. Further references are to be made to the technical specifications, drawings. The approximate dimensions of the rooms are as per the table below:

TABLE 10 : SUBSTATION M APPROXIMATE ROOM DIMENSIONS

Room	(m^2)
MV Switchgear Room	103
VSD and Transformer Room	127
LV and Electronics Room	55
HVAC Room	81
Chiller Plant Yard	60

The building will not have any rest room or ablution facilities.

The building will consist of a concrete framed structure with brick intermediate walls and an external face brick cavity wall. The roof consists of colour-coated aluminium sheeting with an integral insulation sandwich panel, all supported by a steel truss system. Internal wall finishes are generally of plaster and paint.

The building will have a reinforced concrete foundation consisting of strip footings and a reinforced concrete floor. Concrete columns around the perimeter and centre of the structure will stiffen the structure and support the elevated concrete ring beam.

The external walls will comprise of a 280mm cavity wall, with face brick on the exterior and plastered brick on the internal side. Interior walls will be in brickwork. HVAC ducting will be located in the ceiling space.

The roof comprises of aluminium roof sheeting, mill finish, or approved equivalent, with a PDVF coating surface treatment.

False ceilings will be installed for the MV Switchgear, HVAC rooms and any others as shown on the drawings. The ceiling will be suspended from the roof trusses by 50mm x 50mm x 3mm sag bars. The false ceiling shall be 600mm x 1200mm “Lafarge Gypsum Master” or approved equivalent. HVAC ducting is to be located above this ceiling.

The steel trusses shall be bolted down with steel holding-down bolts, cast into the concrete perimeter beam. Colour-coated flashings, of the same material as the roof sheet, will be provided at the gable ends of the roof.

Extruded Aluminium gutters (300mm wide x 200mm deep) are to be provided along the full length of the building, on both sides, with 110mm Ø HDPE down pipes.

All floors will have a “Mastertop 1210 Plus”, or approved equivalent, light grey epoxy floor coating. All internal doors shall be solid core or fire doors, depending on location.

Wherever the required quality databooks are not available, the required inspections and tests need to be conducted on all infrastructure completed by previous contractor to ensure proper and safe commissioning.

1.15.4 Substation N Building

The substation is a rectangular building, with a footprint of approximately 45m x 12m and a height of 8m. The building has dedicated rooms for service systems such as MV switchgear, Electronic, LV, HVAC equipment and the like. Further references are to be made to the technical specifications and drawings. The approximate dimensions of the rooms are as per the table below:

TABLE 11 : SUBSTATION N APPROXIMATE ROOM DIMENSIONS

Room	(m^2)
MV Switchgear Room	103
VSD and Transformer Room	183
LV and Electronics Room	55
HVAC Room	81
Chiller Plant Yard	60

The building will not have any rest room or ablution facilities.

The building will consist of a concrete framed structure with brick intermediate walls and an external face brick cavity wall. The roof consists of colour-coated aluminium sheeting with an integral insulation sandwich panel, all supported by a steel truss system. Internal wall finishes are generally of plaster and paint.

The building will have a reinforced concrete foundation consisting of strip footings and a reinforced concrete floor. Concrete columns around the perimeter and centre of the structure will stiffen the structure and support the elevated concrete ring beam.

The external walls will comprise of a 280mm cavity wall, with face brick on the exterior and plastered brick on the internal side. Interior walls will be in brickwork. HVAC ducting will be located in the ceiling space.

The roof comprises of aluminium roof sheeting, mill finish, or approved equivalent, with a PDVF coating surface treatment.

False ceilings will be installed for the MV Switchgear, HVAC room and any others as shown on the drawings etc. The ceiling will be suspended from the roof trusses by 50mm x 50mm x 3mm sag bars. The false ceiling shall be 600mm x 1200mm “Lafarge Gypsum Master” or approved equivalent. HVAC ducting is to be located above this ceiling.

The steel trusses shall be bolted down with steel holding-down bolts, cast into the concrete perimeter beam. Colour-coated flashings, of the same material as the roof sheet, will be provided at the gable ends of the roof.

Extruded Aluminium gutters (300mm wide x 200mm deep) are to be provided along the full length of the building, on both sides, with 110mm Ø HDPE down pipes.

All floors will have a “Mastertop 1210 Plus”, or approved equivalent, light grey epoxy floor coating. All internal doors shall be solid core or fire doors, depending on location.

Wherever the required quality databooks are not available, the required inspections and tests need to be conducted on all infrastructure completed by previous contractor to ensure proper and safe commissioning.

1.16 HVAC

Closed circuit chilled water HVAC systems are to be installed at the 11 kV Switch House at the Main Intake Substation and at Substations M and N. A similar design is to be used for all three buildings, which will consist of the following main elements.

i. *Air-Cooled Chillers (ACC's)*

Electrically-powered air-cooled chillers (ACC's) will provide cooled water to the air handling units (AHU's). A dry cooling system is to be installed, ie. water will not be exposed to the atmosphere. The ACC's will be equipped with air-cooled condensers, which are an integral part of the ACC and reject heat taken from the building to the atmosphere.

Chillers will contain a number of refrigeration loops, with one loop serving to provide redundancy to ensure that cooling can be maintained in the case of failure of one of the other refrigeration loops, i.e. total cooling can be provided by any three of the four loops or two of the three, as applicable. The refrigeration loops are internal to the chillers (i.e. packaged).

The chilled water buffer tanks, expansion tanks and pumps do not form an integral part of the ACC's and must be provided separately.

ACC's will be located in a dedicated chiller plant room at each building respectively. The ACC's have been procured and were stored on site by the previous contractor. It is the responsibility of the successful bidder to inspect and test these units for compliance and suitability to be used going forward. This shall include FAT, SAT, etc, with appropriate certificates in order to provide the client with the confidence that the plant will last for its designed life cycle.

ii. *Air Handling Units (AHU's)*

AHU's will distribute cooled air to the designated areas within the buildings and receive return air-flows from these designated areas via separate supply-air and return-air ducting.

The AHU's contain the fans and cooling coils, used to transfer heat from the incoming airstream to the flow of cooled water from the ACC's.

iii. *Fresh Air Fans (FAF's)*

Fresh air fans (FAF's) will provide filtered, fresh air to the AHU's and also supply filtered fresh air directly to areas where temperature control is not required (e.g. plantrooms). The FAF's filter unit shall be of a design suitable for airstreams with a large amount of particulates (dust).

To ensure that dust is not entrained into the plant room, outside air is to be ducted to the fresh air fan and filter unit via louvered openings in the plant room wall. Dust removed from the air by the filter unit is to be collected using a filter box with conventional bag filters.

iv. *Piping and Ducting*

Piping (water) systems shall be installed to convey heat from the air handling unit to the ACC. Chilled water reticulation shall be kept away from the electrical installations by routing them via the A/C Rooms and service areas to house the piping. Routing the piping in this way will also ensure that it remains accessible for inspection and possible maintenance.

Ducting will include supply air grilles, return air grilles, sound attenuators and motorized fire dampeners.

v. *Controls*

Each substation building will be sealed to maintain cleanliness. Air is to be supplied into the building to maintain a positive pressure, to assists in keeping dust out. The pressure differential (to outside) is designed to be maintained at 50 Pa while doors are closed. Pressure sensors shall be provided within the equipment rooms and at the main access points to the buildings to register a loss of pressure.

Fire sensors shall be interlocked with the HVAC systems to close the fire dampers within the ducting to rooms/spaces where a fire has been detected. This prevents the fire from spreading to adjacent rooms/fire zones and improves the efficiency of the operation of the fire suppression system. Thus, the supply to the fire affected area will be cut off, without affecting the rest of the HVAC systems operation.

No HVAC installations are required for the Eskom Control Building within the Ystervark portion of the Main Intake Substation.

The table below provides a summary of the type and location of HVAC equipment to be installed at the substation buildings.

TABLE 12 : HVAC INSTALLATIONS

Unit	Location within Building	Supply Areas	Description
MAIN INTAKE SUBSTATION			
ACC 01	Southern End	All AHU's Dual circuit primary chiller with single circuit secondary chiller to provide redundancy.	Air-cooled chiller – Primary unit
ACC 02			Air-cooled chiller – For redundancy
AHU 01	HVAC Room	Relay Room, Metering Room, SCADA Room, LV Room	Horizontal, chilled-water, air handling units
AHU 02		MV Switchgear Room: Southern Side	
AHU 03		MV Switchgear Room: Northern Side	
FAF 01		All AHU's, Internal Corridors, HVAC Room, Stairwells, Level 00 Service Area and Storeroom.	Building fresh air supply fan, with spin filter unit
SUBSTATION M			
ACC 01	Southern End	All AHU's	Identical air-cooled chillers with dual refrigerating circuits, three circuits running, one circuit standby
ACC 02		All AHU's	
AHU 01	HVAC Room	VSD and Transformer Room	Vertical, chilled-water air handling unit
AHU 02	HVAC Room	MV Switchgear Room, LV and Electronics Room	Horizontal, chilled-water air handling unit
FAF 01	HVAC Room	All AHU's and HVAC Room	Building fresh air supply fan, with spin filter unit
SUBSTATION N			
ACC 01	Southern End	All AHU's	Identical air-cooled chillers with dual refrigerating circuits, three circuits running, one circuit standby
ACC 02			
AHU 01	HVAC Room	VSD and Transformer Room	Vertical, chilled-water air handling unit
AHU 02	HVAC Room	MV Switchgear Room, LV and Electronics Room	Horizontal, chilled-water air handling unit
FAF 01	HVAC Room	All AHU's and HVAC Room	Building fresh air supply fan, with spin filter unit

1.17 Fire Protection Systems

The fire protection systems to be provided at the 11 kV Switch House (Main Intake Substation) and the buildings for Substations M and N will include the following:

- Fire detection systems and alarms (as described in the Fire Detection Systems section above and associated other contract documentation).
- Fixed and portable fire extinguishers, including 5kg CO_2, 4.5kg DCP and 25 kg mobile DCP units.
- The fire rating for all other doors shall be as indicated on the drawings.
- All fire-rated side-hung doors shall be of the self-closing type (ie. fitted with door closers).
- 1.0m x 3.6m Mechanically actuated smoke vents, interlocked with the fire alarm, shall be provided at the top of the stairways located on either side of the building (Main Intake Substation only) to provide natural ventilation in the event of a fire.
- Walls around stairwells have been designed for a 2 hour fire rating. Other internal walls will have a 1 hour rating (as indicated on the fire plan drawings).
- An automatic full flood gas suppression system is to be installed and supplied complete with all components necessary for the proper operation of the system. The system shall be designed for NOVEC 1230 or similar approved. The system shall be interlocked with the fire alarms, to be actuated to discharge the suppressant in the event of fire.
- Evacuation signage, as indicated on the drawings.
- Fire stopping shall be provided at floor penetrations, as indicated on the fire plan drawings, and for any openings within fire rated walls.
- The fire protection systems shall comply with the requirements as stipulated by the national building regulations and shall be designed in accordance with all relevant fire standards and codes of practice. This system shall also comply with all aspects of the fire suppression technical specification for the Tippler 3 Bulk Power Supply.

1.18 Civil *Works*

Civil *works* will include the following, as described in further detail below:

- Bulk earthworks to platforms
- Retaining wall systems
- Roads and hard-standing areas around buildings.
- Wet services
- Stormwater management
- Installation of sleeves
- Fencing
- Horizontal directional drilling (HDD) beneath existing rail lines and roads.

Wherever the required quality databooks and tests are not available, the required inspections and tests need to be conducted on all civil works completed by previous contractor to ensure proper and safe commissioning.

1.18.1 Main Intake Substation

Civil *works* for the Main Intake substation will include the following, as described in further detail below:

i. *Bulk Earthworks*

Bulk earthworks have been carried out to create a platform. The platform needs to be completed according to the design drawings with an extent of approximately 120m x 147m and finished levels, to accommodate the new substation yard, switch house, Eskom control house, transformers, switchgear, bus bars, conductors and the like. The earthworks will entail excavations and backfilling. G5 materials with a soil resistivity (p) value of between 10 Ωm - 100 Ωm shall be placed and compacted above the existing finished levels to the for the bulk earthworks.

The minimum finished G5 layer thickness shall be as follows:

- Beneath the 11 kV Switch House : 1.5m
- Remainder of platform : 1.15m

The G5 layer shall be brought in from commercial sources and is to be placed above the exisitng earth mats covering the full extent of the platform. Compaction requirements for bulk earthworks are as follows:

- The G5 layer, extending over the full extent of the platform and earthmats, shall be compacted to 95% Mod AASHTO, in layers no thicker than 150mm.
- Backfilled areas beyond the earthmats and platform shall comprise of G7 materials (minimum) and shall be compacted to 93% Mod AASHTO, in layers no thicker than 300mm.

Excess cut materials shall be disposed of at the designated stockpile area, as indicated in Part C.4 : Site Information.

ii. *Roads and Hard-Standing Areas*

New external gravel roads are to be provided to allow separate access to the Eskom and Transnet portions of the substations. The external road will follow along the outside of the substation perimeter fencing.

Routine access for Eskom personnel will be via the existing gravel road to the Iscor substation, which is to be extended from the northern boundary of the *Employer's* properties, abutting the Sunrise Energy Property, to the new substation. A new gate is to be provided at the boundary fence. This access shall also be used during construction of the Main Intake Substation, until such time as the service roads between the port and Tippler 3 building, to be constructed by Others, have been completed.

Routine access for the *Employer's* operating staff to the substation building and yard will be off the new Service Road 1 between the port and Tippler 3, following the alignment of the existing track to Substation H and continuing between existing Conveyor CV-305 to the port and the new perimeter fence on the western side of the substation yard, up to the entrances to the yard from the northern and southern side of the yard.

Various existing services, including electrical and communication cables, water and effluent pipelines, are located within this corridor and will have to be dealt with in accordance with the specifications and this Works Information.

Access Roads 1 and 2, serving the Eskom portion of the substation, will include the following layerworks:

- 200mm Gravel wearing course compacted to at least 98% MOD AASHTO.
- 150mm G5 subbase compacted to at least 95% MOD AASHTO.
- 150mm imported gravel G7 selected subgrade compacted to at least 95% MOD AASHTO.
- 150mm rip and re-compact in-situ soil to at least 93% MOD AASHTO (100% for sand).

Access Road 3 and 4, serving the *Employer's* portion of the substation, shall include the following layerworks:

- 150mm Gravel wearing course compacted to at least 98% MOD AASHTO.
- 150mm imported gravel G7 selected subgrade compacted to at least 95% MOD AASHTO.
- 150mm rip and re-compact in-situ soil to at least 93% MOD AASHTO (100% for sand).

Two internal roads, with segmental block paving, are to be provided within the fenced-off substation yard, providing separate access to the Eskom and the *Employer's* buildings and parts of the yard respectively. These roads will have the following layerworks.

- 80mm S-A Interlocking heavy duty pavers on 20mm sand bedding.
- 150mm C3 cement-stabilized gravel base compacted to 97% mod AASHTO density.
- 150mm rip and re-compact G5 subbase platform to 95% mod AASHTO.

Concrete-surfaced access is to be provided to the transformers and to the open area between the Main Intake Substation building and block-paved internal Road No. 2, to include the following:

- 250 mm jointed concrete slab with 28-day cube strength of 40 MPa (19mm stone) and design flexural of 3.8 MPa.
- 150 mm C3 cement-stabilized subbase, compacted to 97% Mod AASHTO.
- 150mm rip and re-compact G5 subbase platform to 95% mod AASHTO.

Areas within the substation yard are to be covered with a Class A4 Bidim layer and a 100mm layer of 37.5mm single-sized crushed stone. This shall extend to 1.2 m beyond the perimeter fencing.

Wherever the required quality databooks and tests are not available, the required inspections and tests need to be conducted on all layerworks completed by previous contractor to ensure proper and safe commissioning.

iii. *Stormwater Management*

Stormwater run-off discharging from the undisturbed areas to the east, north and south of the footprint of the bulk earthworks will be collected within an unlined open drain immediately beyond the perimeter of the cut slopes and discharged to adjoining open areas. The run-off will be discharged to areas outside of the substation platform.

Surface run-off generated within the platform area and surrounding access roads will be collected via a series of concrete channels, discharging into catchpits and a below-ground system of uPVC and concrete pipes.

A series of subsurface drains will also be installed along the northern, eastern and southern perimeter of the platform, as well as within the platform area. These drains will discharge into the stormwater catchpits and manholes.
All surface and subsurface run-off will be discharged into a detention pond, which is to be constructed immediately north of the substation platform.

iv. *Wet Services*

The following water supplies and connections are to be provided:

- Two new 110mm diameter water mains, teeing off from an existing 160mm main near the western boundary of the substation platform, are to be provided along the northern and southern side of the Site, to feed the fire hydrants on either side of the platform.
- A 32mm diameter connection will supply water for the HVAC chillers at the main substation building, taking off from the new 110mm main on the southern side of the Site.
- Water to the ablutions at the Eskom control building at the south-eastern corner of the Site will be obtained via a 2500 litre rainwater harvesting tank, to be provided immediately adjacent to the control building.
- Provision is to be made for the discharge of accidental oil spillages from the transformers into a collection system, comprising of sumps, below-ground concrete piping, a 44m^3 oil dam and trap system.
- Effluent discharging from the Eskom control building will be disposed of on Site via a 6m^3 conservancy tank, which will have to be periodically cleaned and pumped out.

v. *Fencing*

The entire substation area shall be fenced off with 2.4m high steel palisade fencing. Further fencing, to the same standard, is to be provided within the substation yard, subdividing the following areas:

- The Eskom control building at the south-eastern corner of the yard is to be fenced off from the rest of the yard, with separate vehicular and pedestrian access to the rest of the Eskom yard.
- The transformers and associated equipment is to be separated from the rest of the yard, with separate gated pedestrian accesses from the Eskom and the *Employer's* portions of the yard.
- Fencing is also to be provided to demarcate further boundaries between the Eskom and Transnet portions of the yard.

The following access points and gates shall be provided:

- One 5.5m wide sliding gate is to be provided for vehicular access from the new Sunrise Energy road onto Access Road 1.
- Four 5.0m wide sliding gates are to be provided for vehicular access from both the northern and southern side of the Eskom portions of the substation yard.
- Two 5.0m wide sliding gates are to be provided for vehicular access from both the northern and southern side of the Transnet portions of the substation yard.
- One 5.0m wide double-leaf gate and one 1.0m wide pedestrian gate are to be installed to provide access from the Eskom control building to the eastern side of the yard, to be operated and maintained by Eskom.
- One 5.0m wide double-leaf gate and one 1.0m wide pedestrian gate are to be installed to provide access from the Transnet 11 kV switch house to the western side of the yard, to be operated and maintained by Transnet.

- One 6.0m wide double-leaf gate is to be installed between Access Road 1 and Access Road 3 to provide access from the Main Intake Substation Site to the rest of the port.
- Provision is also to be made within the fence line along the transformer yard for six removable panels of 5.0m width each, for future access to the transformers.

vi. *Ducting*

110mm and 160mm HDPE ducting shall be provided for all incoming and outgoing cables within the external hard standing areas around the 11 kV Switch Room building, as well as within the substation yard area, as detailed on the drawings and specifications.

1.18.2 Substation M

The following civil *works* are to be undertaken at Substation M:

i. *Earthworks*

Bulk earthworks have been carried out to create a platform. The platform needs to be completed according to the design drawings finished levels. The earthworks will entail excavations and backfilling. A layer of G5 subbase materials with a soil resistivity (p) value of between 10 Ωm - 100 Ωm shall be placed and compacted above the indicated finished levels within the footprint of the building, as shown on the drawings.

The G5 subbase layer shall be brought in from commercial sources and is to be placed above the earth mats covering the full extent of the platform. Should the excavated materials consistently meet the soils classification for resistivity as detailed above, the Employer may consent to the use such materials for backfilling to the platform area.

The imported G5 subbase layer shall be placed in layers not exceeding 150mm and shall be compacted to 95% Mod AASHTO.

The *Contractor's* attention is drawn to the sewer rising mains immediately east of substation building, which may not be damaged during any stage of construction.

ii. *Paving*

Concrete-surfaced access is to be provided to the north of the substation building and an apron slab provided around the remainder of the building.

The concrete paving shall be as follows:

- 250 mm concrete with 28-day cube strength of 40 MPa (19mm stone) and design flexural of 3.8 MPa.
- 150 mm C3 cement-stabilized subbase compacted to 97% Mod AASHTO.
- 150mm imported gravel G7 selected subgrade compacted to at least 95% MOD AASHTO.
- 150mm G9 in-situ material compacted to 93% MOD AASHTO density (100% for sand).

iii. *Retaining Walls*

A retaining wall, extending over a length of 70m and a maximum height of 3.0m, is completed along the eastern side of the building platform, abutting the ArcelorMittal property. The following system was followed for construction of retaining wall:

- Primary Support : 2 rows of R25N self-drilling nails, or approved equivalent, 6m in length, to be installed at an angle of 10° to 15° to the horizontal, spaced at 1.5m c/c horizontally and vertically. Nails shall be fixed with 250mm x 250mm x 8mm dome plates (galvanised) with hexagonal nuts (galvanised) with minimum 40mm shotcrete cover over the nail heads.
- Secondary Support : 175mm thick 30 MPa reinforced shotcrete with 25mm flush coat (total thickness 200mm) with 2 layers of Ref. 395 mesh (galvanised) with 40mm minimum cover.
- Vertical Geodrains : Wick Drain 100 or approved equivalent, at 1.5m c/c with 50mm ø weep pipes at toe of wall. Geodrains to discharge 550mm above earthworks level through 50mm ø HDPE weep pipes.

No quality or commissioning records are available for this structure and will need to be verified and completed as needed.

iv. *Wet Services*

The *Contractor* shall install a 110mm feed from the Tippler 3 building to Substation M, to feed the fire hydrant outside of the substation and the HVAC systems within. The take-off from this 110mm feed will be off the fire ring main around the Tippler 3 building, which is to be installed by Others. A 35mm Polycop connection is to be provided to the substation building to supply water for the HVAC installations.

v. *Stormwater Management*

Stormwater run-off from the substation building roof will be collected via gutters and downpipes and discharged to open drains, channels and catchpits along the perimeter of the surrounding hard-stand platform, as shown on the drawings. Vertical soakaways are to be provided along these open drains.

vi. *Ducting*

160mm HDPE ducting shall be provided for all incoming and outgoing cables within the external hardstanding areas at the building and beneath Service Road 1, on the western side of the building and any other ducting as detailed on the drawings and specifications. The *Contractor* shall schedule and coordinate the installation of these ducts to avoid any delays and disruptions to such Others.

1.18.3 Substation N

i. *Existing Services*

It is known that there are existing services crossing the Substation N Site and shall be relocated to outside of the works area and rendered safe prior to commencement of earthworks operations.
The relocation of services shall be completed as follows:
All pipes and cables to be relocated to corridor immediately east of ArcelorMittal Conveyor CV-305.

- All new pipes and cables to be laid prior to switch-overs.
- Switch-overs to be arranged and coordinated with port authorities.
- Cables to be individually isolated, in conjunction with ports authority, prior to making new cable joints. All cable joints to be made in accordance with specifications.
- Redundant cables and pipes to be removed from Site once relocation has been completed.

Whilst the above services have been identified off available drawings, the *Employer* does not warrant that the services as listed above constitute all services within the *works* area. The *Contractor* shall independently verify the position, size and type of pipeline or cable prior to the relocation or discontinuation of any services.

The *Contractor* shall also undertake a detailed sweep of the *works* area, to identify the presence of any other services not identified on the drawings, as described under Section 5.6 of this Works Information and as detailed in the specifications,

ii. *Earthworks*

Bulk earthworks have been carried out to create a platform. The platform needs to be completed according to the design drawings finished levels. The earthworks will entail excavations and backfilling. A layer of G5 subbase materials with a soil resistivity (p) value of between 10 Ωm - 100 Ωm shall be placed and compacted above the indicated finished levels within the footprint of the building, as shown on the drawings.

The G5 subbase layer shall be brought in from commercial sources and is to be placed above the earth mats covering the full extent of the platform.
Should the excavated materials consistently meet the soils classification for resistivity as detailed above, the Employer may consent to the use such materials for backfilling to the platform area.

The imported G5 subbase layer shall be placed in layers not exceeding 150mm and shall be compacted to 95% Mod AASHTO.

iii. *Retaining Wall*

A retaining wall, extending over a length of 135m and a maximum height of 6.0m, is completed along the eastern side of the building platform. The following system was followed for construction of the retaining wall:

- Secant Pile Wall: 750mm “Hard” piles at 1200mm c/c alternating with "soft” piles at 1200mm c/c. Piles are min 2m deep below working platform.
- Primary Support : 3 Rows of Tian 30/11 Anchors drilled at 15 deg to the horizontal, through every hard pile.
- Secondary Support : Minimum 125mm thick 30 MPa reinforced shotcrete with Ref. 193 mesh

No quality or commissioning records are available for this structure and will need to be verified and completed as needed.

iv. *Wet Services*

A new 110mm diameter water main, teeing off from an existing 160mm main just to the west of the main access road to the new substation, is to be provided along the southern side of the Site, to feed a fire hydrant positioned at the southern end of the platform.

A 35mm diameter Polycop connection will supply water for the HVAC chillers at the main substation building, taking off from the new 110mm main on the southern side of the Site.

v. *Paving*

Heavy duty paving access is to be provided to the north and east of the substation building and an apron around the remainder of the building. The paving shall be as follows:

- 80mm Heavy duty paving in herringbone pattern on 20mm sand bedding.
- 150 mm C3 cement-stabilized gravel subbase compacted to 98% Mod AASHTO.
- 150 mm C4 cement-stabilized gravel subbase compacted to 98% Mod AASHTO.
- 150mm gravel G7 selected subgrade compacted to at least 95% MOD AASHTO.
- 150mm G9 in-situ material compacted to 93% MOD AASHTO density (100% for sand).

vi. *Stormwater Management*

Stormwater run-off from the substation building roof will be collected via gutters, drains and downpipes and discharged to open drains and channels along the perimeter of the surrounding hard-stand platform, as shown on the drawings. Vertical soakaways are to be provided along these open drains and channels.

vii. *Ducting*

160mm HDPE ducting shall be provided within and beyond the platform area, as indicated on the drawings and as detailed in the specifications. Draw boxes to be provided around the building as detailed on the drawings.

2. *EMPLOYER'S* OBJECTIVES

The *Employer* objective for this project in the Saldanha Port Terminal area is to maintain the materials handling capacity by the addition of a third tippler and associated infrastructure. The *Employer* has identified the provision of a third tippler as critical to its continued logistics chain.

The bulk electrical systems as described in this Works Information and accompanying documents will raise the supply to the Port of Saldanha from a Notified Maximum Demand (NMD) of 25 MVA to 40 MVA, to meet the requirements of the Tippler 3 project and to sustain future expansions and developments, including increases in the bulk handling capacity of the port.

3. INTERPRETATION AND TERMINOLOGY

The following abbreviations are used in this Works Information:

Abbreviation	Meaning given to the abbreviation
AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating Current
AIA	Authorised Inspection Authority
AI	Analogue Input
AISI	American Institute of Steel Industries
AO	Analogue output
B-BBEE	Broad Based Black Economic Empowerment
BMS	Building Management System
BS	British Standard
BTU	Battery Terminal Unit
CCR	Central Control Room at Port of Saldanha
CCTV	Closed Circuit Television
CD	Compact Disc
CDR	*Contractor* Documentation Register
CEM SOP	Construction Environmental Management Standard Operating Procedure
CIRP	*Contractor*'s Industrial Relations Practitioner
CKS	Coordinating Specifications issued by the Central Coordinating Committee under the auspices of the South African Bureau of Standards
CM	Construction Manager
CoC	Certificate of Compliance
CRL	*Contractor* Review Label
CSHEO	*Contractor*'s Safety, Health and Environmental Officer
CSIR	Council for Scientific and Industrial Research
CT	Current Transformer
Cu	Copper
DTI	Department of Trade and Industry
ECC	NEC3 Engineering and Construction Contract
ELPA	Earthing and Lightning Protection Association
EM	Environmental Management
EMPr	Environmental Management Programme (as authorized by DEA)
ENCs	Eskom National Contract Schemes
EO	Environmental Officer
FDP	Final Design Package
FO	Fibre Optic

Abbreviation	Meaning given to the abbreviation
HAW	Hazard Assessment Workshop
HAZOP	Hazard and Operability Study
HDD	Horizontal Direction Drilling
HMI	Human Machine Interface
HSSP	Health and Safety Surveillance Plan
HVAC	Heating, Ventilation, and Air-Conditioning
HV	High Voltage
ICT	Information Communication Technology
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
INC	Independent Nominated Consultant
I/O	Input/Output
IP	Industrial Participation
IP	Ingress Protection
IPO	Industrial Participation Obligation
IPP	Industrial Participation Policy
IPS	Industrial Participation Secretariat
IR	Industrial Relations
IRCC	Industrial Relations Co-ordinating Committee
ISO	International Standards Organisation
JSA	Job Safety Analysis
kVA	Kilo Volt Ampere
kV	Kilo Volt
LED	Light Emitting Diode
LPS	Lightning Protection System
LV	Low Voltage
MEIP	Mechanical, Electrical, Instrumentation and Piping
MHSA	Mine Health and Safety Act
MSL	Mean Sea Level
MVA	Mega Volt Ampere
MV	Medium Voltage
OCTS	Off-Circuit Tap Switch
OEM	Original Equipment Manufacturer
OLM	Optical Link Module
OLTS	On Load Tap Switch
PC	Personal Computer
PES	Project Environmental Specifications
PHA	Preliminary Hazard Assessment

Abbreviation	Meaning given to the abbreviation
PILC	Paper Insulated Lead Covered
PIRM	Project Industrial Relations Manager
PIRPMP	Project Industrial Relations Policy and Management Plan
POE	Power over Ethernet
PQP	Project Quality Plan
ProgEM	Programme Environmental Manager
ProjEM	Project Environmental Manager
PSPM	Project Safety Program Manager
PSSM	Project Site Safety Manager
PVT	Power Voltage Transformer
QA	Quality Assurance
QCP	Quality Control Plan
QMS	Quality Management System
RIO	Remote input – output device
RMS	Root Mean Square
SABS	South African Bureau of Standards
SAGC	South African Geomatics Council
SANS	South African National Standards
SAQCC	South African Qualification & Certification Committee
SASRIA	South African Special Risks Insurance Association
SCADA	Supervisory Control and Data Acquisition
SES	Standard Environmental Specification
SHE	Safety, Health and Environment
SHEC	Safety, Health and Environment Co-ordinator
SIP	Site Induction Programme
SMP	Safety Management Plan
SOC	State Owned Company
SSRC	Site Safety Review Committee
SS	Soft Starter
SWA	Steel Wire Armoured
TCP	Transnet Capital Projects
TGC	Transnet Group Capital
TFR	Transnet Freight Rail
TNPA	Transnet National Ports Authority
TPT	Transnet Port Terminals
UPS	Uninterruptable Power Supply
VOIP	Voice Over Internet Protocol
VSD	Variable Speed Drive
VT	Voltage Transformer

Abbreviation	Meaning given to the abbreviation
XLPE	Cross Linked Polyethylene

4. ENGINEERING AND THE *CONTRACTOR'S* DESIGN

4.1 Disclaimer

The *Contractors* warrants that the tender as submitted makes full allowances for all information provided in this Works Information and further documents referenced therein, and includes all and every item(s) required to provide the facilities as described. This shall include also all further information and clarifications provided by the *Employer*, as described in Part T.2.2-36. : Tender Declaration Form.

Further to the above, it will also be the responsibility of the *Contractor* to ensure he has all and associated latest additions of statutory regulations and standards, *Employer* and Eskom standards/specifications and the like. The *Employer* shall not be held liable in any way, shape or form as a result of losses incurred by the *Contractor* not adhering to the above.

4.2 *Employer's* Design

The *Employer*'s design for the *works* covers all disciplines that are required for the construction and operation of the new bulk power installations as described in this Works Information. Further relevant design information is contained in Annexures A and B and includes:

- Annexure A - Project Specifications.
- Annexure B - Tender Drawings.

These documents shall be read in conjunction with the bill of quantities.

The *Employer* grants the *Contractor* a licence to use the copyright in design data presented to the *Contractor* for the purpose of the *works* only.

Concurrent with the *works* as described in this document, the *Employer* also has, or will be, procuring and installing under separate contracts the mechanical, electrical and instrumentation (MEIP) equipment for Tippler 3 and the new conveyors.

The *Employer* has also concluded separate contracts for the construction of the Tippler 3 vault and tunnels and new access roads, which are in close proximity to the *works* that are to be executed by the *Contractor*. The *Contractor* will be provided with associated details where required of the abovementioned and shall take cognisance of the designs for these parts of the project.

4.3 Parts of the *Works* which the *Contractor* is to Design

4.3.1 General

All temporary or permanent *works* designed by the *Contractor* shall remain the *Contractor's* responsibility. The *Contractor* shall appoint suitably qualified, experienced and professionally registered engineers and designers, to be approved by the *Employer*, to carry out detailed designs for the permanent and where applicable temporary *works*, in accordance with this Works Information, the drawings, bills of materials and the project specifications.

The *Contractor* shall indemnify and hold indemnified the *Project Manager* and *Employer* against any claims and actions that may arise out of the design and construction of such permanent and temporary *works*.

The *Contractor* shall be responsible for full compliance with all codes of practice, safety, professional procedures, checking, Site approval and requirements of the construction regulations with regards to the temporary and permanent *works*.

The *Contractor's* designs shall be fully integrated with the design of the *works* as provided by the *Employer*.

Where temporary or permanent *works* are located close to or within infrastructure or property owned by Others, e.g. Transnet, Eskom, Telkom, Haul Road Committee or other service and utility owners as may be the case, the *Contractor* will be responsible for the following, but not limited to:

- Liaising with the relevant parties to ascertain impacts on existing property or on any planned activities. Measures to eliminate or mitigate such impacts shall be developed and agreed to with all affected parties.
- Ensuring compliance with the applicable standards, procedures and requirements of such third parties.
- Identify requirements and provide protection of all infrastructure owned by such third parties.

4.3.2 Permanent *Works*

The *Contractor* shall provide the following, but not limited to, systems associated with the permanent *works* (Refer to section 1.2) in accordance with the respective contract documentation:

- New protection and metering infrastructure at the new substations, including electrical interlocking and calculation of protection settings (settings study).
- New main electronic monitoring and control infrastructure, with associated installations.
- VOIP telephone systems.
- Access control and intruder alarm systems at new substations.
- Buildings fire detection systems at new substations.
- UPS systems at the new substation buildings, including BTU at the new 132 kV Eskom Control Building, in accordance with Eskom's requirements.
- Earthing and lightning protection systems for the substations, including comprehensive lightning risk assessment and soil resistivity tests.
- HVAC and fire suppression systems at new substations.
- The 400V encapsulated busbar system from 3.15MVA 11kV/400V transformer to 400V Low Voltage distribution board in the Tippler 3 building.

The *Employer* remains responsible and accountable for the bulk power supply infrastructure design. However, the *Employer* has determined the specific design parameters that the *Contractor's* systems must adhere to. Therefore, the *Contractor* remains responsible and accountable for the detailed design, supply, installation, commissioning and operational performance of the nominated system(s) as per the contract documentation.

In addition, the *Contractor* is required to submit all system calculations and associated information stipulated in the respective contract documentation to the *Employer* for review prior to procuring the system(s).
The provisions of Section 1.2 above shall apply in respect of the appointment of specialist subcontractors/OEMs for the execution of the above *works.* Reference is made also to Section 4.3.5 below, covering the submission and approval procedures for designs undertaken by the *Contractor*.

The *Contractor* shall further provide method statements, risks assessments and supporting documentation to the *Project Manager,* which shall cover, but not be limited to, the following permanent works:

- Identifying and relocation of existing services.
- Sleeves

4.3.3 Temporary *Works*

Temporary *works* are all *works* other than the permanent *works* indicated in the project specifications, drawings, bill of quantities and associated contract documentation. These include but are not limited to infrastructure to be removed from the Site at the end of construction, protection of new and existing infrastructure/services, dismantling existing infrastructure/services where specified and the like.

All temporary *works* shall be designed by the *Contractor* and shall remain the *Contractor's* responsibility. The *Contractor* is responsible for the overall integration of the design of the temporary *works* with the design of the *Employer.* The *Contractor* shall appoint suitably qualified and experienced designers to carry out such *works* and shall indemnify and hold indemnified the *Project Manager* and *Employer* against any claims and actions that may arise out of the temporary *works*.

The *Contractor* shall be responsible for full compliance with all codes of practice, safety, professional procedures, checking, approvals and requirements of the Construction Regulations and all other statutory regulations and standards, and *Employer* requirements, with regards to the temporary *works*.

The *Contractor* shall provide method statements, risks assessments, designs and supporting documentation to the *Project Manager,* which shall cover, but not be limited to, the following:

- Traffic management plan, covering in particular protection measures to be provided for activities being undertaken above or in close proximity to roads and walkways.
- Permitting procedures to cover all excavations, including in particular within the port area, taking account also of the requirements of the port operator.
- Construction of foundations, including protection of existing services and securing of excavations, in particular where these are located close to existing roads or structures.
- Fabrication and erection of structural steel members, including rigging plans as appropriate.
- Securing of Site where installations are being done in close proximity to ongoing port operations, e.g. installation of new cabling and tie-ins to existing electrical cables and substations.
- Switch-overs from existing to new electrical, instrumentation and control systems that are operated by Eskom and/or the *Employer*.
- Dealing with water on Site, including surface and sub-surface water.

The procedures for the submission and approval of all designs, method statements and the like for temporary *works,* including the relocation of existing services, shall also be as detailed under Section 4.3.5 below.

4.3.4 Geotechnical

The *Contractor* shall take cognisance of the prevailing soil conditions and recommendations as included in the geotechnical reports as referenced under Part C.4 : Site Information.

4.3.5 Procedure for Submission and Acceptance of *Contractor's* Design

In submitting the designs as described above, the *Contractor* shall follow the procedures as detailed below, unless specifically instructed otherwise in the technical specifications or other documents as applicable:

- The *Contractor's* documentation shall be issued to the *Project Manager* under cover of the *Contractor*'s transmittal note, indicating all contract references (i.e. Project No, Contract No, etc.) as well as the *Contractor*'s project document number, revision number, title and chronological listing of transmitted documentation.
- The formats for the *Contractor's* data as submitted will be dependent on the project procedure and will be specified by the *Project Manager*, upon the notified request of the *Contractor*.
- The *Contractor* shall deliver both hard copies and electronic media copies (CD Rom) to the *Project Manager* at the address stated within the Contract Data.
- All electronic documentation shall be submitted by the *Contractor* in Adobe Acrobat (.PDF) and native file format, with drawings also in 'rvt', 'dgn', 'dxf', 'dwg' or similar approved formats.
- The *Contractor* shall also provide any design package software files to the *Employer*, in the format specified by the *Employer*, if so requested, in order to review and/or verify drawings and designs.
- Acceptance of documentation will in no way relieve the *Contractor* of his responsibility for the correctness of information or conformance with his obligation to provide the *works*. This obligation vests solely with the *Contractor*.
- After review by the *Employer*, a copy of the original reviewed/marked-up drawing/ document, with the *Project Manager's* consolidated comments and document status marked on the *Contractor* review label, will be scanned and the hard copy will be returned to the *Contractor* under cover of the project's transmittal note for revision or re-submittal as instructed.
- The *Contractor* shall allow the *Project Manager* two weeks to review and respond to the *Contractor*'s submission of his documentation, i.e. from time of receipt by the *Employer* to the time of despatch to the *Contractor*.
- On receipt of the reviewed documentation, the *Contractor* shall make any modifications as requested or marked up and resubmit the revised documentation to the *Project Manager* within two weeks. Queries regarding comments or changes shall be addressed with the *Project Manager* prior to re-submittal.
- Any re-submittals, which do not include the changes or comments as indicated by the *Employer*, will be returned to the *Contractor* to be corrected. The *Contractor* shall re-issue the revised documentation incorporating all comments and other specified details not included in the previous issue within two working days of receipt of the marked-up document.

The *Contractor* shall undertake design safety reviews as and when requested by the *Project Manager*.

4.4 Use of *Contractor's* Design

The *Contractor* grants the *Employer* a licence to use the copyright in all design data presented to the *Employer* in relation to the *works* for any purpose in connection with the construction, re-construction, refurbishment, repair, maintenance and extension of the *works,* with such licence being capable of transfer to any third party without the consent of the *Contractor*.

The *Contractor* vests in the *Employer* full title to the intellectual property and copyright in the design data created in relation to the *works*, irrespective of where or what those *works* may be.

4.5 Record Drawings, Operating Manuals and Maintenance Schedules

The *Contractor* shall provide, on a monthly basis, throughout the duration of the contract, redline marked-up drawings, including all changes to the drawings for the entire Site, with accurate information pertaining to all constructed installations and infrastructure, irrespective of whether the equipment and infrastructure is underground or above ground. Final as-built drawings shall be submitted in 'rvt', 'dgn', 'dxf', 'dwg' and .PDF formats as applicable.

Operating and maintenance manuals for all electrical, electronic and mechanical installations are to be provided by the *Contractor*. The *Employer* may request, and the *Contractor* shall provide, additional details for specific items or components, or further information for *works* done by other disciplines.

The operating and maintenance manuals shall be neatly bound in a single A4 or A3 format book or file. As a minimum, three paper copies as well as an electronic PDF version will be required. Reference shall be made to the specifications and bill of quantities for additional requirements.

5. CONSTRUCTION

5.1 Coordination of the *Works*

5.1.1 Inspection of adjoining Infrastructure and Properties

Prospective *Contractors* shall visit the Site of the proposed *works* and acquaint themselves with the nature of the *works*, the conditions under which the *works* are to be performed, the means of access to the Site and all further matters that may influence or affect execution of the *works*.

Contractors shall be deemed to have allowed in their tender for any additional cost to be incurred due to the foregoing. No claims for extra costs in connection with the position or nature of the *works* will be entertained.

The *Contractor* shall take particular note of and inspect the existing infrastructure adjoining or adjacent to the Site, including, but not limited to, the following.

i. *Existing ArcelorMittal Conveyor*

ArcelorMittal own and operate an existing conveyor, extending from the Saldanha Steel plant to the port, following along the eastern side of the new roads, rail line and conveyors between Tippler 3 and the port.

Particular note is to be taken of the facility for off-loading pellets from road trucks directly onto this conveyor, which is located adjacent to Substation N. The operation of this facility may not be disrupted during the course of construction *works*. Should access to the road or bridge be required for construction purposes, this shall be properly planned and coordinated with ArcelorMittal and the port authorities.

ii. *Existing TPT Conveyors*

The installation of the new electrical and/or communications cabling within the port area will be done concurrent with the operation of the existing conveyors between Tipplers 1 and 2, the stockyard areas and the ship-loading activities. Special care, coordination and planning will be required whenever *works* are to be done beneath or near these conveyors.

Ongoing port operations may not be disrupted at any stage of the *works* and the *Contractor* will be required to continually coordinate the *works* with the port authorities and operating staff.

iii. *Access Roads and Bridges*

Sections of the new belowground cabling are to be installed adjacent to existing and new roads and bridges within the port and between the port and the new Tippler 3 buildings, including also the roads and bridge around the ArcelorMittal pellet discharge area.

Stringent temporary measures, in accordance with the approved traffic management plan, shall be provided by the *Contractor* to ensure that the safety of vehicles and pedestrians along these sections is not impaired in any way and traffic flows are maintained for the full duration of the *works*.

Should any short-term road closures be required, such closures shall be closely coordinated and scheduled in conjunction with the port authorities and operating staff, as well as other affected parties, such as ArcelorMittal and other users of the Haul Road.
In all cases where the *Contractor's works* impact on road users, adequate traffic accommodation measures shall be provided, including warning and information road

signage, flagmen, amber flashing lights and the like. Workmen working in close proximity to trafficked roads shall also be provided with appropriate high-reflective safety vests.

Further requirements for the use of the Haul Road are outlined under Section 5.3.1 below.

iv. *Electrical and Electronic Installations and Facilities*

The following existing electrical and electronic installations form part of, or are located within close proximity, of the new installations.

- Substation A is located immediately west of Conveyors CV-110 and CV-210, between Tippler 1 and the stockpile area.
- Substation H is located close to the north-western corner of the new Main Intake Substation, next to the stockpile area of ArcelorMittal's existing conveyor CV305. Substations J and K are located at the north-eastern corner of the stockpile area and provide electrical power to the dust suppression and other systems within the stockpile area.
- Electrical and Electronic Cables : Various existing electrical (medium and low-voltage) electrical and electronic (fibre optic etc.) cables pass through the Site, which may not be damaged or disrupted. These cables are critical to the port operations.
- Operational and Security Lighting : Existing outdoor operational and security lighting infrastructure within the port area may not be damaged or disrupted. These are critical to the port's operations and security measures.

The above substations and cables are critical to the port operations, which may not be disrupted at any stage. Any *works* that are to be done within the substations, or which entail *works* to the existing cables, shall be carefully planned, executed and coordinated in conjunction with the *Employer* and the port authorities.

The *Contractor* shall undertake special measures to identify and locate all existing electrical and electronic underground infrastructure prior to commencement of the *works*, as described also under Section 5.6 below. This shall include close liaison with the port authorities and operating personnel.

Certain sections of electrical, communication and data cables must be relocated prior to commencement of the *works*, including in particular cables crossing the area within and around Substation N.

v. *Pipelines*

Existing water and foulsewer pipelines are located both within the port area, near Substation N, and along the western boundary of the ArcelorMittal premises, as shown on the drawings. The *Contractor* will be required to undertake special measures to identify and locate the position of these water mains prior to commencement of the *works*, as described also under Section 5.6 below. This shall include close liaison with the port authorities and operating personnel.

The pipelines adjacent to the ArcelorMittal property near Substation M do not require relocation. The exact location of these pipelines shall however be identified prior to the commencement of the *works* at the substation and shall be protected during the full duration of the construction *works*.

vi. *Eskom 66 kV Overhead Line*

The existing Eskom Blouwater-Iscor 66 kV overhead line follows along the corridor between the Haul Road and the ArcelorMittal property boundary, veering eastwards to the

Iscor substation immediately north of the existing Substation H. Particular attention is drawn to the following: 1924701-2-300-E-LA-0062-01-AE

- Electrical and other cables to the new Substation M will be installed in close proximity to portions of the existing Eskom 66 kV overhead line. Prior to commencement of these *works*, the *Contractor* shall obtain the necessary permits from Eskom, which shall be strictly adhered to during the execution of the *works*.
- Detailed *works* procedures and execution plans for stringing of conductors, OPGW and hardware installations in close proximity to the existing 66 kV lines shall be compiled by the *Contractor*, in conjunction with, and subject to the approval of, the *Employer* and Eskom. The scheduling of these *works* shall also be coordinated with the *Employer*, Eskom and Sunrise Energy. The switch-overs may have to be done during the annual shutdown of the port operations, which usually occurs between the months of August and October.

5.1.2 Cooperating with Others

Ongoing coordination and cooperation will be required between the *Contractor*, *Employer*, *Project Manager*, Others appointed by the *Employer* and any other 3rd party stakeholders. This shall include, but is not limited to, all officials and employees of the *Employer* and all parties acting on behalf of the *Employer*.

The *Contractor* shall be responsible for his own construction programme, which shall be subject to approval by the *Employer* and *Project Manager*. *Contractors* shall be deemed to have allowed in their tender for any additional cost to be incurred due to the foregoing. No claims for extra costs for coordination and cooperation with Others will be entertained.

The *works* as described herein form one of a number of construction packages to be undertaken as part of the overall Tippler 3 project by Others. Further details are provided below.

i. *Tippler 3 MEIP Installations*

The Tippler MEIP installation will include the design, fabrication, installation and commissioning of the mechanical facilities and associated hydraulic, electrical, monitoring, control and instrumentation equipment required for the tippler, including electrical and instrumentation installations, monitoring and control (data and communications), as well as SCADA installations for equipment provided as part of Tippler MEIP installations. The following interfaces between the *Contractor* and the MEIP installations are highlighted:

- The *Contractor* shall install the 11/0.4 kV step-down transformer within the Tippler 3 building, including the main MV/LV earth bar. The 400V busbar feed and the main Tippler 3, 400 V main distribution board will be supplied and installed by the contractor.
- The Tippler 3 building will include the main server room. The *Contractor* will supply and install the main network switch within this server room and provide the fibre optic cable link from this network switch to Substation M, and hence to the new main data and communications network.

ii. *Tippler 3 Vault, Tunnels and Shed*

The Tippler 3 civils and structural installations will include all earthworks, civils and structural work for the tippler vault, tunnels, equipment and control building, including all utilities (HVAC, LV electrical, lighting, wet services), all hard-standing areas, stormwater

drainage and all utility connections around the tippler building. The Tippler 3 building is located close to Substation M and the following interfaces are highlighted.

- Large-scale earthworks, including blasting, will be required for the construction of the tippler vault and tunnels. Laydown areas will also be required during erection of the superstructure. Access to the Substation M Site may be constrained in the course of these operations.
- The *Contractor* will have to obtain access to within the Tippler 3 building for the installation of the 11/0.4 kV transformer and the cabling to feed this transformer.
- The *Contractor* shall provide a 110mm feed from the Tippler 3 building to Substation M, to feed the fire hydrants outside of the substation and the HVAC systems within. The take-off from this 110mm feed will be off the fire ring main around the Tippler 3 building, which is to be installed by Others.
- The *Contractor* shall be responsible for the main transformer MV/LV earth bar at the Tippler 3 building, inside the transformer room. This earth bar shall also function, amongst others, as the earthing interconnection with Substation M and other new and existing main earth infrastructure.
- The *Contractor* will also be required to provide the communications infrastructure, from the Tippler 3 building transformer to Substation M, for communications purpose between the respective protection systems.

iii. *New Conveyors*

New conveyors and transfer stations are to be installed to move iron ore from the Tippler 3 building to the port. The following, but not limited to, equipment for the conveyors is to be installed within Substations M and N by Others.

- VSDs.
- Main LV distribution board for LV supplies to the conveyors.
- Dedicated UPS' for conveyors.
- Conveyor PLC (Inside Substation N).
- Conveyor/plant control network switches.
- Further plant control and monitoring infrastructure required for the operation of the conveyors.
- The field earth mats/grids for the conveyor systems shall be connected to the main/raw earth bars inside the buildings, which are to be installed by the *Contractor*.
- The conveyor LV earths shall be connected to the main conveyor LV distribution boards, which will be obtained from the substations' main/raw earth bar and main LV distribution boards as applicable.
- Earthing of the VSDs shall be directly onto the main/raw earth bar(s) and the electronics earth bar(s) inside the substations, unless otherwise specified or instructed.
- For the required new fibre optic cable link between conveyor CV 309 and the new Haul Road Security Building, the *Contractor* will connect the one end of the new fibre optic cable onto the respective patch panel located at CV 309 drive station.

The new conveyors will extend up to the stockpile area within the port and will include construction of foundations and elevated structures to support the conveyors, drive stations and the like. Access to areas around these structures may be constrained during the course of erection and construction of the conveyors.

All cabling between Substations M and N and the conveyors will be done by Others.

iv. *Roadworks and Bridges*

New surfaced roads are to be constructed by Others, to be appointed by t*he Employer*, following along the eastern and western side of the conveyors between the Tippler 3 building and the port. The following interfaces are highlighted:

- The Substation M building will be located immediately adjacent to the new road. This road is complete. Care must be taken when installing any new adjacent infrastructure.
- A series of ducts and a new water main between the Tippler 3 building and Substation M *have been partly installed by others* across the new road. These ducts and pipes will have to be completed and coordinated with existing sewer and water infrastructure.
- The new access road to the Main Intake Substation will tie into the new service road between the Tippler 3 building and the port. If this access is not available or accessible, alternative access to the Main Intake Substation may have to be obtained from the northern side of the substation premises, crossing the Sunrise Energy property. The use of this access will have to be coordinated with Sunrise Energy and TPT Security.

vi. *New 200mm Water Main*

A new 200mm HDPE water main between the Tippler 3 building and the port is to be constructed within the same corridor as the new roads, rail lines and conveyors.

The water main will follow along the eastern side of the new roads and conveyors from the port up to a point immediately south the ArcelorMittal stockpile area, near Substation H. The water main will then cross the new roads, rail lines and conveyors from east to west, continuing to the Tippler 3 building between the new rail lines and the Haul Road.

The water main and new belowground cables between the port and Substation H will follow along the same corridor as the new electrical and fibre optic cabling. The *Contractor* shall liaise with the Others constructing this pipeline, to coordinate encroachment and crossing of the water main.

vii. *Instrumentation, Controls and SCADA*

The new data links to be provided by the *Contractor* will be integrated with the overall communication network for the Tippler 3 project and the port.

viii. *Rail*

Others will be appointed by the *Employer* to construct the formation, layerworks, ballast, sleepers, rail lines, signalization, turn-outs, point systems, power and data cables and the like, required for the rail lines. This will include the outgoing rail line from Tippler 3 to the port, which will be located in the same corridor as the new conveyors, to the east of the Haul Road.

ix. *Haul Road Security Building*

The *Contractor* will be required to make the new permanent 400/230 V electrical connection, from the new dedicated field supply distribution kiosk provided at the building by Others, onto the new main distribution board of the building also provided by Others, via cabling, unless otherwise instructed.

x. *Existing South Rail Shunt Control Building*

The *Contractor* will be required to make the new permanent 400/230 V electrical connection, from the new dedicated field supply distribution kiosk provided at the building by Others, onto the existing main distribution board of the building, via cabling, unless otherwise instructed.

xi. *New North Rail Shunt Control Building*

The *Contractor* will be required to make the new permanent 400/230 V electrical connection, from the new dedicated field supply distribution kiosk provided at the building by Others, onto the new main distribution board of the building also provided by Others, via cabling, unless otherwise instructed.

xii. *Existing SAX-A Cubicle*

The *Contractor* will be required to make the new permanent 400/230 V electrical connection, from the new dedicated field supply distribution kiosk provided at the cubicle by Others, onto the existing main distribution board of the cubicle, via cabling, unless otherwise instructed.

5.2 Particular Construction Constraints

Full cooperation between the *Contractor*, the *Employer*, the *Project Manager*, the *Supervisor* and all affected third parties will be essential throughout the project.

Ongoing commercial activities by the *Employer* or third parties will take precedence over any construction activities.

The *Contractor* will be required to provide method statements, risk assessments, job safety analyses and the like, which shall specifically include measures to mitigate risks at identified high-risk locations. Particular risks that have already been identified at such locations are outlined below.

i. *Camps and Laydown Areas*

- Shipment, loading and off-loading.
- Rigging plans for installation of heavy goods.

ii. *Earthworks*

- Haulage to and from Site, including designated stockpile area.
- Dealing with dust and water.
- Preservation of topsoil and restoration of Site, in line with the environmental management plans.

iii. *Relocation and Protection of Services*

- Prior to commencement of construction *works* at Substation N, various electrical and wet services must be relocated. Risk assessments, method statements and procedures must be compiled and approved by the *Employer* for these *works*, including in particular the tie-in of the existing and relocated sections of these services.

- Measures for the protection of services, where relocation is not required, shall also be documented. Method statements shall be approved by the *Employer* prior to commencement of *works* near such services.

iv. *Tie-Ins, Switch-Overs and Commissioning of Electrical Services*

- The *Contractor* shall compile detailed procedures, including risk assessments, for all electrical tie-ins, switch-overs and commissioning of electrical installations.
- These procedures shall be submitted to the *Employer* for approval well in advance of any such activities, no less than four weeks prior to the commencement of these *works*.

The above lists do not constitute a comprehensive schedule of such risks but are intended only as an initial guideline to the *Contractor*.

5.3 *Employer*'s Requirements

5.3.1 *Employer*'s Site Entry and Security Control, Permits, and Site Regulations

i. *Access and Permits within Port Boundary*

Portions of the new installations are located within the port area, which is owned and operated by TNPA and TPT respectively. The following permit and access requirements shall apply to *works* done within the port area:

- Medicals : Each of the *Contractor's* employees shall undergo a medical examination, certifying that the employee is fit and capable of undertaking the assigned tasks, as applicable.
- Induction : Each of the *Contractor's* employees shall undergo an induction, which will be provided by the TPT SHEQ department. The *Contractor* shall provide at least 48 hours prior notice of when such inductions are required. Each employee shall also, as part of the inductions, be required to present the medical report as outlined above.
- Police clearance : Each of the *Contractor's* employees shall have a valid police clearance.
- Employee permitting : Upon completion of the medicals, inductions and police clearances, the *Contractor* shall submit the list of employees, including full names and identification numbers, to TNPA, for issuing of a 1-year access permit. Such permits are usually issued within a period of two working days.
- Vehicle permits : The *Contractor* shall submit a list of all vehicles entering and leaving the port area to TNPA for issuing of vehicle permits. The list shall include the type, model and registration number of the vehicle, as well as the name of the designated driver.
- Tool lists : All tools brought into the port area shall be declared at the TNPA main security entrance. Tools are to be assigned to a designated vehicle, for further control during entrance and departure from the port area.
- *Contractor's* Materials, Plant and Equipment : All *Contractor's* Materials, Plant and Equipment brought into the port area shall be declared at the main security entrance. The documentation for such Materials, Plant and Equipment shall be presented to the TNPA security persons whenever these are removed again from within the port boundaries.
- Employee's Equipment : Should the *Contractor* ever be required to take any of the *Employee's* Equipment out of the port boundaries, such Equipment shall be identified and declared in accordance with the TNPA gate pass procedures.

- Safety files : Prior to commencement of any *works* within the port area, the *Contractor* will be required to submit his safety file to the *Employer* and to the TPT SHEQ department for review and approval. Provided that these files meet all requirements, an allowance of 2 working days must be made for the approval of such files.
- PPE : The minimum PPE requirements for any of the *Contractor's* employees within the port boundaries shall include hard hats, safety vests and safety boots. Where special circumstances dictate this, or where so advised by the *Employer* and/or TPT, the *Contractor* shall also provide his employees with ear muffs, goggles and dust masks.

Regular meetings shall be held between the *Contractor's* Site manager, the *Project Manager* and the designated TPT representative to discuss and arrange access for the execution of *works* within the port boundaries. Preference shall at all times be given to port operations, which may not be disrupted.

ii. *Access and Permits outside of Port Boundary*

Portions of the Site are located on properties controlled by TFR, outside of the port boundaries. The following access and permitting requirements shall apply:

- All of the *Contractor's* staff shall undergo induction by Transnet Freight Rail (TFR). Medical certificates are to be submitted to TFR prior to the inductions.
- All safety plans, issued in accordance with the Safety Risk Management procedures, shall be submitted to TFR for their review and comment at least two weeks prior to the commencement of the *works.* Any changes shall be implemented in consultation with the *Project Manager*.
- TFR may require the *Contractor* to obtain further written permits for particular parts of the *works*.
- The *Contractor* shall timeously submit all applications for occupations and permits and shall strictly abide by the requirements stipulated by TFR.

iii. *Access to Haul Road*

The Haul Road is a dedicated, privately operated freight route that provides access between the port and various industries inland of the port, for the conveyance of bulk and other cargo.

Access to the Haul Road can be obtained by prior arrangement with the Haul Road Committee, although usage of the road is subject to the terms and conditions as stipulated by the committee. Should the *Contractor* wish to make use of the Haul Road between the Tippler 3 building and the port, the following requirements will apply:

- Prior approvals are to be obtained from the Haul Road Committee.
- An assumption must be made that access to the Haul Road may not be available for an average of two working days per month.
- On all other days, the *Contractor* may use the Haul Road for construction-related activities, on the provision that the *Contractor's* vehicles do not disrupt the flow of vehicles of the existing users of the road, as represented by the Haul Road Committee (Transnet, Tronox, ArcelorMittal and Duferco).
- The *Contractor* shall provide clearly designated points of access to and from the Site, which are to be properly signposted along the Haul Road. The number and location of these access points shall be as approved by the *Employer* and shall be the sole points of access off the Haul Road.

- The *Contractor* may also be required to provide flagmen to alert and guide vehicles using the Haul Road, including construction traffic entering and leaving the Site.

5.3.2 Restrictions to Access on Site, Roads, Walkways and Barricades

Apart from gaining entry or exit to the *works* area, the *Contractor* shall ensure that staff members do not move about in areas where they are not permitted to be. Staff members shall also refrain from entering buildings occupied by the *Employer,* unless required for specific work purposes.

The *Contractor* shall also provide special inductions to all personnel that are required to execute *works* close to live installations, including conveyors and associated operational plant. Movement of personnel close to such live installations shall also be restricted to the execution of activities essential to the execution of *works* in these areas.

Staff members shall refrain from moving along private roads, including the Haul Road and service roads, without the necessary authorizations and permits.

The *Contractor* shall provide adequate transport for all staff members between the construction Site and *Contractor* yard, as well as transport to and from work.

Staff members shall refrain from coming close to or crossing the operational rail lines, unless travelling in a construction vehicle and crossing at an official, demarcated crossing. All *Contractor's* staff shall refrain from coming close to any trains or rail wagons. Any person found climbing onto or under parked rail wagons will be permanently removed from Site. The terms and conditions set forth in the following specifications shall also apply:

- E7/1 : Specification for General Works on, over, under or adjacent to Railway Lines and Near High Voltage Equipment.

5.3.3 People Restrictions on Site, Hours of Work, Conduct and Records

The working hours shall be in accordance with the requirements of the Department of Labour and as agreed with the relevant trade unions. Relevant documentation and information shall be provided to the *Project Manager* and *Supervisor* on a regular basis, and prior to commencement of any section of the *works*.

The *Contractor* shall keep daily records of his people engaged on Site, including all subcontractors and suppliers. The *Project Manager* shall be given unencumbered access to such daily records at all reasonable times.

5.3.4 Title to Materials from demolition and excavation

As per the *Employer's* standard regulations, the *Contractor* shall have no title to materials from any excavation or demolition. Where such materials become available for spoiling, the *Project Manager* shall instruct the *Contractor* how to label, mark, set aside and/or dispose of such materials for the benefit of the *Employer,* in accordance with ECC Clause 73.1.

5.3.5 Cooperating with and obtaining acceptance of Others

The *Contractor* shall manage all persons executing the *works*, including all sub-contractors/OEMs and suppliers undertaking temporary or permanent *works,* or supplying Plant and Materials to Site. The *Contractor* shall cooperate with:

- All authorised officials and employees of TNPA, TPT, TFR, TCP.
- Eskom.
- Sunrise Energy and any other effected/associated 3rd parties.
- Any local and/or national authorities, including but not limited to traffic officials.
- Representatives of the Haul Road Committee, including industries and transport operators making regular use of this road.
- Others appointed by the *Employer,* including, but not limited to, the following:

  i. Tippler MEIP installations.
  ii. Construction of Tippler 3 vault and buildings.
  iii. Construction of earthworks, roads and bridges.
  iv. New rail tracks and signalling to Tippler 3 and the port.
  v. Installation of new 200mm water main between Tippler 3 and the port.
  vi. Security fencing and area lighting.

5.3.6 Publicity and progress photographs

The *Contractor* shall produce and compile, for submission to the *Employer,* photographic records during all stages of the *works.* The associated costs shall be included in the tendered rates. The *Employer* shall advise the *Contractor* on Site for which particular parts of the *works* detailed photographic records are required.

The *Contractor* shall under no circumstances share with any 3rd party or publish any photographs, without the explicit written approval of the *Employer.*

The *Contractor* shall also refrain from making any statements or engaging with the media on any matter relating to this project, without the express written consent of the *Employer*.

5.3.7 Plant and Materials provided by the *Employer*

None.

5.3.8 Site Records

The *Contractor* shall keep daily records of all construction activities, including records of manpower and equipment on Site. Copies of these records shall be forwarded to the *Project Manager* on a daily basis.

Regular progress reports shall also be submitted to the *Employer* and *Project Manager*, as detailed under Section 7.6 of the Works Information.

5.4 Facilities for *Contractor*

5.4.1 Access

The Site and access to the Site will be made available to the *Contractor* for the duration of the *works,* subject to the limitations provided in this Works Information. The *Employer* will not provide any security, power or communications systems for the *works*. Access routes are as indicated in Part C4 – Site Information.

5.4.2 Yard and Laydown Areas

The *Contractor* may establish a yard and laydown areas as indicated under Part C4 - Site Information. Provision of utility services shall be as detailed in the Site Information.

The *Contractor* shall ensure that the areas are properly fenced and secured at all times and shall provide all access control. The areas may only be used for storage of materials, temporary sanitation facilities and other essential activities required for the *works*.

Accommodation of the *Contractor*'s staff at the yard and laydown areas will not be permitted. The *Contractor* may retain 24-hour security at the yard and laydown areas, provided that proper temporary sanitation and shelters are provided.

No office or Site facilities are required for the *Employer*'s or *Project Manager*'s staff.

The yard and laydown areas and any other areas disturbed during construction shall be rehabilitated to their original standard prior to handing back of the Site to the *Employer*.
The *Employer* will not provide any further designated space on Site for the establishment of offices, workshops, storage areas or the like. The *Contractor* may however liaise with the *Employer* and Others engaged in concurrent construction activities to obtain their consent for temporary storage of materials and equipment outside of the designated yard and laydown areas. This will be at the sole risk of the *Contractor.*

5.4.3 Existing Premises, inspection of adjoining Private and Public Properties

The *Contractor* shall take note of and inspect the existing infrastructure adjoining and/or adjacent to the Site, which includes, but is not limited to:

- 66 kV Electrical power line.
- Iscor substation.
- Substations A, B, H, J and K.
- Tippler 1 and 2 buildings.
- CCR and Electronics Workshop (Engineering Station) at port offices.
- ArcelorMittal conveyor.
- Existing power and communications cables.
- Existing wet services and pipelines.
- Existing area lighting.
- Haul Road and service roads.
- TFR below and above-ground fibre optic cables.
- Existing rail lines.

5.5 Survey Control and Setting out of the *Works*

Any topographical survey carried out as part of the *works* shall be undertaken by a SAGC registered surveyor, to be appointed by the *Contractor* and to be approved by the *Employer*.

The *Contractor* shall appoint such a competent surveyor to properly set out all *works*. Should the *Project Manager* be unsatisfied with the setting out details, he may request that an additional surveyor be appointed to validate all setting out coordinates.

Complete land surveys of the Site were carried out by a professional land surveyor. Survey reference points will be provided by the *Employer*. The *Contractor* shall, within two weeks after the Site has been handed over to him, ascertain himself of the correctness of all surveys and reference points. Any discrepancy shall immediately be reported in writing to the *Employer*. Any costs arising from discrepancies that were not reported to the *Employer* within the aforementioned period shall be the sole responsibility of the *Contractor*.

The *Contractor* shall take care that property beacons, trigonometrical survey beacons or setting-out beacons are not displaced or destroyed without the consent of the *Employer*. Property

beacons and trigonometrical survey beacons that have been displaced or destroyed shall be replaced by a registered land surveyor, who shall certify such replacement.

The cost of replacing any beacons displaced or destroyed during the course of the Contract without the consent of the *Employer* shall be to the *Contractor*'s account.

The *Contractor* is to note that the co-ordinates shown on all drawings relate to the WGS 84 survey system. A local system using LO18 has been used for this project.

5.6 Underground Services and Infrastructure

No excavations shall be done within and outside the port area, as applicable, in the absence of a written permit, to be issued by the port authorities and other relevant parties. The *Contractor* shall also ensure that any other required permits to excavate are in place.

The *Contractor* shall make every effort to obtain all relevant drawings, indicating the position of potential existing services, via the *Employer.* At any location where construction activities will occur, including in particular excavations and earthworks, the *Contractor* shall also undertake surveys via ground-penetrating radar systems and electrical cable locators, as an added measure, to determine the presence of existing underground services and infrastructure.

Where any live, existing services are anticipated, the *Contractor* shall excavate by hand trial pits and proving trenches. Prior to commencing with such hand excavations, the *Contractor* shall provide detailed and specific method statements, risk assessments and the like for approval by the *Employer.*

Care shall be taken by the *Contractor* to protect all existing services, unless they are confirmed to be abandoned or will be replaced as part of this project.

If any existing service is damaged, that should have been located or protected by the *Contractor*, the *Contractor* shall be required to carry the cost of the repair of that service.

Should any service be damaged by the *Contractor*, it is the responsibility of the *Contractor* to report such damage to the *Project Manager* immediately.

Where the *Contractor* encounters existing underground services or existing services cables or service ducts, the *Contractor* shall undertake the following:

- Immediately notify the *Project Manager* of the located service.
- Immediately notify the relevant utility owners or officials.
- Ascertain whether the service is still required and must remain live, or whether the service has been abandoned.
- If the service is confirmed as abandoned, the *Contractor* shall remove such service, if so instructed by the *Employer.*
- If the service is deemed live, it shall be protected by the *Contractor* and marked on the specific record drawing(s) for that area or service discipline. The service shall be demarcated by placement of brightly painted wooden stakes to provide clear visibility of such services to the construction teams and Others working in the area. This requirement shall be included in the method statements, risk assessments and the like, to be submitted by the *Contractor* for approval by the *Employer*.

5.7 Giving Notice of *Works* to be Covered Up

The *Contractor* shall notify the *Supervisor* prior to covering up any of the completed *works*, so as to allow the *Supervisor* time for inspection of those *works*. This shall include, but not be limited to:

- All belowground cabling and ducts, prior to laying of cable/ducts and prior to backfilling.
- All foundation excavations and compaction prior to casting of blinding layer.
- All reinforcement and shuttering prior to concreting.
- All buried pipelines.
- All earthworks and road layerworks, prior to placement of the next layer.

5.8 Hook-Up to Existing *Works*

The new installations are to be fully integrated with the existing installations, which shall include, but not be limited to, the following:

- Integration of electrical power supplies.
- Integration of data networks and communications systems.
- Connection of new 110mm Ø fire lines (at all new substations) to existing 160mm Ø water main.
- Connection of all new access roads and hard standing areas (at all substations) to existing access and service roads by means of proper benching techniques.

Reference shall be made to the specifications and drawings as referenced under Annexures A and B respectively.

5.9 Temporary *Works* and Site Services

5.9.1 Excavations and associated Water Control

It is the responsibility of the *Contractor* to ensure that all excavations are rendered safe and suitable for construction and conform to the requirements of the Construction Regulations. The *Contractor* shall not continue construction in conditions that the *Project Manager* does not approve of. The *Contractor* will be required to design and submit for approval the methods of excavation.

The control of water during construction, including in particular dewatering of deep excavations, shall be managed and controlled in accordance with method statements to be compiled by the *Contractor* and approved by the *Project Manager* prior to the commencement of the *works*.

These method statements shall include all measures that are required to remove or mitigate adverse environmental impacts. The *Contractor* will only be allowed to construct such drainage water control systems once the method statement is approved by the *Project Manager*.

5.9.2 Control of Noise, Dust and Waste

The *Contractor* shall take all reasonable steps to contain unacceptable levels of noise and dust, in accordance with the specified and referenced environmental, health and safety requirements.

The control of water during construction, including in particular drainage of deep excavations, shall be managed and controlled in accordance with method statements to be compiled by the *Contractor* and approved by the *Project Manager* prior to commencement of the *works*. These

method statements shall include all measures that are required to remove or mitigate adverse environmental impacts.

The *Contractor* shall dispose of all waste products at an appropriately licensed and registered waste disposal Site, to be approved by the *Project Manager*. The *Contractor* shall provide written proof that all permits for the waste disposal Site are in place.

Waste may not be disposed of at the designated stockpile area, as described in Part C4 - Site Information.

5.10 Completion, Testing, Commissioning and Correction of Defects

5.10.1 *Work* to be done by the Completion Date

The *Contractor* shall have done everything required to provide the *works* on or before the completion date and certain individual items ahead of the Sectional Completion Dates, as stated in the Contract Data.

5.10.2 *Works* to be done before Completion has been Certified

The *Contractor* shall install and commission all *works* before the *Contractor* can hand over the facilities to the *Employer*.

5.10.3 Materials Facilities and Samples for Tests and Inspections

Reference shall be made to the discipline-specific specifications for sampling and testing requirements.

5.10.4 Access for Correction of Defects

Should the *Contractor* have to return to the Site after completion of the *works* to effect an improvement or repair, the *Contractor* shall organise access cards for all staff members required to perform the *works.* The *Contractor* shall also carry the costs of such access cards.

5.10.5 Commissioning

Commissioning of all facilities is required upon the successful completion of the *works*. Both hot and cold commissioning will be required as per standard practice for electrical, electronic, mechanical and the like *works* of this nature.

5.10.6 Take over Procedures

Take over procedures shall be agreed with the *Employer* prior to the commissioning phase.

5.10.7 Training and Technology Transfer

As part of his commissioning documentation, the *Contractor* shall provide operating and maintenance manuals and provide training workshops for the *Employer's* operating staff. Such training shall be conducted in accordance with the requirements as detailed in the specifications.

5.10.8 Operational Maintenance after Completion

The *Contractor* may be required to perform operational maintenance within the first year after completion. The level and extent of such operational maintenance will be agreed and negotiated with the *Contractor* during execution of the *works*.

6. PLANT AND MATERIALS STANDARDS AND WORKMANSHIP

6.1 Electrical and Mechanical Engineering *Works*

Where SANS specifications are used in the Works Information, specifications or bills of quantities, and the term "Equipment" or the like is used, with the meaning of installations and items forming part of the *works*, this shall be read as the term "Plant and Materials" in accordance with the ECC defined terms for compliance.

6.2 Building *Works*

Where the Association of South African Quantity Surveyors Model Preamble for Trades 2008 is used within the Works Information, specifications and bills of quantities, the following interpretations and meanings shall apply:

- In case of any conflict in interpretation, ambiguity or discrepancy between the Model Preamble for Trades 2008 and the *Conditions of Contract*, the *Conditions of Contract* will take precedence within the ECC Contract.
- In case of any conflict in interpretation, ambiguity or discrepancy between the Model Preamble for Trades 2008 and the Works Information, specifications or bills of quantities, the Works Information and specifications will prevail, without prejudice to the *Project Manager's* express duty to resolve any ambiguity or inconsistency in the Works Information or specifications under ECC Clause 17.1.
- Within the Model Preambles for Trades 2008, the following amendments and interpretations will apply:

  i. Where the word or expression "Principal Agent" is used, read "*Project Manage*r" or "*Supervisor*" as the context requires.
  ii. Where the word or expression "Contractor" is used, read "*Contractor*".
  iii. Where the word or expression "Engineer" is used, read "*Project Manager*" or "*Supervisor*" as the context requires.
  iv. Where the Model Preambles for Trades 2008 mention "rates" for measured *works* and any contractual statements relating to payment, all such statements shall be discounted, with the ECC *Conditions of Contract* taking precedence.

Within the Model Preambles for Trades 2008: Section A: General, the following amendments and interpretations shall apply:

- Where the word or expression "bills of quantities" is used, this shall be discounted for the purposes of the Works Information. The ECC Contract Data - Part One states the main option to apply within the ECC Contract between the Parties.
- Within the Model Preambles for Trades 2008, Section B: Alterations, Section B.2: Materials from the Alterations, Credit, etc., and Section C: Earthworks – Clause C1.4: Materials from Demolitions, will not apply. The Works Information states details of the *Contractor's* title (if any) to materials arising from excavations and/or demolitions and how such materials are either to be disposed of or re-used in the *works*.

6.3 Civil Engineering and Structural *Works*

Where the SANS 1200 series of specifications are used within the Works Information or specifications, the following interpretations and meanings shall apply:

- In case of any conflict in interpretation, ambiguity or discrepancy between any SANS 1200 Specification and the *Conditions of Contract*, the *Conditions of Contract* take precedence within the ECC contract.
- In case of any conflict in interpretation, ambiguity or discrepancy between any SANS 1200 specification and the Works Information or specifications, the Works Information and specifications shall prevail, without prejudice to the *Project Manger's* express duty to resolve any ambiguity or inconsistency in the Works Information under ECC Clause 17.1.

Within SANS 1200 A: GENERAL, the following amendments and interpretations shall apply:

- Where the word or expression "Employer" is used, read "*Employer*".
- Where the word or expression "Contractor" is used, read "*Contractor*".
- Where the word or expression "Engineer" is used, read "*Employer*", "*Project Manager*" or "*Supervisor*" as the context requires.
- Where the word or expression "schedule of quantities" is used, this is deleted in its entirety. Assessment and payment is in accordance with the *Conditions of Contract* (and the ECC main and secondary options stated therein).

Within SANS 1200 A: GENERAL 2.3 DEFINITIONS, the following apply:

- "Acceptable, Approved (Approval)" is interpreted as either a *Project Manage*r or a *Supervisor* communication or instruction in relation to Works Information compliance, consistent with the *Conditions of Contract*, as the context requires.
- "Adequate" is deleted. The *Project Manager* notifies the *Contractor* where the *Contractor* has not complied with the Works Information.
- "Measurement and payment" and the further definitions are deleted. Assessment and payment is in accordance with the *Conditions of Contract*.

Within SANS 1200 A: GENERAL 2.6 APPROVAL, the following applies:

- "Approval" by either the *Project Manager* and/or the *Supervisor* is without prejudice to ECC Clause 14.1 and, inter alia, ECC Clauses 13.1, 14.3 and 27.1.

SANS 1200 A: GENERAL 2.8 ITEMS IN SCHEDULE OF QUANTITIES, is deleted in its entirety. Assessment and payment is in accordance with the *Conditions of Contract*.

Within SANS 1200 A: GENERAL 7.1 PLANT, the following applies:

- Where the word or expression "Plant" is used, read "Equipment".

SANS 1200 A: GENERAL 7.2 *CONTRACTOR*'S OFFICES, STORES AND SERVICES, applies but the *Project Manager* resolves any inconsistency with statements included in the Works Information.

Within SANS 1200 A: GENERAL 3.2 WATCHING, BARRICADING, LIGHTING AND TRAFFIC CROSSINGS, the following applies:

- Where the word or expression "specification" is used, read "Works Information".

SANS 1200 A: GENERAL 3.4 PROTECTION OF OVERHEAD AND UNDERGROUND SERVICES applies only to the extent that it is consistent with the specific statements made elsewhere in the Works Information and in any case and at all times consistent with the *Conditions of Contract*.

Within SANS 1200 A: GENERAL 5 TESTING, the following applies:

- Where the word or expression “Engineer” is used, read “*Employer*”, “*Project Manager*” or “*Supervisor*” as the context requires.

SANS 1200 A: GENERAL 8 MEASUREMENT AND PAYMENT, is deleted in its entirety. Assessment and payment is in accordance with the *Conditions of Contract*.

7. MANAGEMENT AND START-UP

7.1 Management Meetings

Regular meetings to be convened and chaired by the *Project Manager* are as follows:

Title and purpose	Approximate time & interval	Location	Attendance by:
Kick-Off Meeting	Prior to Commencement of Construction	Saldanha	*Employer*, *Contractor* (key persons) and *Project Manager* (appropriate delegates)
Contract Progress Meeting	Fortnightly	Saldanha	*Employer*, *Contractor* (key persons) and *Project Manager* (appropriate delegates)
Weekly Technical Meetings	Weekly	Saldanha	*Employer*, *Contractor* (key persons) and *Project Manager* (appropriate delegates)
Risk Register and Compensation Events	Weekly	Saldanha	*Project Manager* (and appropriate delegates), *Supervisor* (and appropriate delegates) and *Contractor* (appropriate key persons)
Monthly SHE meeting	Monthly	Saldanha	*Employer, Project Manager* (and appropriate delegates), *Contractor (*line management, Site supervisors, safety officer, environmental officer and safety reps)
Safety Visible Felt Leadership Walkabout	Weekly	On Site	*Project Manager* (and appropriate delegates) and *Contractor* (appropriate key persons)
Safety Workshop	Bi-weekly	On Site	*Contractor's* Site supervisors
Safety Committee Meeting	Every second month	Saldanha	*Employer*, *Contractor* (key persons) and *Project Manager* (appropriate delegates)

Meetings of a specialist nature may be convened as specified elsewhere in this Works Information or, if not so specified, by persons and at times and locations to suit the parties. Records of these meetings are to be submitted to the *Project Manager* by the person convening the meeting within five days of the meeting.

All meetings are to be recorded using minutes and a register prepared and circulated by the person who convened the meeting. Such minutes and registers are not to be used for the purpose of confirming actions or instructions under the contract, as these are to be done separately by the person identified in the Conditions of Contract to carry out such actions or instructions.

7.2 Documentation Control

The *Contractor* provides documentation in accordance with the requirements of the *Contractor* Documentation Submittal Requirements and the *Contractor* Documentation Schedule (CDS) and makes specific reference thereto within his Quality Management System and Quality Procedures.

The CDS is contained within Annexure E (*Contractor* Documentation Schedule) of the Works Information.

The *Contractor* Document Submittal Requirements is contained within Annexure F (Contractor Documentation Submittal Requirements) of the Works Information.

A standard *Contractor* Documentation 'Starter Kit' will be issued to the *Contractor* upon award and consists of the following:

- Standard Project Drawing Sheet.
- Contractor Document Register (DOC-FAT-0002).
- A4 Review Coversheet for Documents (DOC-FAT-0067).
- Document Deliverable Matrix (DOC-FAT-0075).

The *Contractor* shall assign a dedicated person to provide the services required to execute the documentation control function.

The nominated individual shall be fully conversant with document control systems and be suitably qualified with a minimum of 5 years' experience in Document Management to provide an acceptable interface with the *Employer's* Document Control. The CV of the nominated person shall be submitted to the *Project Manager* for approval.

7.3 Health and Safety Mangement

a. The *Contractor* shall comply with the following HAS specifications and standards:
   (1) Annexure E: Contractors Health and Safety Specification Guidelines;
   (2) Occupational Health and Safety Act (Act 85 of 1993) and Regulations;
   (3) Transnet health and safety policies and procedures;
   (4) National Road Traffic Act.

a. The *Contractor* shall ensure that its subcontractors comply with the above-mentioned requirements.

b. The *Employer* will acknowledge the achievement of specific safety milestones set for the project with regards to incident statistics, incident recording, safety observation and conversations (SOC's) and Visible Felt Leadership (VFL) participation, safety initiatives, etc.

c. The *Contractor* makes the HAS specification Guideline available to its employees and subcontractors in the language of this contract and other local languages as required.

d. The *Contractor* conducts a risk assessment and method statement pack prior to carrying out any activity on the *Site* to the approval of the *Project Manager*.

e. The lines of communication of the various personnel acting on behalf of the *Project Manager*, who communicates directly with the *Contractor*, and his key persons with respect to the HAS specification, are contained within Annexure D (Contractors Health and Safety Specification Guidelines) One such person is the *Employer's* appointed PrCHSA who will be responsible for obtaining the project construction work permit.
f. The roles and responsibilities of the various personnel acting on behalf of the *Project Manager* with respect to the HAS Project specification and health and safety issues as per Annexure D (Health and Safety Specification Guidelines)
g. The *Contractor* shall appoint a full time CHSO per shift, registered with SACPCMP for the duration of the works, the number of which depending on the scope, complexity, and high-risk activities involved, as required by the Construction Regulations of 2014, regulation 8(5). The *Health and Safety Officer(s)* must be on site when work commences at the start of the day and must remain on site until all activities for that day (including the activities of subcontractors) have been completed.
h. The *CM* is responsible, within the context of the HAS project Specification, for health and safety on the *Site* and reports to the *Project Manager*. The *CM* specific tasks are detailed in Annexure E (Contractors Health and Safety Specification Guidelines).
i. All items of plant, equipment and vehicles travelling within the *Site* shall be equipped with fully operational amber rotating flashing lights. All vehicles shall be roadworthy and shall at all times adhere to all traffic signage and speed limits.
j. All employees of the *Contractor* and its subcontractors will undergo entry medicals before the commencement of the project and thereafter on an annual basis inclusive of exit medicals. Medicals are to include drug testing.
k. Training as stipulated in the *Contractors'* HS specification guidelines must be conducted by the relevant *Contractor's* employees before the commencement of the project.
l. Everyone coming onto the *Site* shall comply with PPE requirements as mentioned in this document as well as the *Contractor's* HS project specification taking note that only long sleeve pants and shirts are allowed to be worn on site.
m. Transportation of employees on the back of bakkies will not be allowed.
n. All permit costs required for any activities relating to the project shall be for the *Contractor's* account.
o. The *Contractor* shall further comply with all applicable legislative requirements and standards with respect to his own activities and others on the *Site*. A health and safety file shall be submitted by the *Contractor* for approval by the *Employer* or *Employer's* representative before site access can be granted.
p. The *Contractor* must submit a Health and Safety File to TPT HS department for approval after being appointment. Sufficient time must be allowed for the Health and Safety File to be approved by the *Employer's* HS staff as well as TPT HS Department.
q. The *Contractor* and its Subcontractors may not commence with any *Work*s on site unless the Health and Safety file has been approved by TPT HS.
r. The *Contractor* shall submit a Method Statement to TPT for approval with all the necessary holding points.
s. The *Contractor* shall compile a Risk Register and share it with the TPT Engineer for endorsement.

7.4 Environmental Management

A project specific Environmental Management Plan (EMPr) has been compiled and is included under Annexure H (Environmental Management Programme). This is aligned with the *Employer*'s standard Construction Environmental Management Standard Operating Procedure (CEM SOP), Contractor Environmental and Sustainable Specifications , Bulk Power Basic Assessment Report (BAR) and Environmental Authorization (EA) and its amendment included under Annexure I (Environmental Documentation).

The EMPr provides an integrated approach to environmental management. This approach is designed to guide the appropriate allocation of human resources, assign responsibilities, develop procedures and ensure project compliance with regulatory and best practice requirements.

Where conflict exists between this and any other document / specification, the following shall apply in descending order of applicability:

- Transnet Integrated management System (TIMS) Policy Statement- refer to Annexure I.
- A DFFE Environmental Authorization – refer to Annexure I.
- A DFFE authorised (EMPr) – refer to Annexure H.
- Bulk Power Basic Assessment Report (BAR) – refer to Annexure I.
- CEM SOP – refer to Annexure I.
- Contractor's Environmental and Sustainable Specification Guidelines – refer to Annexure I.
- Contractual Specifications.

The *Contractor* shall perform the *works* and all construction activities within the Site, having due regard to the environment and to environmental management practices, as described within the EA, BAR, CEM SOP, Contractor Environmental and Sustainable Specifications and EMPr.

The Contractor's Environmental and Sustainable Specification Guidelines describes the minimal acceptable standard for environmental management for a range of environmental aspects commonly encountered on construction projects and sets environmental objectives and targets, which the *Contractor* shall observe and comply with.

The EMPr proposes higher minimal standards than those described in the Contractor's Environmental and Sustainable Specification Guidelines. .

The overarching obligations of the *Contractor* under the CEM SOP before construction activities commence on the Site are to provide environmental method statements for particular construction operations at the Site by the *Contractor*.

The *Contractor* shall identify the kinds of environmental impacts that will occur as a result of his activities and then prepare separate method statements describing how each of those impacts will be prevented or managed, so that the standards set out in this document are achieved. These method statements will be prepared in accordance with the requirements set out in the CEM SOP and EMPr.

Activities may only commence once the Environmental Method Statements have been approved by the Transnet CM, Transnet PER and ECO (where relevant). In some instances, local authorities may also need to approve the method statements.

All changes to the original Environmental Method Statements must be approved by the Transnet prior to implementation.

Typical method statements to be provided by the *Contractor* shall include, but are not limited to, the following:

- Establishment of construction lay down area.
- Hazardous and non-hazardous solid waste management.
- Storm water management.
- Contaminated water management.

- Prevention of marine pollution.
- Hydrocarbon spills.
- Refuelling procedures.
- Dust control.
- Spoil dumping.
- Sourcing, excavating, transporting and dumping of fill material.
- Noise and vibration control.
- Removal of rare, endemic or endangered species.
- Removal and stockpiling of soil.
- Rodent and pest control.
- Environmental awareness training.
- Site division.
- Emergency procedures for environmental incidents.
- Closure of construction laydown area.

The *Contractor* shall ensure that its management, foremen and the general workforce, as well as all suppliers and visitors to Site, have attended the induction programme before undertaking any *works* on Site.

A guideline has been included within the EMPr. If new personnel commence *works* on the Site during construction, the *Contractor* shall ensure that these personnel undergo the induction programme and are made aware of the environmental specifications on Site.

The “Declaration of understanding form ” shall be signed and submitted to the CM within 14 days after the Contract Date.

Where directed by the *Employer*, one of the first actions to be undertaken by the *Contractor* shall be to erect and maintain a temporary fence along the boundaries of the Site and around any no-go areas identified on the layout plans, to the satisfaction of the *Project Manager*.

The plant search and rescue must be undertaken and completed prior to any Site clearance or any other construction activity that may damage the vegetation.

The *Contractor* must appoint a suitably qualified and experienced Environmental Officer (EO) to monitor environmental issues, e.g. litter, spills, illegal activities, fence patrol, dust and the like. This EO shall be required to have either a National Diploma, Degree or higher in Environmental Management. This appointment, along with details of the individual being appointed and job descriptions, must be sent to the *Project Manager* for his/her approval.

During the construction period, the *Contractor* complies with the following:

- Upon award the *Contractor* will receive a CD containing, but not limited to the environmental file templates and copies of the project’s EA, permits and licences, EMPr, CEM SOP, Contractor’s Environmental and Sustainable Specification Guidelines, , etc. Documents on this CD must be available in hard copy on Site and must be continuously updated.
- The *Contractor* shall ensure that all the personnel on Site (including subcontractors and their staff) as well as suppliers are familiar with and understand the specifications contained in these documents.
- Method statements that are required during construction must be submitted to the *Project Manager* for approval at least 20 days prior to the proposed commencement of the activity. Emergency construction activity method statements may also be required. The activities requiring method statements cannot commence if the method statements have not been approved by the *Project Manager*. The scope of the required method statements for

completion by the *Contractor* shall, as a minimum, include all such items as are listed within the EMPr.

- Where applicable, the *Contractor* shall provide job-specific training on an ad hoc basis when workers are engaged in activities which require method statements.
- The *Contractor's* EO shall submit monthly updates of the environmental file electronically which shall be in accordance with the environmental file index.
-

The *Contractor* shall ensure that anyone making deliveries to Site is properly informed of all procedures and restrictions, e.g. which access roads to use, no go areas, speed limits, noise and the like, as required by the relevant project's licences and permits and project's EMPr.

Existing access routes to the construction/works areas must be used as far as possible. Access tracks must be maintained in a good condition at all times during construction to minimize erosion and dust generation.

The *Contractor* shall be responsible for rehabilitating and re-vegetating all areas to the satisfaction of the ECO as detailed in the EMPr.

The *Contractor* shall clear and clean the Site and ensure that everything not forming part of the *works* is removed from the Site and that all re-instatement has taken place in accordance with the EMPr.

A Site closure audit will be conducted by the *Employer's* EO of which upon closure of all findings and observations, the *Contractor's* EO must scan the entire environmental file according to the environmental file index and submit both a hard and soft copy to the *Employer*. An Environmental Closure Certificate (TRN-IMS-GRP-TMP-014.23) must be issued by the EO/ECO and signed off by the *Project Manager*.

The *Contractor* shall comply with the findings of all environmental inspections and audits, as per the project's EA, permits and licences, EMPr,SES, CEM SOP, method statements etc. and/or as instructed by the *Employer*.

7.5 Quality Assurance Requirements

7.5.1 General Requirements

The *Contractor* shall execute the *works* in accordance with the project specification General Quality Requirements for *Contractors* and Suppliers included in Annexure J (General Quality Requirements for Contractors and Suppliers) of the Works Information.

The *Contractor's* Quality Management System shall conform to the International ISO 9001 Standard or an equivalent standard acceptable to the *Project Manager*.
Prior to the commencement of the *works* on Site, the *Contractor* shall submit his quality assurance proposal(s) to the *Employer* for review. *Works* on Site may only commence once these proposals have been approved by the *Employer*.

This proposal shall detail the *Contractor's* quality management system as it applies to all aspects of supply or service provision, including design, procurement, manufacturing, construction, installation, erection and commissioning. The *Contractor* shall make allowance for the provision of suitably qualified quality control staff to manage and carry out inspection on all supplier/subcontractor activities in all disciplines included within the Works Information.

7.5.2 Quality Policy

The Quality Policy is a concise document, approved by the *Contractor's* executive management that defines organisational goals and objectives with regard to quality, a commitment to meeting stated requirements and an undertaking to drive continuous improvement throughout the organisation's activities. It must be suitable for the organisation and provide a framework for establishing, communicating and monitoring performance against agreed quality objectives.

7.5.3 Project Quality Plan

The *Contractor* shall submit a Project Quality Plan (PQP), which shall also contain specific proposals and details with regard to quality control (QC) for the scope of the *works*.

The PQP includes the *Contractor's* statement that outlines strategy, methodology, resources allocation, QA and quality control co-ordination activities to ensure that the *works* meet the standards stated in the Works Information.

The PQP is generally in narrative form detailing the Project Specific QA and QC systems and controls required by the *Contractor* for the specific *works*.

The requirements for a PQP are detailed in the project standard and shall include, but not be limited to, the following:

- Include all quality activities relevant to the *works*, identifying all procedures, reviews, audits, controls and records used to control and verify compliance with the specified contractual requirements.
- Include a listing of all special processes (e.g. welding and non-destructive testing, cube testing, etc.) envisaged for use, including confirmation of personnel certification as required.
- Include a list of all Suppliers.
- Include a list of all proposed method statements for Site-based work activities.
- Include a description of the *Contractor*'s project organization, with key positions and responsibilities identified and individuals named. The organization structure shall also indicate the resources committed to the management / coordination of QA / QC activities, both within the *Contractor*'s organization and that of his subcontractors and suppliers.
- Include a listing of all Quality Control Plans (QCP's), and associated Field Inspection Checklists (FIC's), as applicable.
- Identify in the PQP any supplier/subcontractor work. Supplier/subcontractor quality plans shall be approved by the *Contractor*, and a copy forwarded to the *Project Manager* for approval.
- Include the proposed Authorized Inspection Authority (where applicable - for pressurized equipment and systems).
- Include a Data Book Index, scheduling the proposed quality records that will form the permanent record of conformance to requirements.

7.5.4 Submissions and Records

The *Contractor* submits his Quality Management System documents to the *Project Manager* as part of his programme under ECC3 Clause 31.2 to include details of:

- PQP for the contract;
- Quality Policy;
- Index of procedures to be used;
- A schedule of internal and external audits during the contract.

The *Contractor* develops and maintains a comprehensive register of documents that will be generated throughout the *works*, including all quality related documents as part of its Quality Plan.

The *Project Manager* indicates those documents required to be submitted for information, review or acceptance and the *Contractor* indicates such requirements within his register of documents. The register shall indicate the dates of issue of the documents and the dates upon which the *Project Manager* responded to documents submitted by the *Contractor*.

The index of procedures shall contain a list of the *Contractor's* quality management system procedures to be applied during the course of the *works*, including any relevant instructions or 3rd tier quality system documentation. Where aspects of the *works* are to be subcontracted, the *Contractor* shall include procedures for the management of suppliers and subcontractors.

A schedule of internal and external audits shall be included in the *Contractor's* PQP, detailing the location, frequency and extent of internal and external quality system audits to be carried out during the contract period. The schedule shall include all locations at which such audits are carried, i.e. the *Contractor's* offices and construction Sites, as well as the premises of suppliers and service providers.

7.5.5 Staffing

The *Contractor* shall nominate a suitably experienced quality representative for all aspects of the *works*, including general Site activities, with a staff complement that is adequate to perform the requirements of the PQP.

The *Contractor* shall submit the CV of his nominated quality representative for the *Project Manager's* review and approval.

7.6 Programming and Progress Reporting

7.6.1 General

The contract programme, progress reports, subsequent updates, revisions and supplementary programmes as detailed in this section are an essential part of the project control system used by the *Employer* for managing the *works* and in monitoring progress of the *works.* Key dates and completion dates, as defined in the Contract Data, are incorporated into the programme.

7.6.2 Tender Schedule

The *Contractor's* detailed programme, which complies with the requirements (Annexure K) as indicated in the Works Information, shall be submitted in both hard and soft copy forms. Primavera P6 version 8.2 is being used by the *Employer* for planning on the project. The *Contractor* shall use a suitable computerised planning package (Primavera, MS Projects), as approved by the *Project Manager.*
The activity durations are estimated in working days and shall be realistic and based on quantities and applied resources. The *Contractor* shall submit a basis of the schedule to the *Project Manager* for approval.

The calendars used are based on normal working hours per day and working days per week, or as prescribed by the *Project Manager*.

7.6.3 Network

The Critical Path Method (CPM) technique of planning and scheduling will be used for the project. The *Contractor* shall provide a programme showing the critical path(s), together with a total float report for acceptance by the *Project Manager.*

The programme network shall have no fewer activities than the technical and commercial breakdowns listed in the activity programme.

Networks are constructed to reflect the sequence of activities, using resource scheduling to stagger the performance of activities into the most probable sequence.

The activity durations are estimated in working days and shall be realistic and based on quantities and applied resources.

The calendars used are based on normal working hours per day and working days per week, or as prescribed by the *Project Manager* in accordance with the contract.

7.6.4 Structure and Methodology

The programme layouts shall take into account the approved Facility Breakdown Structure (FBS), reflecting the manner in which the *works* are to be performed. The following levels of programme are to be used for this project:

- ***Level 1 Master Programme*** - defines the major activities and interfaces between engineering, procurement, fabrication and construction, transportation, installation, and pre-commissioning, commissioning, and start-up. This is a high level summary programme, and is included in the monthly progress report.
- ***Level 2 Project Programme -*** summary programme "rolled up" from the level 3 project programme. The structure and layout will be in accordance with the FBS as defined in the Level 3 programme.
- ***Level 3 Project Programme -*** detailed programme, which is generated for tracking and control of various activities and deliverables for all phases of the project. The activities will be coded in accordance with the FBS. Various layouts and corresponding filters can be developed to reflect the requirements of the project leads and managers.
- ***Level 4 Project Programme -*** This detailed, discipline-specific programme is developed and maintained by the *Contractor* and generated for tracking and control of various activities and deliverables for all phases of the project. This programme utilizes the FBS structure and relates to the programmed activities in the pricing activity programme or groups of activities. The programme represents the day-to-day activities by discipline that are work-unit based and become summarized in the Level 3 activities.

7.6.5 Progress Reporting and Reports

1. *Reporting and Monitoring:*

   To demonstrate the actual progress and forecast completion of the *works*, the *Contractor* shall, on a weekly basis, update and submit to the *Project Manager* the latest accepted programme and progress report, including histograms and S-curves.
   Monitoring and review of the progress of the *works* shall consist of an assessment of all activities currently in progress to determine percentage complete, forecast completion dates, manning histogram, showing plan versus forecast, deviations from the target programme and actions required for remedy.

   Weekly progress review meetings shall be conducted to report and assist control of the *works*.

2. *Reports:*

- ***Level 4 Programme -*** updated weekly, showing two separate bars for each task, i.e. the primary bar shall reflect the current forecast dates and the secondary bar the latest accepted programme.
- ***4-Week Look-Ahead Programme -*** in the same format as above, updated and issued weekly.
- ***Manpower Histogram -*** updated and issued weekly, showing actual, forecast and planned manpower utilization.
- ***S-curves -*** updated and issued weekly, showing actual % complete versus planned % for the overall contract and utilizing the earned values as calculated by the detailed progress report.
- ***Detailed progress report -*** updated and issued weekly, utilizing a spreadsheet to calculate earned progress of activities, as reflected on the Level 4 programme, based on installed quantities. Activities shall be weighted using man-hours. Report shall indicate progress 'this period' and 'progress to date'.
- ***Weekly report -*** a narrative report consisting of an executive summary, area/facility synopsis of the *works* that are in progress and critical action items (top 10). The report shall be accompanied with a 4-week look-ahead programme and S-curve.
- ***Bi-Weekly report -*** a narrative status report submitted every second week (with the second report issued a week before the last Friday of each month), or as required by the *Project Manager*. The report shall include, but not be limited to, the following:

    - Summary of progress achieved during the reporting period.
    - Latest updated programme.
    - Project milestones table – planned versus actual and forecast.
    - Status and performance of on-Site *works*.
    - Status and performance of off-Site *works*.
    - Histograms and s-curves.
    - Critical action items list (top 10).

7.7 *Contractor*'s Management, Supervision and Key People

The *Contractor* provides an organogram of all his key people, as required by the *Employer* and as stated in the Contract Data, and how such key people communicate with the *Project Manager* and the *Supervisor* and their delegates.

The *Contractor* shall include the following as part of his key people under ECC Clause 24.1 an Electrical Engineer, Controls and Instrumentation Engineer, Mechanical Engineer, Structural Engineer, Contracts Manager, Quantity Surveyor, Land Surveyor, Construction Manager, Project Manager, Construction Supervisor,Construction Planner. All these key people should have the relevant experience, qualifications and should be professionally registered with their respective professional bodies. The key people are not limited to the above mentioned people. The *Contractor* shall ensure that all required people execute all parts of the works in accordance with transnet works information and specifications.

<u>Environmental Officer</u>
The *Contractor* appoints an EO as a key person under ECC Clause 24.1. The EO ensures that the *works*, including all parts thereof, are undertaken subject to prior environmental method statement(s), approved by the *Project Manager*, and ensures that all the project's EA, permits and licences, EMPr, Contractor's Environmental and Sustainable Specification, CEM SOP, etc. are implemented by the *Contractor* in a timely and proper manner.

The EO provides the *Project Manager* with all environmental method statements for approval

prior to commencing with the required *works*. The EO tasks are:

- Daily, weekly, and monthly inspections of the Site and working areas. Monitor compliance with the project's EA, permits and licences, EMPr,, CEM SOP, method statements etc.
- Reporting of environmental incidents to the *Project Manager*.
- Attendance at all SHE meetings, toolbox talks and induction programmes.
- Litter control and ensuring the *Contractor* clears litter from the Site.
- Ensuring that environmental signage and barriers are correctly placed.
- The EO submits daily, weekly and monthly checklists to the *Employer*'s EO/ECO.

CIRP

The *Contractor* nominates a CIRP as a key person under ECC Clause 24.1. The CIRP is based on Site and ensures that all reports and IR requests are submitted accurately and in a timely manner to the *Project Manager*. The *Contractor* is referred to Annexure L (Industrial Relations Policy and Management Plan). The CIRP tasks are:

- Dedicated to human resources, industrial relations and any other *Contractor* employee related functions;
- Resolve all human resources and industrial relations matters arising from the *Contractor*'s employees;
- Represent the *Contractor* at all industrial relations meetings.

7.8 Training Workshops and Documentation

The *Contractor* facilitates the following requirements for training workshops:

- Pre-mobilization workshop, scheduled for one week prior to Site establishment. Workshop will be attended by the Site management team including Site agents, all *Contractor's* supervisors and safety personnel. Reference is made to Annexure G (Health and Safety Specification and Standard);
- Additional training will include, but is not limited to, SOC training, Ripples of Loss, Serious Injuries, Demonstration of Care, etc.;
- Preliminary hazard assessment workshops will be held with all role players before Site establishment and on a bi-weekly basis, directed at Site management and safety staff, all as specified in the health and safety specifications;
- Launching HIV/AIDS awareness programme to Transnet employees, local schools and community centres in the area;
- Life skills development and induction programmes relating to the social environment introduced.

The *Contractor* provides the following documentation to the *Employer*:

- Health and Safety Management Plan and Standard.
- Incident Management.
- Performance Reporting.
- Site Training Packages.
- Functional Guides.
- Safe Work Methods.
- Safety Procedures.
- Risk Assessment Process and Systems.
- Insurance provided by the *Employer*.
- Insurance provided by the *Employer* is contained in the Contract Data – Part 1.

7.9 Contract Change Management

No additional requirements apply to ECC3 Clause 60 series.

7.10 Provision of Bonds and Guarantees

The form in which the bond or guarantee is to be provided by the Contractor is given in Part 1: Agreements and Contract Data, Document C1.3, Forms of Securities.

The Contractor provides a bond or guarantee as required by the Conditions of Contract concurrent with the execution by the parties of the Form of Agreement for the ECC.

8. PROCUREMENT

8.1 Code of Conduct

The *Employer* aims to achieve the best value for money when buying or selling goods and obtaining services. This must however be done in an open and fair manner that supports and drives a competitive economy. Underpinning the process are several acts and policies that any supplier dealing with the *Employer* must understand and support. These are:

- The Transnet Procurement Procedures Manual (PPM).
- Section 217 of the Constitution - the five pillars of Public PSCM (Procurement and Supply Chain Management): fair, equitable, transparent, competitive and cost effective.
- The Public Finance Management Act (PFMA).
- The Broad Based Black Economic Empowerment Act (B-BBEE).
- The Anti-Corruption Act.

This code of conduct has been included in this Works Information to formally appraise the *Employer's* suppliers of the *Employer's* expectations regarding behaviour and conduct of suppliers.

8.2 Prohibition of Bribes, Kickbacks, Unlawful Payments, and Other Corrupt Practices

The *Employer* is in the process of transforming itself into a self-sustaining State Owned Enterprise, actively competing in the logistics industry. Its aim is to become a world class, profitable, logistics organisation. As such, its transformation is focused on adopting a performance culture and to adopt behaviours that will enable this transformation.

1. *The Employer will not participate in corrupt practices and therefore expects its suppliers to act in a similar manner.*

    - The *Employer* and its employees will follow the laws of this country and keep accurate business records that reflect actual transactions with and payments to its suppliers.
    - Employees must not accept or request money or anything of value, directly or indirectly, to:

        i. Illegally influence their judgement or conduct to ensure a desired outcome of a sourcing activity.
        ii. Win or retain business or to influence any act or decision by stakeholders involved in sourcing decisions.
        iii. Gain an improper advantage.

    - There may be times when a supplier is confronted with fraudulent or corrupt behaviour of the *Employer*s employees. The *Employer* expects its suppliers to use the "Tip-Offs Anonymous" Hot Line to report these acts (0800 003 056).

2. *The Employer is firmly committed to the ideas of free and competitive enterprise.*

    - The *Contractor* is expected to comply with all applicable laws and regulations regarding fair competition and antitrust.
    - The *Employer* does not engage with non-value adding agents or representatives solely for the purpose of increasing B-BBEE spend (fronting).

3. *The Employer's relationship with suppliers requires it to clearly define requirements, exchange information and share mutual benefits.*

- Generally, suppliers have their own business standards and regulations. Although the *Employer* cannot control the actions of suppliers, the *Employer* will not tolerate any illegal activities. These include, but are not limited to:

  i. Misrepresentation of their product (origin of manufacture, specifications, intellectual property rights, etc.).
  ii. Collusion.
  iii. Failure to disclose accurate information required during the sourcing activity (ownership, financial situation, B-BBEE status, etc.).
  iv. Corrupt activities as listed above.
  v. Harassment, intimidation or other aggressive actions towards the *Employer*'s employees.

- The *Contractor* must be evaluated and approved before any materials, components, products or services are purchased from them. Rigorous due diligence is conducted and the supplier is expected to participate in an honest and straight forward manner.
- The *Contractor* must record and report facts accurately, honestly and objectively. Financial records must be accurate in all material respects.

8.3 Conflicts of Interest

A conflict of interest arises when personal interests or activities influence (or appear to influence) the ability to act in the best interests of the *Employer*

- Doing business with family members.
- Having a financial interest in another company in the industry.

8.4 The *Contractor's* Invoices

When the *Project Manager* certifies payment (see ECC Clause 51.1) following the assessment date, the *Contractor* complies with the *Employer's* procedure for invoice submission.

The invoice must correspond to the *Project Manager's* assessment of the amount due to the *Contractor* as stated in the payment certificate. The invoice states the following:

Invoice addressed to Transnet SOC Ltd.
Transnet SOC Limited's VAT No: 4720103177.
Invoice number.
The *Contractor*'s VAT Number.
The Contract number: 1924701-E004.

The invoice is presented either by post or by hand delivery.

Invoices submitted by post are addressed to:

Transnet Port Terminal
1st Floor Salkor Administration Building
Orex Road
Saldanha Bay
7395
South Africa

For the attention of The Contract Administrator

Invoices submitted by hand are presented to:

1st Floor Salkor Administration Building
Orex Road
Saldanha Bay
7395
South Africa

For the attention of The Contract Administrator

The invoice is presented as an original.

9. PEOPLE

Minimum requirements of people employed on the Site include the following:

- Employee's medical certificate with 5 panel drug test results.
- Health and Safety induction training.

The *Contractor* complies with Annexure L (Industrial Relations Policy and Management Plan), including the following requirements.

9.1 *Contractor* Liability

The *Contractor* warrants that it will be liable to the *Employer* for any loss or damage caused by strikes, riots, lockouts or any labour disputes by and/or confined to the *Contractor's* employees, which loss will include any indirect or consequential damages.

The *Contractor* warrants that no negotiations or feedback meetings by the *Contractor's* employees shall take place on the *Employer's* premises, whether owned or rented by the *Employer*.

The *Contractor* shall give notice to the *Employer* of any industrial action by the *Contractor's* employees immediately upon becoming aware of any actual or contemplated action that is or may be carried out on the *Employers* premises, whether owned or rented, and shall notify the *Employer* of all matters associated with such action that may potentially affect the *Employer*.

The *Contractor* is responsible for educating its employees on relevant provisions of the Labour Relations Act which deal with industrial action processes and the risks of non-compliance.

The *Contractor* is required to develop a contingency strike handling plan, which plan the *Contractor* is obliged to update on a three monthly basis. The *Contractor* must provide the *Employer* with this plan and all updates to the plan. The *Contractor* is responsible to communicate with its employees on Site details of the plan.

9.2 Industrial Action by *Contractors* Employees

In the event of any industrial action by the *Contractor's* employees, the *Contractor* is required to provide competent contingency resources permitted in law to carry out any of the duties that are, or could potentially be, interrupted by industrial action in delivering the service.

The *Contractor* warrants that it will compensate the *Employer* for any costs the *Employer* incurs in providing additional security to deal with any industrial action by the *Contractor's* employees.

In the event of any industrial action by the *Contractor's* employees, the *Contractor* is obliged to prepare and deliver to the *Employer*, within two (2) hours of the commencement of industrial action, an industrial action report. If the industrial action persists, the *Contractor* is required to deliver the report at 8h30 each day.

The industrial action report must provide at least the following information:

- Industrial incident report.
- Attendance registers.
- Productivity / progress to schedule reports.
- Operational contingency plan.
- Site security report.

- Industrial action intelligence gathered.

The final industrial action report is to be delivered 24 hours after finalization of the industrial action.

The management of the *Contractor* is required to hold a daily industrial action teleconference with personnel identified by the *Employer* to discuss the industrial action, settlement of the industrial action, security issues and the impact on delivery under the contract.

The resolution of any disputes or industrial action by the *Contractor's* employees is the sole responsibility of the *Contractor*.

Access to the *Employer's* premises by the *Contractor* and its employees is only provided for purposes of the *Contractor* delivering its services to the *Employer*.

Should the *Contractor* and its employees not, for any reason, be capable of delivering its services, the *Employer* is entitled to restrict or deny access onto its premises and, unless otherwise authorized, such person will be deemed to be trespassing.

The *Contractor* performs the *works* having due regard to the PIRPMP, statutory requirements and industry agreements.

The *Contractor* complies with the requirements of the IRCC involving the engineering construction *Contractors* engaged (including all future *Contractors*) by the *Employer*.

The roles and responsibilities of the various personnel acting on behalf of the *Project Manager* with respect to IR issues are stated in the following paragraphs.

The PIRM is responsible for ensuring that the *Contractor* complies with the PIRPMP. The PIRM acts on behalf of the *Project Manager.*

The PIRM specific tasks are:

- As per Annexure L (Industrial Relations Policy and Management Plan).
- To liaise with the *Contractor* prior to the commencement of construction activities, as per the *Contractor*'s programme accepted by the *Project Manager*, with respect to IR issues.
- Responsible, inter alia, for day-to-day IR on the Site through the implementation of the PIRPMP.
- The PIRM reports directly to the *Project Manager*.

10. B-BBEE AND PREFERENCE SCHEME

Points will be awarded to tenderers based on preference using the balanced Department of Trade and Industry (DTI) scorecard. The application of the Broad-Based Black Economic Empowerment recognition levels and score preference points are as follows:

Contribution Level	Qualification Points on the generic scorecard	Broad-Based BEE Recognition Level	Preferencing Points Scored
Level 1	Greater than or equal to 100 points	135%	10
Level 2	Greater than or equal to 85 points but less than 100 points	125%	9
Level 3	Greater than or equal to 75 points but less than 85 points	110%	8
Level 4	Greater than or equal to 65 points but less than 75 points	100%	5
Level 5	Greater than or equal to 55 points but less than 65 points	80%	4
Level 6	Greater than or equal to 45 points but less than 55 points	60%	3
Level 7	Greater than or equal to 40 points but less than 55 points	50%	2
Level 8	Greater than or equal to 30 points but less than 40 points	10%	1
Level 9	Less than 30 points	0%	0

On the basis the tenderer with a B-BBEE recognition level of 135% will achieve 10 points, and the points will be allocated accordingly on a pro-rata basis as per the table above.

In addition to the above, provision is made for the case where a tenderer has greater than 50% black ownership. In this instance, provided the requisite documentary evidence is supplied, the tenderer will then be awarded preference points one level above that awarded based on the DTI scorecard. For example, a tenderer with > 50% black ownership obtaining a Level 6 contribution equating to 3 points will be awarded 4 preference points (Level 5).

Tenderers claiming Preference Points must submit together with the tender document their generic scorecard, evaluated by an independent accreditation agency. The *Employer* therefore requires tenderers to have been accredited by SANAS or IRBA Accreditation Agencies in accordance with the latest relevant Codes of Practice applicable not more than 3 months prior to the date of tender.

Should the B-BBEE rating not be provided, the *Employer* reserves the right to award no points. The *Employer* also reserves the right to carry out an independent audit of the tenderers scorecard components at any stage from the date of close of the tenders until completion of the contract. The *Contractor* with no accreditation will score zero points for preference.

11. SUBCONTRACTING

Where the *Contractor* employs a subcontractor who constructs or installs part of the *works* or who supplies plant and materials for incorporation into the *works* which involves a subcontractor operating on the Site, then the *Contractor* ensures that any such subcontractor complies with the EMPr, CEMP and SES as described in the Works Information, as appropriate.

The subcontract documentation shall place back-to-back obligations on the subcontractor, which reflect the *Contractor*'s obligations under the EMPr, CEMP and SES, all within the *Contractor*'s quality management system, as per the Works Information.

Where the *Contractor* employs a subcontractor who constructs or installs part of the *works,* or who supplies plant and materials for incorporation into the *works* which involves a subcontractor operating on the Site and/or working areas, then the *Contractor* ensures that any such subcontractor complies with the PIRPMP as appropriate and that the subcontract documentation places back-to-back obligations on the subcontractor which reflect the *Contractor*'s obligations under the PIRPMP, all within the *Contractor*'s quality management system as per the Works Information.

12. PLANT AND MATERIALS

The *Contractor* provides plant and materials for inclusion in the *works* in accordance with COLTO 1208 Item (e), unless stated otherwise in the Works Information provided by the *Employer*.

All Plant and Materials are new, unless the use of old or refurbished goods and/or materials are expressly permitted as stated elsewhere in this Works Information, or as may be subsequently instructed by the *Project Manager*.

The *Contractor* replaces any Plant and Materials subject to breakages (whether in the working areas or not) or any plant and materials not conforming to standards or specifications stated and notifies the *Project Manager* and the *Supervisor* on each occasion where replacement is required.

C3.5 *EMPLOYER'S* WORKS INFORMATION: ANNEXURES

Annexure A – Project Specifications

Annexure B – Tender Drawings

Annexure C – E7/1 Specification for General Work and Works on, under or adjacent to railway lines and near High Voltage Equipment

Annexure D – Security Specification
1924701-SP-0005
RFP No: GSM/12/09/0538

Annexure E – Contractor Documentation Schedule (CDS)

Annexure F – Contractor Documentation Submittal Requirements
DOC-STD-0001

Annexure G – Health and Safety Specification and Standard
HAS-STD-0001

Annexure H – Environmental Management Programme
EMPR-QMF-GE-EV-973- REV0-01/08/2016
SRK Consulting: 494610 TCP Bulk Power Saldanha EMP

Annexure I – Environmental Documentation
Transnet Integrated management System (TIMS) Policy Statement
14/12/16/3/3/1/1520- Environmental Authorisation
14/12/16/3/3/1/1520/AM1- Amended Environmental Authorisation
QMF-GE-EV-972- REV0-01/08/2016- Basic Assessment Report
SRK Consulting: 494610 TCP Bulk Power- Basic Assessment Report
Standard Operating Procedure -Construction Environmental Management-
009-TCC-CLO SUS-11386
Contractor Environmental and Sustainable Specifications- TRN-IMS-GRP-GDL-014.4

Annexure J – General Quality Requirements for Contractors and Suppliers
QAL-STD-0001

Annexure K – Tender Schedule

Annexure L – Industrial Relations Policy and Management Plan
ACM-IR-POL-001

Annexure A – Project Specifications

Document Number	Document Title
1924701-2-300-E-SP-0006	Technical Specification: Tippler 3 – High and Medium Voltage Installations
1924701-2-300-E-SP-0007	*Technical Specification: Tippler 3 - 66 kV Branch Line to New Main Intake Substation*
1924701-2-300-E-SP-0008	Technical Specification: Tippler 3 - Low Voltage Installations
1924701-2-300-E-SP-0009	Technical Specification: Tippler 3 - Protection and Metering Installations
1924701-2-300-E-SP-0010	Technical Specification: Tippler 3 - Monitoring and Control Installations
1924701-2-300-B-SP-0001	Technical Specification: Tippler 3 - Structural *Works*
1924701-2-300-A-SP-0001	Technical Specification: Tippler 3 - Architectural
1924701-2-300-C-SP-0001	Technical Specification: Tippler 3 - Civil *Works*
1924701-2-300-B-SP-0002	Technical Specification: Tippler 3 - HVAC
1924701-2-300-B-SP-0003	Technical Specification: Tippler 3 - Fire Suppression
1924701-2-300-J-SP-0001	Tippler 3 Bulk Power ICT and Security System Specification

Annexure B – Tender Drawings

This is the list of drawings issued by the *Employer* at or before the Contract Date and which apply to this contract.

Drawing No	Drawing Title
ELECTRICAL	
GENERAL	
1924701-2-300-E-DE-0012	Cable Route Trench Details – Type 1
1924701-2-300-E-DE-0013	Cable Route Trench Details – Type 2
1924701-2-300-E-DE-0014	Cable Route Trench Details – Type 3
1924701-2-300-E-DE-0015	Cable Route Trench Details – Type 4
1924701-2-300-E-DE-0016	Cable Route Trench Details – Type 5
1924701-2-300-E-DE-0017	Cable Route Trench Details – Type 6
1924701-2-300-E-DE-0018	Cable Route Trench Details – Type 7
1924701-2-300-E-DE-0029	Cable Route Trench Details – Type 8
1924701-2-300-E-DE-0019	Close Proximity of Services, Clearances and Protection Requirements
1924701-2-300-E-LA-0012	Site Layout
1924701-2-300-E-PD-0001	MV Block Diagram
1924701-2-300-E-PD-0002	Fibre Optic Block Diagram
1924701-2-300-E-PD-0012	High Level Network Architecture and Integration Block Diagram
1924701-2-300-E-LA-0061	Tippler 3 Power System Study
MAIN INTAKE SUBSTATION	
1924701-2-300-E-GA-0003	New Main Intake Substation General Arrangement
1924701-2-300-E-LA-0064	New Main Intake Substation Earthmat Layout
1924701-2-300-E-LA-0020	New Main Intake Substation Lighting Layout
1924701-2-300-E-LA-0021	New Main Intake Substation Lightning Protection Layout
1924701-2-300-E-LA-0023	New Main Intake Substation Medium Voltage Equipment Layout
1924701-2-300-E-SD-0008	New Main Intake Substation Protection Schematic Diagram
1924701-2-300-E-SE-0001	New Main Intake Substation Section Views
1924701-2-300-E-SL-0008	New Main Intake Substation MV Single Line Diagram
1924701-2-300-E-PD-0005	New Main Intake Substation Monitoring and Control Block Diagram
1924701-2-300-E-PD-0010	New Main Intake Substation LV & Communication Block Diagram
1924701-2-300-E-SL-0013	New Main Intake Substation Main Distribution Board (MDB) Single Line Diagram
1924701-2-300-E-SL-0014	New Main Intake Substation MV Equipment Sub Distribution Board (SDB-MVE) Single Line Diagram
SUBSTATION M	
1924701-2-300-E-LA-0015	Substation M Medium Voltage Equipment
1924701-2-300-E-LA-0024	Substation M Earthing & Lightning Protection System - Earth Grid Layout
1924701-2-300-E-LA-0065	Substation M Earthing Protection System - Earth Grid Layout
1924701-2-300-E-PD-0003	Substation M Monitoring & Control Block Diagram

Drawing No	Drawing Title
1924701-2-300-E-PD-0006	Substation M LV & Communication Block Diagram
1924701-2-300-E-SD-0006	Substation M Protection Schematic Diagram
1924701-2-300-E-SL-0005	Substation M MV Single Line Diagram
1924701-2-300-E-SL-0009	Substation M Main Distribution Board (MDB) Single Line Diagram
1924701-2-300-E-SL-0010	Substation M MV Equipment Sub Distribution Board (SDB-MVE) Single Line Diagram
SUBSTATION N	
1924701-2-300-E-LA-0016	Substation N Medium Voltage Equipment
1924701-2-300-E-LA-0025	Substation N Earthing & Lightning Protection System - Earth Grid Layout
1924701-2-300-E-LA-0083	Substation N Earthing Protection System - Earth Grid Layout
1924701-2-300-E-PD-0004	Substation N Monitoring & Control Block Diagram
1924701-2-300-E-PD-0008	Substation N LV & Communication Block Diagram
1924701-2-300-E-SD-0007	Substation N Protection Schematic Diagram
1924701-2-300-E-SL-0006	Substation N MV Single Line Diagram
1924701-2-300-E-SL-0011	Substation N Main Distribution Board (MDB) Single Line Diagram
1924701-2-300-E-SL-0012	Substation N MV Equipment Sub Distribution Board (SDB-MVE) Single Line Diagram
66 KV BRANCH LINE	
1924701-2-300-E-LA-0062	66kV Branch Line Mast Positions & Clearances
MECHANICAL	
MAIN INTAKE SUBSTATION	
1924701-2-510-M-GA-0026	Main Intake Substation HVAC General Arrangement Level 00
1924701-2-510-M-GA-0027	Main Intake Substation HVAC General Arrangement Level 01
1924701-2-510-M-GA-0028	Main Intake Substation HVAC General Arrangement Level 02
1924701-2-510-M-SD-0004	Main Intake Substation - Chilled Water Schematic
1924701-2-510-M-SE-0005	Main Intake Substation – HVAC Section Layout
1924701-2-510-M-ST-0008	Main Intake Substation - Standard Ducting Layout
1924701-2-510-M-ST-0009	Main Intake Substation - Standard Piping Layout
1924701-2-510-M-LA-0011	Main Intake Substation Level 00 Fire Protection Plan
1924701-2-510-M-LA-0012	Main Intake Substation Level 01 Fire Protection Plan
1924701-2-510-M-LA-0013	Main Intake Substation Level 02 Fire Protection Plan
SUBSTATION M	
1924701-2-510-M-GA-0029	Substation M - HVAC General Arrangement Layout
1924701-2-510-M-SD-0005	Substation M - Chilled Water Schematic
1924701-2-510-M-SE-0006	Substation M - HVAC Section Layout (Sheet 1)
1924701-2-510-M-SE-0007	Substation M - HVAC Section Layout (Sheet 2)
1924701-2-510-M-ST-0004	Substation M - Standard Ducting Layout
1924701-2-510-M-ST-0005	Substation M - Standard Piping Layout
1924701-2-510-M-LA-0014	Substation M - Fire Plans
SUBSTATION N	
1924701-2-510-M-GA-0031	Substation N - HVAC General Arrangement Layout
1924701-2-510-M-SD-0007	Substation N - Chilled Water Schematic
1924701-2-510-M-SE-0009	Substation N - HVAC General Arrangement Section Layout (Sheet 1)
1924701-2-510-M-SE-0010	Substation N - HVAC General Arrangement Section Layout (Sheet 2)
1924701-2-510-M-ST-0006	Substation N - Standard Ducting Layout

Drawing No	Drawing Title
1924701-2-510-M-ST-0007	Substation N - Standard Piping Layout
1924701-2-510-M-LA-0016	Substation N - Fire Plans
ARCHITECTURAL	
MAIN INTAKE SUBSTATION	
1924701-2-510-A-DE-0063	Main Intake - Elevations
1924701-2-510-A-GA-0018	Main Intake - General Arrangement
1924701-2-510-A-GA-0018	Main Intake - General Arrangement Sht2
1924701-2-510-A-GA-0018	New Main Intake Substation - Ceiling Plan
1924701-2-510-A-SC-0038	Main Intake - Door Schedule
1924701-2-510-A-SC-0039	Main Intake - Louvre Schedule
1924701-2-510-A-SC-0042	Main Intake - Room Finish Schedule
1924701-2-510-A-SC-0044	Main Intake - Ironmongery Schedule
1924701-2-510-A-SC-0046	Main Intake – Shopfront Schedule
1924701-2-510-A-SE-0012	Main Intake - Sections
1924701-2-510-A-SE-0012	Main Intake - Sections Sht2
1924701-2-510-A-DE-0070	New Main Intake Substation - Plan Details
1924701-2-510-A-DE-0071	New Main Intake Substation - Skin Sections
1924701-2-510-A-DE-0071	New Main Intake Substation - Skin Sections Sheet 2
1924701-2-510-A-DE-0072	New Main Intake Substation - Skin Section Details
1924701-2-510-A-DE-0072	New Main Intake Substation - Skin Section Details Sheet 2
SUBSTATION M	
1924701-2-510-A-DE-0061	Substation M - Elevations
1924701-2-510-A-GA-0016	Substation M - General Arrangement
1924701-2-510-A-GA-0016	Substation M - General Arrangement Sht2
1924701-2-510-A-GA-0016	Substation M - Ceiling Plan
1924701-2-510-A-SC-0034	Substation M - Door Schedule
1924701-2-510-A-SC-0035	Substation M - Louvre Schedule
1924701-2-510-A-SC-0041	Substation M - Room Finish Schedule
1924701-2-510-A-SC-0043	Substation M - Ironmongery Schedule
1924701-2-510-A-SE-0010	Substation M - Sections
1924701-2-510-A-SE-0010	Substation M – Sections Sht2
1924701-2-510-A-DE-0065	Substation M - Roof and Trench Details
1924701-2-510-A-DE-0064	Substation M - Plan Details
1924701-2-510-A-DE-0066	Substation M - General Details
1924701-2-510-A-DE-0066	Substation M - General Details Sht2
1924701-2-510-A-DE-0066	Substation M - General Details Sht3
SUBSTATION N	
1924701-2-510-A-DE-0062	Substation N - Elevations
1924701-2-510-A-GA-0017	Substation N - General Arrangement
1924701-2-510-A-GA-0017	Substation N - General Arrangement Sht2
1924701-2-510-A-GA-0017	Substation N - Ceiling Plan
1924701-2-510-A-SC-0036	Substation N - Door Schedule
1924701-2-510-A-SC-0037	Substation N - Louvre Schedule
1924701-2-510-A-SC-0040	Substation N - Room Finish Schedule

Drawing No	Drawing Title
1924701-2-510-A-SC-0045	Substation N - Ironmongery Schedule
1924701-2-510-A-SE-0011	Substation N - Sections
1924701-2-510-A-SE-0011	Substation N - Sections Sht2
1924701-2-510-A-DE-0067	Substation N - Plan Details
1924701-2-510-A-DE-0068	Substation N - Roof Details
1924701-2-510-A-DE-0068	Substation N - Roof and Trench Details
1924701-2-510-A-DE-0069	Substation N - General Details
1924701-2-510-A-DE-0069	Substation N - General Details Sht2
1924701-2-510-A-DE-0069	Substation N - General Details Sht3
YSTERVARK SUBSTATION	
1924701-2-510-A-LA-0031	Ystervark Substation - Relay House Building - Elevations & Roof Plan
1924701-2-510-A-LA-0030	Ystervark Substation - Relay House Building - Ground Plan & Details
1924701-2-510-A-DE-0075	Ystervark Substation - Relay House Building - Sections & Details
1924701-2-510-A-DE-0074	Ystervark Substation - Relay House Building - Door Schedule & Details
CIVILS	
GENERAL	
1924701-2-510-C-DE-0010-01	Site Information Board
1924701-2-510-C-LA-0044-01	Substation M, N & Main Intake Locality Plan
MAIN INTAKE SUBSTATION	
1924701-2-510-C-DE-0011-01	Details: Fencing & Gates Sheet 1 of 2
1924701-2-510-C-DE-0011-02	Details: Fencing & Gates Sheet 2 of 2
1924701-2-510-C-LA-0054-01	Main Intake Substation Survey
1924701-2-510-C-LA-0054-02	Main Intake Substation Site Clearance and Accommodation of Traffic
1924701-2-510-C-LA-0055-01	Main Intake Substation Bulk Earthworks
1924701-2-510-C-LA-0055-02	Main Intake Substation Main Backfill Layout
1924701-2-510-C-LA-0055-03	Main Intake Substation Detention Pond Layout
1924701-2-510-C-LA-0056-01	Main Intake Substation Road Layout and Surfacing
1924701-2-510-C-LA-0056-02	Main Intake Substation Internal Levels
1924701-2-510-C-LA-0056-03	Main Intake Substation Fencing Layout
1924701-2-510-C-LA-0056-04	Main Intake Substation Concrete Layout
1924701-2-510-C-LA-0057-01	Main Intake Substation Services Layout Stormwater Drainage & Fire Water
1924701-2-510-C-LA-0057-02	Main Intake Substation Services Layout Foulsewer and Waste Water Drainage
1924701-2-510-C-LA-0057-03	Main Intake Substation Services Layout Cable Trenches
1924701-2-510-C-LA-0057-04	Main Intake Substation Services Layout Service Sleeves
1924701-2-510-C-SE-0005-01	Main Intake Substation Longitudinal Sections Access Roads
1924701-2-510-C-SE-0005-02	Main Intake Substation Longitudinal Sections Internal Roads
SUBSTATION M	
1924701-2-510-C-LA-0045-01	Substation M Survey and Site Clearance
1924701-2-510-C-LA-0046-01	Substation M Earthworks
1924701-2-510-C-LA-0047-01	Substation M Geometry and Levels
1924701-2-510-C-LA-0048-01	Substation M Services
SUBSTATION N	
1924701-2-510-C-LA-0049-01	Substation N Survey and Site Clearance
1924701-2-510-C-LA-0050-01	Substation N Relocation of Existing Services
1924701-2-510-C-LA-0051-01	Substation N Earthworks

Drawing No	Drawing Title
1924701-2-510-C-LA-0051-02	Substation N Backfilling
1924701-2-510-C-LA-0052-01	Substation N Geometry and Levels
1924701-2-510-C-LA-0052-02	Substation N Concrete Layout
1924701-2-510-C-LA-0053-01	Substation N Services
STRUCTURAL	
MAIN INTAKE SUBSTATION	
1924701-2-510-B-DE-0028	Main Intake Substation Stair Layout & Details
1924701-2-510-B-DE-0029	Main Intake Substation Roof Details
1924701-2-510-B-DE-0030	Main Intake Substation Roof Elevations
1924701-2-510-B-LA-0046	Main Intake Substation Level 00 – Layout Part 1
1924701-2-510-B-LA-0047	Main Intake Substation Level 00 – Layout Part 2
1924701-2-510-B-LA-0048	Main Intake Substation Level 01 – Layout Part 1
1924701-2-510-B-LA-0049	Main Intake Substation Level 01 – Layout Part 2
1924701-2-510-B-LA-0050	Main Intake Substation Level 02 – Layout Part 1
1924701-2-510-B-LA-0051	Main Intake Substation Level 02 – Layout Part 2
1924701-2-510-B-LA-0052	Main Intake Substation Roof Layout Part 1
1924701-2-510-B-LA-0053	Main Intake Substation Roof Layout Part 2
1924701-2-510-B-SE-0014	Main Intake Substation Building Sections Sheet 1
1924701-2-510-B-SE-0014	Main Intake Substation Building Sections Sheet 2
1924701-2-510-B-SE-0015	Main Intake Substation Building Elevations
1924701-2-510-B-SE-0016	Main Intake Substation Roof Sections
1924701-2-510-B-DE-0018	Main Intake Substation Equipment Foundation Details
1924701-2-510-B-DE-0021	Main Intake Substation Equipment Foundation Details
1924701-2-510-B-DE-0022	Main Intake Substation Equipment Foundation Details
1924701-2-510-B-DE-0023	Main Intake Substation Equipment Foundation Details
1924701-2-510-B-DE-0024	Main Intake Substation Column 132 / C Equipment Foundation Details
1924701-2-510-B-DE-0027	Main Intake Substation 40MVA Transformer Plinth
1924701-2-510-B-LA-0045	Main Intake Substation General Arrangement Foundations
1924701-2-510-T-DE-0019	Main Intake Substation 2.5m Medium Equipment Support Steelwork Details
1924701-2-510-T-DE-0020	Main Intake Substation 11kV Cable End Support Steelwork Details
1924701-2-510-T-DE-0021	Main Intake Substation 132kV Circuit Breaker Support Steelwork Details
1924701-2-510-T-DE-0022	Main Intake Substation 132kV Isolator Support Steelwork Details
1924701-2-510-T-DE-0023	Main Intake Substation 132kV Inline Isolator Support Steelwork Details
1924701-2-510-T-DE-0024	Main Intake Substation SA Bracket on Isolator Steelwork Details
1924701-2-510-T-DE-0025	Main Intake Substation 132kV Twin Tubular Busbar Support Steelwork Details
1924701-2-510-T-DE-0026	Main Intake Substation 21m Lighting Mast Steelwork Details
1924701-2-510-T-DE-0027	Main Intake Substation Fire Barrier Steelwork Details
1924701-2-510-T-DE-0028	Main Intake Substation NECRT Support Steelwork Details
1924701-2-510-T-DE-0029	Main Intake Substation Column 132 / C & Earthwire Support Steelwork Details
1924701-2-510-T-DE-0030	Main Intake Substation Beam 132/40/1 Steelwork Details
1924701-2-510-T-LA-0004	Main Intake Substation General Arrangement Steel
1924701-2-510-B-RD-0035	Trench Wall Rebar Layout - Sheet 1
1924701-2-510-B-RD-0036	Level 00 - Raft Slab Rebar Layout - Sheet 2
1924701-2-510-B-RD-0037	Level 00 - Raft Slab Rebar Layout - Sheet 2
1924701-2-510-B-RD-0038	Level 00 - Raft Beam Rebar Layout - Sheet 2

Drawing No	Drawing Title
1924701-2-510-B-RD-0039	Level 00 - Raft Beam Rebar Layout - Sheet 3
1924701-2-510-B-RD-0040	Level 01 - Slab Rebar Layout - Sheet 1
1924701-2-510-B-RD-0041	Level 01 - Slab Rebar Layout - Sheet 2
1924701-2-510-B-RD-0043	Level 01 - Beam Rebar - Sheet 2
1924701-2-510-B-RD-0046	Wall Rebar Layouts - Sheet 1
1924701-2-510-B-RD-0047	Wall Rebar Layouts - Sheet 1
1924701-2-510-B-RD-0049	Main Intake Substation - Level 02 Rebar Layout
1924701-2-510-B-RD-0048	Main Intake Substation - Column Rebar
1924701-2-510-B-RD-0042	Main Intake Substation - Level 01 - Beam Rebar - Sheet 1
1924701-2-510-B-RD-0044	Main Intake Substation - Level 01 - Beam Rebar - Sheet 3
1924701-2-510-B-RD-0045	Main Intake Substation - Level 01 - Beam Rebar - Sheet 4
1924701-2-510-B-RD-0050	Stairs Rebar Layout
1924701-2-510-B-RD-0051	Steel Stair Details
1924701-2-510-B-RD-0054	Oil Dam and Oil Separator Reinforcing
SUBSTATION M	
1924701-2-510-B-DE-0015	Substation M Typical Details
1924701-2-510-B-LA-0033	Substation M Foundation Layout
1924701-2-510-B-LA-0034	Substation M Surface Bed Layout
1924701-2-510-B-LA-0035	Substation M Steel Roof Layout
1924701-2-510-B-LA-0042	Substation M Eaves Beam Layout
1924701-2-510-B-SE-0011	Substation M Sections Sht1
1924701-2-510-B-RD-0026	Substation M - Foundation Rebar Layout
1924701-2-510-B-RD-0028	Substation M - Ground Floor Slabs and Column Rebar Layouts
1924701-2-510-B-RD-0027-01	Trench Wall Rebar Layout - Sheet 1
1924701-2-510-B-RD-0027-02	Trench Wall Rebar Layout - Sheet 2
1924701-2-510-B-RD-0029	Eaves Beam Rebar Layout
1924701-2-510-B-RD-0030	Substation M - Rebar Schedule
1924701-2-510-B-RD-0052	Stormwater Channels Reinforcing
SUBSTATION N	
1924701-2-510-B-DE-0016	Substation N Typical Details
1924701-2-510-B-LA-0036	Substation N Foundation Layout
1924701-2-510-B-LA-0037	Substation N Surface Bed Layout
1924701-2-510-B-LA-0038	Substation N Steel Roof Layout
1924701-2-510-B-LA-0043	Substation N Eaves Beam Layout
1924701-2-510-B-SE-0012	Substation N Sections
1924701-2-510-B-RD-0031	Substation N - Foundation Rebar Layout
1924701-2-510-B-RD-0032	Eaves Beam and Slabs Rebar Layout
1924701-2-510-B-RD-0033	Trench Wall Rebar Layout - Sheet 1
1924701-2-510-B-RD-0034	Substation N - Trench Walls continued and Column Rebar Sheet 2
1924701-2-510-B-RD-0053	Stormwater Channels Reinforcing
YSTERVARK SUBSTATION	
1924701-2-510-B-DE-0031	Relay House Building - Foundation & Steel Reinforcement Layout

Annexure C – E7/1 Specification for General Work and Works on, under or adjacent to railway lines and near High Voltage Equipment

Annexure D – Security Specification 1924701-SP-0005 RFP No: GSM/12/09/0538

Annexure E – *Contractor* Documentation Schedule (CDS)

Document Number	Document Title
1924701-E004-SCH-0002	Bulk Power Upgrade – Contractor Documentation Schedule (CDS)

Annexure F – Contractor Documentation Submittal Requirements DOC-STD-0001

Annexure G – Health and Safety Specification and Standard HAS-STD-0001

Annexure H – Environmental Management Programme

Document Number	Document Title
QMF-GE-EV-973- REV0-01/08/2016	Environmental Management Programme for the Part two(2) amendment of the Environmental Authorisation
494610	SRK Consulting: TCP Bulk Power Saldanha EMPr

Annexure I – Environmental Documentation

Document Number	Document Title
IMS-GRP=GDL-002-1	Transnet Integrated management System (TIMS) Policy Statement
14/12/16/3/3/1/1520	Environmental Authorisation
14/12/16/3/3/1/1520/AM1	Amended Environmental Authorisation
QMF-GE-EV-972-REV-01/08/2016	Basic Assessment Report
494610	SRK Consulting: TCP Bulk Power- Basic Assessment Report
009-TCC-CLO-SUS-11386	Standard Operating Procedure- Construction Environmental Management
TRN-IMS-GRP-GDL-014.4	Contractor Environmental and Sustainable Specifications

Annexure J – General Quality Requirements for Contractors and Suppliers QAL-STD-0001

Annexure K – Tender Schedule

Annexure L – Industrial Relations Policy and Management Plan ACM-IR-POL-001

C1.1: Form of Offer & Acceptance

Offer

The Employer, identified in the Acceptance signature block, has solicited offers to enter into a contract for the procurement of:

FOR THE SUPPLY AND INSTALLATION OF BULK ELECTRICAL SUPPLY INCLUDING TRANSFORMERS, SWITCHGEARS, MCC AND SUB-STATION BUILDINGS AT SALDANHA BULK TERMINAL FOR TRANSNET SOC LTD (REG.NO.1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS, (HEREINAFTER REFERRED TO AS "TPT"),

By the representative of the tenderer, deemed to be duly authorised, signing this part of this Form of Offer and Acceptance the tenderer offers to perform all of the obligations and liabilities of the *Contractor* under the contract including compliance with all its terms and conditions according to their true intent and meaning for an amount to be determined in accordance with the *conditions of contract* identified in the Contract Data.

The offered total of the Prices exclusive of VAT is	**R**
Value Added Tax @ 15% is	**R**
The offered total of the Prices inclusive of VAT is	**R**
(in words)	

This Offer may be accepted by the Employer by signing the Acceptance part of this Form of Offer and Acceptance and returning one copy of this document including the Schedule of Deviations (if any) to the tenderer before the end of the period of validity stated in the Tender Data, or other period as agreed, whereupon the tenderer becomes the party named as the *Contractor* in the *conditions of contract* identified in the Contract Data.

Signature(s)

Name(s) .....

Capacity .....

For the tenderer:

.....

(Insert name and address of organisation)

Name & signature of witness .....

Date .....

Tenderer's CIDB registration number: .....

Acceptance

By signing this part of this Form of Offer and Acceptance, the *Employer* identified below accepts the tenderer's Offer. In consideration thereof, the *Employer* shall pay the *Contractor* the amount due in accordance with the *conditions of contract* identified in the Contract Data. Acceptance of the tenderer's Offer shall form an agreement between the *Employer* and the tenderer upon the terms and conditions contained in this agreement and in the contract that is the subject of this agreement.

The terms of the contract, are contained in:

Part C1	Agreements and Contract Data, (which includes this Form of Offer and Acceptance)
Part C2	Pricing Data
Part C3	Scope of Work: Works Information
Part C4	Site Information

and drawings and documents (or parts thereof), which may be incorporated by reference into the above listed Parts.

Deviations from and amendments to the documents listed in the Tender Data and any addenda thereto listed in the Returnable Schedules as well as any changes to the terms of the Offer agreed by the tenderer and the Employer during this process of offer and acceptance, are contained in the Schedule of Deviations attached to and forming part of this Form of Offer and Acceptance. No amendments to or deviations from said documents are valid unless contained in this Schedule.

The tenderer shall within two weeks of receiving a completed copy of this agreement, including the Schedule of Deviations (if any), contact the Employer's agent (whose details are given in the Contract Data) to arrange the delivery of any securities, bonds, guarantees, proof of insurance and any other documentation to be provided in terms of the *conditions of contract* identified in the Contract Data at, or just after, the date this agreement comes into effect. Failure to fulfil any of these obligations in accordance with those terms shall constitute a repudiation of this agreement.

Notwithstanding anything contained herein, this agreement comes into effect on the date when the tenderer receives one fully completed original copy of this document, including the Schedule of Deviations (if any).

Unless the tenderer (now *Contractor*) within five working days of the date of such receipt notifies the Employer in writing of any reason why he cannot accept the contents of this agreement, this agreement shall constitute a binding contract between the Parties.

Signature(s)			
Name(s)			
Capacity			
for the Employer	Transnet SOC Ltd		
	(Insert name and address of organisation)		
Name & signature of witness		Date	

Schedule of Deviations

Note:

1. To be completed by the Employer prior to award of contract. This part of the Offer & Acceptance would not be required if the contract has been developed by negotiation between the Parties and is not the result of a process of competitive tendering.
2. The extent of deviations from the tender documents issued by the Employer prior to the tender closing date is limited to those permitted in terms of the Conditions of Tender.
3. A tenderer's covering letter must not be included in the final contract document. Should any matter in such letter, which constitutes a deviation as aforesaid be the subject of agreement reached during the process of Offer and Acceptance, the outcome of such agreement shall be recorded here and the final draft of the contract documents shall be revised to incorporate the effect of it.

No.	Subject	Details
1		
2		
3		
4		
5		

By the duly authorised representatives signing this Schedule of Deviations below, the Employer and the tenderer agree to and accept this Schedule of Deviations as the only deviations from and amendments to the documents listed in the Tender Data and any addenda thereto listed in the Tender Schedules, as well as any confirmation, clarification or changes to the terms of the Offer agreed by the tenderer and the Employer during this process of Offer and Acceptance.

It is expressly agreed that no other matter whether in writing, oral communication or implied during the period between the issue of the tender documents and the receipt by the tenderer of a completed signed copy of this Form shall have any meaning or effect in the contract between the parties arising from this Agreement.

	For the tenderer:	**For the Employer**
Signature		
Name		
Capacity		
On behalf of	*(Insert name and address of organisation)*	Transnet SOC Ltd OPERATING AS TRANSNET PORT TERMINALS

Name & signature of witness	.....	.....
Date	.....	.....

C1.2 Contract Data

Part one - Data provided by the *Employer*

Clause	Statement	Data	
1	**General**		
	The *conditions of contract* are the core clauses and the clauses for main Option		
		B:	**Priced contract with bill of quantities**
	dispute resolution Option	**W1:**	**Dispute resolution procedure**
	and secondary Options		
		X1:	**Price adjustment for inflation**
		X2	**Changes in the law**
		X5:	**Sectional Completion**
		X7:	**Delay damages**
		X13:	**Performance Bond**
		X16:	**Retention**
		X18:	**Limitation of liability**
		Z:	***Additional conditions of contract***
	of the NEC3 Engineering and Construction Contract June 2005 (amended June 2006 and April 2013)		
10.1	The *Employer* is:	**Transnet SOC Ltd (Registration No. 1990/000900/30) operating as Transnet Port Terminals, (hereinafter referred to as "TPT").**	

	Address	Registered address: **Transnet Port Terminals** **202 Anton Lembede Street** **Durban** **4000**
	Having elected its Contractual Address for the purposes of this contract as:	**Transnet Port Terminals** *Ground Floor* **Orex Road.** **Saldanha** **7395**
10.1	The *Project Manager* is: (Name)	**TBC**
	Address	**TPT: Saldanha** **Salkor Admin Building** **Orex Road** **Saldanha, 7395**
	Tel	**TBC**
	e-mail	**TBC**
10.1	The *Supervisor* is: (Name)	**TBC**
	Address	**TPT: Saldanha** **Salkor Admin Building** **Orex Road** **Saldanha, 7395**
	Tel No.	**TBC**
	e-mail	**TBC**
11.2(13)	The *works* are	**Supply and installation of Bulk Electrical supply including Transformers, Switchgears, MCC and sub-station buildings.**
11.2(14)	The following matters will be included in the Risk Register	**Will be informed by the final negotiation with the successful bidder.**
11.2(15)	The *boundaries of the site* are	**Refer to Part C4.**
11.2(16)	The Site Information is in	**Part C4**
11.2(19)	The Works Information is in	**Part C3**
12.2	The *law of the contract* is the law of	**the Republic of South Africa subject to the jurisdiction of the Courts of South Africa.**

13.1	The *language of this contract* is	**English**
13.3	The *period for reply* is	**2 weeks**
2	**The *Contractor*'s main responsibilities**	**No additional data is required for this section of the *conditions of contract*.**
3	**Time**	
11.2(3)	The *completion date* for the whole of the *works* is	**Will be informed by the final negotiation with the successful bidder.**
30.1	The *access dates* are	**Part of the Site** **Date** **1 Construction Site access** **2 will be further developed when successful bidder is been identified**
31.1	The *Contractor* is to submit a first programme for acceptance within	**2 weeks of the Contract Date.**
31.2	The *starting date* is	**01 May 2024**
32.2	The *Contractor* submits revised programmes at intervals no longer than	**2 weeks.**
35.1	The *Employer* is not willing to take over the *works* before the Completion Date.	
4	**Testing and Defects**	
42.2	The *defects date* is	**52 (fifty two) weeks after Completion of the whole of the *works*.**
43.2	The *defect correction period* is	**2 weeks**
5	**Payment**	
50.1	The *assessment interval* is monthly on the	**18th (eighteenth) day of each successive month.**
51.1	The *currency of this contract* is the	**South African Rand.**

51.2	The period within which payments are made is	**Payment will be effected on or before the last day of the month following the month during which a valid Tax Invoice and Statement were received.**
51.4	The *interest rate* is	**the prime lending rate of Standard Bank of South Africa –**
6	**Compensation events**	
60.1(13)	The *weather measurements* to be recorded for each calendar month are,	**the cumulative rainfall (mm)**
		the number of days with rainfall more than 10 mm
		the number of days with minimum air temperature less than 0 degrees Celsius
		the number of days with snow lying at 08:00 hours South African Time
	The place where weather is to be recorded (on the Site) is:	**The *Contractor*'s Site establishment area**
	The *weather data* are the records of past *weather measurements* for each calendar month which were recorded at:	**Saldanha Bay Area**
	and which are available from:	**South African Weather Service 012 367 6023 or info3@weathersa.co.za.**
7	**Title**	**No additional data is required for this section of the *conditions of contract*.**
8	**Risks and insurance**	
80.1	These are additional *Employer*'s risks	**No additional risks are accepted by the Employer other than those which are provided for in this contract – will be test on completion of the negotiations with the successful bidder**
84.1	The *Employer* provides these insurances from the Insurance Table	

1	Insurance against:	**Loss of or damage to the *works*, Plant and Materials is as stated in the Insurance policy for Contract Works/ Public Liability.**
	Cover / indemnity:	**to the extent as stated in the insurance policy for Contract Works / Public Liability**
	The deductibles are:	**as stated in the insurance policy for Contract Works / Public Liability**
2	Insurance against:	**Loss of or damage to property (except the *works*, Plant and Materials & Equipment) and liability for bodily injury to or death of a person (not an employee of the *Contractor)* arising out of or in connection with the performance of the Contract as stated in the insurance policy for Contract Works / Public Liability**
	Cover / indemnity	**Is to the extent as stated in the insurance policy for Contract Works / Public Liability**
	The deductibles are	**as stated in the insurance policy for Contract Works / Public Liability**
3	Insurance against:	**Loss of or damage to Equipment (Temporary Works only) as stated in the insurance policy for contract Works and Public Liability**
	Cover / indemnity	**Is to the extent as stated in the insurance policy for Contract Works / Public Liability**
	The deductibles are:	**As stated in the insurance policy for Contract Works / Public Liability**
4	Insurance against:	**Contract Works SASRIA insurance subject to the terms, exceptions and conditions of the SASRIA coupon**
	Cover / indemnity	**Cover / indemnity is to the extent provided by the SASRIA coupon**
	The deductibles are	**The deductibles are, in respect of each and every theft claim, 0,1% of the contract value subject to a minimum of R2,500 and a maximum of R25,000.**

	Note:	**The deductibles for the insurance as stated above are listed in the document titled "Certificate of Insurance: Transnet (SOC) Limited Principal Controlled Insurance."**
84.1	The minimum limit of indemnity for insurance in respect of death of or bodily injury to employees of the *Contractor* arising out of and in the course of their employment in connection with this contract for any one event is	**The *Contractor* must comply at a minimum with the provisions of the Compensation for Occupational Injuries and Diseases Act No. 130 of 1993 as amended.**
	The *Contractor* provides these additional Insurances	**1 Where the contract requires that the design of any part of the *works* shall be provided by the *Contractor* the *Contractor* shall satisfy the *Employer* that professional indemnity insurance cover in connection therewith has been affected** **2 Where the contract involves manufacture, and/or fabrication of Plant & Materials, components or other goods to be incorporated into the *works* at premises other than the site, the *Contractor* shall satisfy the *Employer* that such plant & materials, components or other goods for incorporation in the *works* are adequately insured during manufacture and/or fabrication and transportation to the site.** **3 Should the *Employer* have an insurable interest in such items during manufacture, and/or fabrication, such interest shall be noted by endorsement to the *Contractor's* policies of insurance as well as those of any sub-contractor** **4 Motor Vehicle Liability Insurance comprising (as a minimum) "Balance of Third Party" Risks including Passenger and Unauthorised Passenger Liability indemnity with a minimum indemnity limit of R 5 000 000.**

		7 The insurance coverage referred to in 1, 2 & 3 above shall be obtained from an insurer(s) in terms of an insurance policy approved by the *Employer*. The *Contractor* shall arrange with the insurer to submit to the *Project Manager* the original and the duplicate original of the policy or policies of insurance and the receipts for payment of current premiums, together with a certificate from the insurer or insurance broker concerned, confirming that the policy or policies provide the full coverage as required. The original policy will be returned to the *Contractor.*
84.2	The minimum limit of indemnity for insurance in respect of loss of or damage to property (except the works, Plant, Materials and Equipment) and liability for bodily injury to or death of a person (not an employee of the *Contractor*) caused by activity in connection with this contract for any one event is	**Whatever the *Contractor* requires in addition to the amount of insurance taken out by the *Employer* for the same risk.**
84.2	The insurance against loss of or damage to the works, Plant and Materials as stated in the insurance policy for contract works and public liability selected from:	**Principal Controlled Insurance policy for Contract OR Project Specific Insurance for the contract**
9	**Termination**	**There is no additional Contract Data required for this section of the *conditions of contract*.**
10	**Data for main Option clause**	
B	**Priced contract with Bill of Quantities**	**No additional data is required for this Option.**

60.6	The *method of measurement* is	**The Bill of Quantities have been measured in accordance with SANS 1200 unless indicated otherwise.**
11	**Data for Option W1**	
W1.1	The *Adjudicator* is	**Both parties will agree as and when a dispute arises. If the parties cannot reach an agreement on the *Adjudicator*, the Chairman of the Association of Arbitrators will appoint an *Adjudicator.***
W1.2(3)	The *Adjudicator nominating body* is:	**The Chairman of the Association of Arbitrators (Southern Africa)**
	If no *Adjudicator nominating body* is entered, it is:	**The Association of Arbitrators (Southern Africa)**
W1.4(2)	The *tribunal* is:	**Arbitration**
W1.4(5)	The *arbitration procedure* is	**The Rules for the Conduct of Arbitrations of the Association of Arbitrators (Southern Africa)**
	The place where arbitration is to be held is	**Saldanha, Western Cape, South Africa**
	The person or organisation who will choose an arbitrator - if the Parties cannot agree a choice or - if the arbitration procedure does not state who selects an arbitrator, is	**The Chairman of the Association of Arbitrators (Southern Africa)**
12	**Data for secondary Option clauses**	
X1	**Price adjustment for inflation**	**N/A**
X1.1(a)	The *base date* for indices is	**Note for information: Procurement to insert the month. Always One Month before Tender Closing Date! Delete this sentence.**

X1.1(c)	The proportions used to calculate the Price Adjustment Factor are:	**Pro-portion**	**linked to index for**	**Index prepared by**
		0.30	**Labour (People)**	**The Consumer Price Index (CPI) for "All Items" in Table 1 (Consumer price indices for the total country) of the Statistical Release P0141 "Consumer Price Index - Additional Tables" published by Statistics South Africa. (Link- http://www.statssa.gov.za/?page_id=1854&PPN=P0141)**
		0.10	**Plant (Equipment)**	**The "Plant and Equipment" index in Table 4 (Mining and construction plant and equipment price index) of the Statistical Release P0151.1 "Construction Materials Price Indices" published by Statistics South Africa.**

	0.15	**Material (Civil)**	**The "Civil Engineering Material - Total" index in Table 6 (Civil engineering material price indices) of the Statistical Release P0151.1 "Construction Materials Price Indices" published by Statistics South Africa. (Link – http://www.statssa.gov.za/?page_id=1854&PPN=P0151.1); and**
	0.25	**Material (Electrical)**	**The "Electrical Engineering" index in Table 5 (Mechanical and Electrical Engineering Input Price Indices) of the Statistical Release P0151.1 "Construction Materials Price Indices" published by Statistics South Africa.**

		0.10	**Steelwork Materials**	**The "Mechanical Engineering" index in Table 5 (Mechanical and Electrical Engineering Input Price Indices) of the Statistical Release P0151.1 "Construction Materials Price Indices" published by Statistics South Africa.**
		0.10	**Fuel**	**The "Diesel" index in Table 1 (PPI for final manufactured goods) of the Statistical Release P0142.1 "Producer Price Index" published by Statistics South Africa.** (Link - http://www.statssa.gov.za/?page_id=1854&PPN=P0142.1
		1.00		

***Statistical release P0151 – Contract Price Adjustment Provisions (CPAP) Work Group and Selected Materials Indices**

X2	**Changes in the law**	**No additional data is required for this Option**		
X5	**Sectional Completion**			
X5.1	The *completion date* for each *section* of the *works* is:	***Section***	**Description**	***Completion date***
		1		

		2		
		3		
X5 & X7	**Sectional Completion and delay damages used together**			
X7.1 X5.1	Delay damages for late Completion of the *sections* of the *works* are:	***Section***	**Description**	**Amount per day**
		1		**R**
		2		**R**
		3		**R**
	Remainder of the *works*			**R**
X13	**Performance bond**			
X13.1	The amount of the performance bond is	**5% of the total of the Prices**		
X16	**Retention**			
X16.1	The retention free amount is	**Nil**		
	The retention percentage is	**8% on all payments certified.**		
X18	**Limitation of liability**			

X18.1	The *Contractor*'s liability to the *Employer* for indirect or consequential loss is limited to:	**An amount being equal to the total Contract Value inclusive of VAT**
X18.2	For any one event, the *Contractor's* liability to the *Employer* for loss of or damage to the *Employer's* property is limited to:	**The deductible of the relevant insurance policy**
X18.3	The *Contractor's* liability for Defects due to his design which are not listed on the Defects Certificate is limited to:	**The cost of correcting the Defect**
X18.4	The *Contractor's* total liability to the *Employer* for all matters arising under or in connection with this contract, other than excluded matters, is limited to:	**The Total of the Prices**
X18.5	The *end of liability date* is	**52 (Fifty-Two) Weeks after Completion of the whole of the *works***

Z	***Additional conditions of contract* are*:***	
Z2 **Z2.1**	**Additional clause relating to Performance Bonds and/or Guarantees**	**The Performance Guarantee under X13 above shall be an irrevocable, on-demand performance guarantee, to be issued exactly in the form of the Pro Forma documents provided for this purpose under C1.3 (Forms of Securities), in favour of the *Employer* by a financial institution reasonably acceptable to the *Employer.***

Z3	**Additional clauses relating to Joint Venture**	**Insert the additional core clause 27.5**
Z3.1		**27.5. In the instance that the *Contractor* is a joint venture, the *Contractor* shall provide the *Employer* with a certified copy of its signed joint venture agreement, and in the instance that the joint venture is an 'Incorporated Joint Venture,' the Memorandum of Incorporation, within 4 (four) weeks of the Contract Date.** **The Joint Venture agreement shall contain but not be limited to the following:** • **A brief description of the Contract and the Deliverables;** • **The name, physical address, communications addresses and domicilium citandi et executandi of each of the constituents and of the Joint Venture;** • **The constituent's interests;** • **A schedule of the insurance policies, sureties, indemnities and guarantees which must be taken out by the Joint Venture and by the individual constituents;** • **Details of an internal dispute resolution procedure;** • **Written confirmation by all of the constituents:** **i. of their joint and several liabilities to the *Employer* to Provide the Works;** **ii. identification of the lead partner in the joint venture confirming the authority of the lead partner to bind the joint venture through the *Contractor's* representative;** **iii. Identification of the roles and responsibilities of the constituents to provide the Works.**

		• **Financial requirements for the Joint Venture:** **iv. the working capital requirements for the Joint Venture and the extent to which and manner whereby this will be provided and/or guaranteed by the constituents from time to time;** **v. the names of the auditors and others, if any, who will provide auditing and accounting services to the Joint Venture.**
Z3.2		**Insert additional core clause 27.6** **27.6. The *Contractor* shall not alter its composition or legal status of the Joint Venture without the prior approval of the *Employer.***
Z4	**Additional obligations in respect of Termination**	
Z4.1		**The following will be included under core clause 91.1:** **In the second main bullet, after the word 'partnership' add 'joint venture whether incorporate or otherwise (including any constituent of the joint venture)' and** **Under the second main bullet, insert the following additional bullets after the last sub-bullet:** • **commenced business rescue proceedings (R22)** • **repudiated this Contract (R23)**
Z4.2	**Termination Table**	**The following will be included under core clause 90.2 Termination Table as follows:** **Amend "A reason other than R1 – R21" to "A reason other than R1 – R23"**

Z4.3		**Amend "R1 – R15 or R18" to "R1 – R15, R18, R22 or R23."**
Z5	**Right Reserved by the *Employer* to Conduct Vetting through SSA**	
Z5.1		**The *Employer* reserves the right to conduct vetting through State Security Agency (SSA) for security clearances of any *Contractor* who has access to National Key Points for the following without limitations:** **1. Confidential – this clearance is based on any information which may be used by malicious, opposing or hostile elements to harm the objectives and functions of an organ of state.** **2. Secret – clearance is based on any information which may be used by malicious, opposing or hostile elements to disrupt the objectives and functions of an organ of state.** **3. Top Secret – this clearance is based on information which may be used by malicious, opposing or hostile elements to neutralise the objectives and functions of an organ of state.**
Z6	**Additional Clause Relating to Collusion in the Construction Industry**	
Z6.1		**The contract award is made without prejudice to any rights the *Employer* may have to take appropriate action later with regard to any declared tender rigging including blacklisting.**

Z7	**Protection of Personal Information Act**	
Z7.1		**The *Employer* and the *Contractor* are required to process information obtained for the duration of the Agreement in a manner that is aligned to the Protection of Personal Information Act.**
Z8	**BBBEE Clauses**	
Z8.1		Insert additional clause 27.7. **27.7.1.** The *Employer* encourages its *Contractors* to constantly strive to improve their B-BBEE Contributor Status Levels. To this end, the *Contractor* is to maintain and/or improve its B-BBEE Improvement Plan over the Contract period as per Returnable Schedule T2.2. 10 BBEE Socio-Economic Obligations and Plan. **27.2.2.** The *Contractor* shall, for the duration of the Works, comply with the B-BBEE Improvement Plan. The accepted *Contractor's* B-BBEE Improvement Plan, constitutes an offer to perform all its B-BBEE commitments and will constitute a binding agreement. **27.7.3.** Breach of B-BBEE Improvement Plan commitments provide the *Employer* cause to terminate the contract.

27.7.6. The performance of the *Contractor* as compared to with the accepted B-BBEE Improvement Plan, shall be measured on an annual basis within 60 (sixty) days after the Anniversary Date for the duration of the Contract Period. To this end, the *Contractor* shall grant the *Employer* a right of access and provide the underlying data supporting the achievement by the *Contractor* of the targets specified in the accepted B-BBEE Improvement Plan, which underlying data shall be auditable.

27.7.7. The *Contractor* shall ensure that it has the relevant internal mechanisms and procedures in place to allow the *Employer* to measure and verify the *Contractor's* compliance with the accepted B-BBEE Improvement Plan. Without limiting the generality of the foregoing, the *Contractor* shall be obliged to provide the *Employer* with written quarterly status reports specifying the progress made by the *Contractor* in relation to the accepted B-BBEE Improvement Plan.

27.7.10. To the extent of that the *Contractor* has not complied with the accepted B-BBEE Improvement Plan, the *Employer* shall be entitled to levy penalties which shall be determined with reference to the actual aggregate amounts paid by the *Employer* to the *Contractor* in respect of the preceding 12 (twelve) calendar month intervals, such interval period shall commence from the Contract Date as follows:

Interval One	…….
Interval Two	…….
Interval Three	…….
Interval Four	Refer to paragraph 27.7.10 – 27.7.12 below

27.7.11. Penalties will be levied based on the failure of the *Contractor* to achieve the targets specified in the accepted B-BBEE Improvement Plan rather than the failure of any constituent of the *Contractor* to contribute to the achievement of the targets in the accepted B-BBEE improvement plan;

27.7.12. In order to guarantee that the *Contractor* meet its obligations in terms of the accepted B-BBEE Improvement Plan and specifically during interval ……the *Employer* shall be entitled to retain 5% (five percent) of every payment due by the *Employer* to the *Contractor* ("B-BBEE Retention Amount").

27.7.13. The B-BBEE Retention amount shall be retained by the *Employer* as guarantee for the remaining obligations of the *Contractor* in terms of the accepted B-BBEE Improvement Plan;

27.7.14 The B-BBEE Retention Amount shall be deducted as part of the Retention in X16.1. The Retention in X16.1 shall be reduced to accommodate the B-BBEE Retention Amount. As such total Retention for the *works* shall not exceed 10%;

27.7.15. Should the *Contractor's* obligations:

- be met in terms of the accepted B-BBEE Improvement Plan, the B-BBEE Retention amount shall be released within 30 (thirty) days of the date of verification of compliance by the *Contractor* of its obligations in terms of the accepted B-BBEE Improvement Plan, at which time the monies shall be paid over to the *Contractor*;
- not be met, unless such failure is an attributable occurrence of an event which:
  - stops the *Contractor* Providing the *works* or
  - stops the *Contractor* Providing the *works* by the date shown on the Accepted Programme

  and which
  - neither Party could prevent and
  - an experienced *Contractor* would have judged at the Contract to have such a small chance of occurring that it would have been unreasonable for him to have allowed for it

  the *Contractor* shall forfeit the B-BBEE Retention Amount and shall have no further claim against the *Employer* for the repayment of such amount.

27.7.16. Should the contract be extended the same provisions as applicable in the last interval shall continue to apply until Completion Date.

C1.2 Contract Data

Part two - Data provided by the *Contractor*

The tendering *Contractor* is advised to read both the NEC3 Engineering and Construction Contract - June 2005 (with amendments June 2006 and April 2013) and the relevant parts of its Guidance Notes (ECC3-GN) in order to understand the implications of this Data which the tenderer is required to complete. An example of the completed Data is provided on pages 156 to 158 of the ECC3 Guidance Notes.

Completion of the data in full, according to Options chosen, is essential to create a complete contract.

Clause	Statement	Data
10.1	The *Contractor* is (Name):	
	Address	
	Tel No.	
	Fax No.	
11.2(8)	The *direct fee percentage* is	**%**
	The *subcontracted fee percentage* is	**%**
11.2(18)	The *working areas* are the Site and	
24.1	The *Contractor's* key persons are:	
	1 Name:	
	Job:	
	Responsibilities:	
	Qualifications:	
	Experience:	
	2 Name:	
	Job	
	Responsibilities:	
	Qualifications:	
	Experience:	

		CV's (and further key persons data including CVs) are appended to Tender Schedule entitled .
11.2(14)	The following matters will be included in the Risk Register	
31.1	The programme identified in the Contract Data is	
B	**Priced contract with bill of quantities**	
11.2(21)	The *bill of quantities* is in	
11.2(31)	The tendered total of the Prices is	(in figures) (in words), excluding VAT
	Data for Schedules of Cost Components	*Note "SCC" means Schedule of Cost Components starting on page 60 of ECC, and "SSCC" means Shorter Schedule of Cost Components starting on page 63 of ECC.*

B	**Priced contract with bill of quantities**	**Data for the Shorter Schedule of Cost Components**		
41 in SSCC	The percentage for people overheads is:	**%**		
21 in SSCC	The published list of Equipment is the last edition of the list published by			
	The percentage for adjustment for Equipment in the published list is	**%** (state plus or minus)		
22 in SSCC	The rates of other Equipment are:	**Equipment**	**Size or capacity**	**Rate**

61 in SSCC	The hourly rates for Defined Cost of design outside the Working Areas are	**Category of employee**	**Hourly rate**
62 in SSCC	The percentage for design overheads is	**%**	
63 in SSCC	The categories of design employees whose travelling expenses to and from the Working Areas are included in Defined Cost are:		

Annex C

RETURNABLE DOCUMENT:

Local Content Declaration - Summary Schedule

(C1)	**Tender No.**	**iCLM HQ 847/TPT**
(C2)	**Tender description:**	For the supply and installation of Bulk Electrical supply incluc
(C3)	**Designated product(s)**	
(C4)	**Tender Authority:**	
(C5)	**Tendering Entity name:**	
(C6)	**Tender Exchange Rate:**	Pula EU GBP
(C7)	**Specified local content %**	

Note: VAT to be excluded from all calculations

	Calculation of local content							Tender summary			
Tender item no's	**List of items**	**Tender price - each (excl VAT)**	**Exempted imported value**	**Tender value net of exempted imported content**	**Imported value**	**Local value**	**Local content % (per item)**	**Tender Qty**	**Total tender value**	**Total exempted imported content**	**Total Imported content**
(C8)	*(C9)*	*(C10)*	*(C11)*	*(C12)*	*(C13)*	*(C14)*	*(C15)*	*(C16)*	*(C17)*	*(C18)*	*(C19)*
1	Bulk material Handling										
2	Transformers and Shunt Reactors: Class 0										
3	Transformers and Shunt Reactors: Class 1										
4	Transformers and Shunt Reactors: Class 2										
5	Transformers and Shunt Reactors: Class 3										
6	Transformers and Shunt Reactors: Class 4										

(C20) **Total tender value**	**R 0**
(C21) **Total Exempt imported content**	**R 0**
(C22) Total **Tender value net of exempt imported content**	**R 0**
(C23) **Total Imported content**	**R 0**
(C24) **Total local content**	**R 0**
(C25) **Average local content % of tender**	

Signature of tenderer from Annex B

Date: _____

SATS 1286.2011

Annex D

ESSENTIAL RETURNABLE DOCUMENT:

Imported Content Declaration - Supporting Schedule to Annex C

(D1)	**Tender No.**	
(D2)	**Tender description:**	
(D3)	**Designated Products:**	
(D4)	**Tender Authority:**	
(D5)	**Tendering Entity name:**	
(D6)	**Tender Exchange Rate:**	Pula

Note: VAT to be excluded from all calculations

EU R 9,00 GBP R 12,00

A. Exempted imported content

				Calculation of imported content						Summary	
Tender item no's	Description of imported content	Local supplier	Overseas Supplier	Forign currency value as per Commercial Invoice	Tender Exchange Rate	Local value of imports	Freight costs to port of entry	All locally incurred landing costs & duties	Total landed cost excl VAT	Tender Qty	Exempted imported value
(D7)	*(D8)*	*(D9)*	*(D10)*	*(D11)*	*(D12)*	*(D13)*	*(D14)*	*(D15)*	*(D16)*	*(D17)*	*(D18)*

(D19) **Total exempt imported value** R 0

This total must correspond with Annex C - C 21

B. Imported directly by the Tenderer

				Calculation of imported content						Summary	
Tender item no's	Description of imported content	Unit of measure	Overseas Supplier	Forign currency value as per Commercial Invoice	Tender Rate of Exchange	Local value of imports	Freight costs to port of entry	All locally incurred landing costs & duties	Total landed cost excl VAT	Tender Qty	Total imported value
(D20)	*(D21)*	*(D22)*	*(D23)*	*(D24)*	*(D25)*	*(D26)*	*(D27)*	*(D28)*	*(D29)*	*(D30)*	*(D31)*
	`										

(D32) **Total imported value by tenderer** R 0

C. Imported by a 3rd party and supplied to the Tenderer

				Calculation of imported content						Summary	
Description of imported content	Unit of measure	Local supplier	Overseas Supplier	Forign currency value as per Commercial Invoice	Tender Rate of Exchange	Local value of imports	Freight costs to port of entry	All locally incurred landing costs & duties	Total landed cost excl VAT	Quantity imported	Total imported value
(D33)	*(D34)*	*(D35)*	*(D36)*	*(D37)*	*(D38)*	*(D39)*	*(D40)*	*(D41)*	*(D42)*	*(D43)*	*(D44)*
`											

(D45) **Total imported value by 3rd party** R 0

D. Other foreign currency payments

			Calculation of foreign currency payments		Summary of payments
Type of payment	Local supplier making the payment	Overseas beneficiary	Foreign currency value paid	Tender Rate of Exchange	Local value of payments
(D46)	*(D47)*	*(D48)*	*(D49)*	*(D50)*	*(D51)*

(D52) **Total of foreign currency payments declared by tenderer and/or 3rd party**

Signature of tenderer from Annex B

(D53) **Total of imported content & foreign currency payments - *(D32), (D45) & (D52)* above** R 0

This total must correspond with Annex C - C 23

Date:

SATS 1286.2011

Annex E

ESSENTIAL RETURNABLE DOCUMENT:

Local Content Declaration - Supporting Schedule to Annex C

(E1)	**Tender No.**	iCLM HQ 847/TPT
(E2)	**Tender description:**	For the supply and installation of Bulk Electrical supply inclu
(E3)	**Designated products:**	
(E4)	**Tender Authority:**	
(E5)	**Tendering Entity name:**	

Note: VAT to be excluded from all calculations

Local Products (Goods, Services and Works)	Description of items purchased	Local suppliers	Value
	(E6)	*(E7)*	*(E8)*

***(E9)* Total local products (Goods, Services and Works)** R 0

(E10) **Manpower costs** (Tenderer's manpower cost) R 0

(E11) **Factory overheads** (Rental, depreciation & amortisation, utility costs, consumables etc.) R 0

(E12) **Administration overheads and mark-up** (Marketing, insurance, financing, interest etc.) R 0

***(E13)* Total local content** R 0

This total must correspond with Annex C - C24

Signature of tenderer from Annex B

Date:

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
1		**SECTION 1 : PRELIMINARY & GENERAL**				
		NOTE Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works To be read in conjunction with but not limited to the following Project Technical Specification(s) : 1924701-E004-SOW-0001				
	SANS 1200 A	**SECTION: GENERAL**				
	PSA 8.3	**SCHEDULED FIXED-CHARGE ITEMS**				
	8.3.1	**CONTRACTUAL REQUIREMENTS:**				
A		Sureties	Sum			
B		Insurance of the *works* and plant	Sum			
C		Third party or public liability insurance	Sum			
D		Unemployment insurance	Sum			
E		Other	Sum			
	PSA 8.3.2	**ESTABLISHMENT OF FACILITIES ON THE SITE**				
	PSA 8.3.2.1	**FACILITIES FOR *EMPLOYER***				
F	PSA 8.3.2.1.c)	c) Nameboards (2 No.)	Sum			
	8.3.2.2	**FACILITIES FOR *CONTRACTOR***				
G	8.3.2.2.a	Offices and storage sheds	Sum			
H	8.3.2.2.b	Workshops	Sum			
I	8.3.2.2.c	Laboratories	Sum			
J	8.3.2.2.d	Living accommodation	Sum			
K	8.3.2.2.e	Ablution and latrine facilities	Sum			
L	8.3.2.2.f	Tools and equipment	Sum			
M	8.3.2.2.g	Water supplies, electric power and communications	Sum			
N	8.3.2.2.h	Dealing with water	Sum			
O	8.3.2.2.i	Access	Sum			
P	8.3.2.2.j	Plant	Sum			
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSA 8.3.3	**OTHER FIXED-CHARGE OBLIGATIONS**				
Q		a) Management meetings	Sum			
R		b) Document control	Sum			
S		c) Safety risk management	Sum			
T		d) Environmental management	Sum			
U		e) Quality assurance requirements	Sum			
V		f) Programming and progress reporting	Sum			
W		g) Training	Sum			
X		h) Industrial relations management	Sum			
Y		i) Permits and mandatory approvals	Sum			
Z		j) Factory acceptance tests	Sum			
AA		k) Site acceptance tests	Sum			
AB		l) Other	Sum			
		REMOVAL OF SITE ESTABLISHMENT				
AC	8.3.4	Removal of site establishment	Sum			
	PSA 8.4	**SCHEDULED TIME-RELATED ITEMS**				
	8.4.1	**CONTRACTUAL REQUIREMENTS**				
AD		Sureties	Sum			
AE		Insurance of the *works* and plant	Sum			
AF		Third party or public liability insurance	Sum			
AG		Unemployment insurance	Sum			
AH		Other	Sum			
	PSA 8.4.2	**OPERATION AND MAINTENANCE OF FACILITIES ON SITE, FOR DURATION OF CONSTRUCTION, EXCEPT WHERE OTHERWISE STATED** **PLEASE STATE ON SITE PROJECT CONSTRUCTION DURATION HERE. _____ MONTHS**				
	PSA 8.4.2.1	**FACILITIES FOR *EMPLOYER***				
AI	PSA 8.4.2.1.c)	c) Nameboards (2 No.)	Sum			
	8.4.2.2	**FACILITIES FOR *CONTRACTOR***				
AJ	8.4.2.2.a	Offices and storage sheds	Month			
AK	8.4.2.2.b	Workshops	Month			
AL	8.4.2.2.c	Laboratories	Month			
AM	8.3.2.2.d	Living accommodation	Month			
AN	8.4.2.2.e	Ablution and latrine facilities	Month			
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
AO	8.4.2.2.f	Tools and equipment	Month			
AP	8.4.2.2.g	Water supplies, electric power and communications	Month			
AQ	8.4.2.2.h	Dealing with water	Month			
AR	8.4.2.2.i	Access	Month			
AS	8.4.2.2.j	Plant	Month			
		SUPERVISION FOR DURATION OF CONSTRUCTION				
AT	8.4.3	Supervision for duration of construction	Month			
		COMPANY AND HEAD OFFICE OVERHEAD COSTS FOR THE DURATION OF THE CONTRACT				
AU	8.4.4	Company and head office overhead costs for the duration of the contract	Month			
	PSA 8.4.5	**OTHER TIME-RELATED OBLIGATIONS**				
AV		a) Management meetings	Month			
AW		b) Document control	Month			
AX		c) Safety risk management	Month			
AY		d) Environmental management	Month			
AZ		e) Quality assurance requirements	Month			
BA		f) Programming and progress reporting	Month			
BB		g) Training	Month			
BC		h) Industrial relations management	Month			
BD		i) Permits and mandatory approvals	Month			
BE		j) Factory acceptance tests	Month			
BF		k) Site acceptance tests	Month			
BG		l) Other	Month			
	PSA 8.8	**TEMPORARY WORKS**				
BH	8.8.1	Main access roads to Works	Sum	1		
BI	PSA 8.8.2	Dealing with Traffic	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ANY OTHER PRELIMINARY AND GENERAL ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY				
BJ		a)	Sum	1		
BK		b)	Sum	1		
BL		c)	Sum	1		
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
2		**SECTION 2 : CABLES AND CONDUCTORS**				
		NOTE				
		This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc.				
		MEDIUM VOLTAGE CABLES				
		Armoured MV Cables				
		XLPE Insulated, Cu, Copper Tapped Screened, SWA (or AWA as applicable), 6.35/11kV Cables. Note: Additional specific compliance stated next to each item with additional SANS/IEC/BS EN requirements and make up as applicable				
		a) 630mm², 1 core, Cu, AWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
A		i) Supply	m	1 505		
B		ii) Install	m	1 505		
		b) 500mm², 1 core, Cu, AWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
C		i) Supply	m			Rate only
D		ii) Install	m			Rate only
		c) 300mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing type - (Red Stripe)**				
E		i) Supply	m			Rate only
F		ii) Install	m			Rate only
		d) 240mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing type - (Red Stripe)**		.		
G		i) Supply	m	3 500		
H		ii) Install	m	3 500		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) 185mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing type - (Red Stripe)**		.		
I		i) Supply	m	826		
J		ii) Install	m	826		
		f) 150mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing type - (Red Stripe)**				
K		i) Supply	m			Rate only
L		ii) Install	m			Rate only
		g) 120mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
M		i) Supply	m	187		
N		ii) Install	m	187		
		h) 120mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing type - (Red Stripe)**		.		
O		i) Supply	m	1 350		
P		ii) Install	m	1 350		
		i) 95mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing type - (Red Stripe)**				
Q		i) Supply	m	46		
R		ii) Install	m	46		
		j) 70mm^2, 3 core, Cu, SWA, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing type - (Red Stripe)**				
S		i) Supply	m			Rate only
T		ii) Install	m			Rate only
		<u>Non - Armoured MV Cables</u>				
		XLPE Insulated, Cu, Copper Tapped Screened 6.35/ 11kV Cables. Note: Additional specific compliance stated next to each item with additional SANS/IEC/ BS EN requirements and make up as applicable				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		a) 630mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
U		i) Supply	m			Rate only
V		ii) Install	m			Rate only
		b) 500mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
W		i) Supply	m			Rate only
X		ii) Install	m			Rate only
		c) 300mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
Y		i) Supply	m	104		
Z		ii) Install	m	104		
		d) 240mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AA		i) Supply	m	0		Rate Only
AB		ii) Install	m	0		Rate Only
		e) 185mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AC		i) Supply	m	587		
AD		ii) Install	m	587		
		f) 120mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AE		i) Supply	m	483		
AF		ii) Install	m	483		
		g) 95mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AG		i) Supply	m	104		
AH		ii) Install	m	104		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		h) 70mm^2, 1 core, Cu, 6,35/11kV XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AI		i) Supply	m	332		
AJ		ii) Install	m	332		
		LOW VOLTAGE CABLES				
		Armoured LV Cables				
		XLPE Insulated, Cu, EVA Bedding, SWA, EVA Sheath 600/1000V Cables. Note: (1) Additional specific compliance stated next to each item with additional SANS/IEC/BS EN requirements and make up as applicable. (2) Where PVC type cables can comply fully with the stated additional requirements they may be used				
		a) 185mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AK		i) Supply	m	550		
AL		ii) Install	m	550		
		b) 150mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
AM		i) Supply	m			Rate only
AN		ii) Install	m			Rate only
		c) 95mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
AO		i) Supply	m			Rate only
AP		ii) Install	m			Rate only
		d) 70mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
AQ		i) Supply	m			Rate only
AR		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) 50mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
AS		i) Supply	m			Rate only
AT		ii) Install	m			Rate only
		f) 35mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AU		i) Supply	m	250		
AV		ii) Install	m	250		
		g) 25mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
AW		i) Supply	m			Rate only
AX		ii) Install	m			Rate only
		h) 16mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
AY		i) Supply	m	300		
AZ		ii) Install	m	300		
		i) 10mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
BA		i) Supply	m			Rate only
BB		ii) Install	m			Rate only
		j) 6mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
BC		i) Supply	m			Rate only
BD		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		k) 4mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
BE		i) Supply	m	0		Rate Only
BF		ii) Install	m	0		Rate Only
		Armoured LV Cables				
		PVC Insulated, PVC Bedded, SWA, PVC Sheathed 600/1000V Cables				
		a) 16mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe): Dedicated LV supply cables for New Haul Road Security Building, New and Existing Rail Shunt Control Buildings and SAX-A Cubicle from kiosks installed by Others**		.		
BG		i) Supply	m	150		
BH		ii) Install	m	150		
		Armoured LV Cables - Eskom Specification				
		PVC Insulated, PVC Bedded, SWA, PVC Sheathed 600/1000V Cables				
		a) 35mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
BI		i) Supply	m	100		
BJ		ii) Install	m	100		
		b) 16mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: (1) To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe). (2) Between AC/DC distribution panel and battery bank**		.		
BK		i) Supply	m	200		
BL		ii) Install	m	200		
		c) 6mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**				
BM		i) Supply	m			Rate only
BN		ii) Install	m			Rate only
		d) 4mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
BO		i) Supply	m	773		
BP		ii) Install	m	773		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) 4mm^2, 2 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
BQ		i) Supply	m	50		
BR		ii) Install	m	50		
		Non - Armoured LV Cables				
		XLPE Insulated, Cu, EVA Bedding, EVA Sheath 600/ 1000V Cables. Note: (1) Additional specific compliance stated next to each item with additional SANS/IEC/ BS EN requirements and make up as applicable. (2) Where PVC type cables can comply fully with the stated additional requirements they may be used				
		a) 300mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
BS		i) Supply	m	1 400		
BT		ii) Install	m	1 400		
		b) 185mm^2, 4 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
BU		i) Supply	m	50		
BV		ii) Install	m	50		
		c) 185mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
BW		i) Supply	m	150		
BX		ii) Install	m	150		
		d) 150mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
BY		i) Supply	m	650		
BZ		ii) Install	m	650		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) 120mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CA		i) Supply	m			Rate only
CB		ii) Install	m			Rate only
		e) 95mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
CC		i) Supply	m	250		
CD		ii) Install	m	250		
		f) 70mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CE		i) Supply	m			Rate only
CF		ii) Install	m			Rate only
		g) 50mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CG		i) Supply	m			Rate only
CH		ii) Install	m			Rate only
		h) 25mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CI		i) Supply	m			Rate only
CJ		ii) Install	m			Rate only
		i) 16mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CK		i) Supply	m			Rate only
CL		ii) Install	m			Rate only
		j) 10mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CM		i) Supply	m			Rate only
CN		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		k) 6mm^2, 1 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CO		i) Supply	m			Rate only
CP		ii) Install	m			Rate only
		l) 50mm^2, 4 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CQ		i) Supply	m			Rate only
CR		ii) Install	m			Rate only
		m) 16mm^2, 4 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CS		i) Supply	m	50		
CT		ii) Install	m	50		
		n) 10mm^2, 4 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
CU		i) Supply	m	150		
CV		ii) Install	m	150		
		o) 6mm^2, 4 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
CW		i) Supply	m			Rate only
CX		ii) Install	m			Rate only
		p) 150mm^2, 3 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
CY		i) Supply	m	20		
CZ		ii) Install	m	20		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		q) 70mm^2, 3 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
DA		i) Supply	m	30		
DB		ii) Install	m	30		
		r) 50mm^2, 3 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
DC		i) Supply	m			Rate only
DD		ii) Install	m			Rate only
		s) 25mm^2, 3 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
DE		i) Supply	m			Rate only
DF		ii) Install	m			Rate only
		t) 16mm^2, 3 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
DG		i) Supply	m	50		
DH		ii) Install	m	50		
		u) 6mm^2, 3 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
DI		i) Supply	m	50		
DJ		ii) Install	m	50		
		v) 4mm^2, 3 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
DK		i) Supply	m	400		
DL		ii) Install	m	400		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		LOW VOLTAGE CONTROL AND SIGNAL CABLES				
		Armoured LV Control Cables				
		XLPE Insulated, Cu, EVA Bedding, SWA, EVA Sheath 600/1000V Cables. Note: (1) Additional specific compliance stated next to each item with additional SANS/IEC/BS EN requirements and make up as applicable. (2) Where PVC type cables can comply fully with the stated additional requirements they may be used				
		a) 4mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
DM		i) Supply	m	4 200		
DN		ii) Install	m	4 200		
		b) 2.5mm^2, 4 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
DO		i) Supply	m	1 350		
DP		ii) Install	m	1 350		
		c) 2.5mm^2, 12 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
DQ		i) Supply	m	1 670		
DR		ii) Install	m	1 670		
		d) 2.5mm^2, 19 core, Cu, SWA, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**		.		
DS		i) Supply	m	1 950		
DT		ii) Install	m	1 950		
		Armoured LV Signal Cables				
		Polyethylene (PE) Insulated, Overall Screened, SWA, 300/500V, Aluminium/Polyethylene Laminate (APL) Moisture/Water Barrier, Polyethylene (PE) Sheathed Communications Cable. Note: Additional specific compliance stated next to each item with additional SANS/IEC/BS etc. requirements and make up where applicable				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		a) 10 Pair, 0.5mm Dia. Cu, TPH10AX cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type**		.		
DU		i) Supply	m	3 010		
DV		ii) Install	m	3 010		
		Non - Armoured LV Signal Cables				
		Polyethylene (PE) Insulated, Overall Screened, 300/500V, Aluminium/Polyethylene Laminate (APL) Moisture/Water Barrier, Polyethylene (PE) Sheathed Communications Cable. Note: Additional specific compliance stated next to each item with additional SANS/IEC/BS etc. requirements and make up where applicable				
		a) 10 Pair, 0.5mm Dia. Cu, TPH10AX cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type**		.		
DW		i) Supply	m	3 100		
DX		ii) Install	m	3 100		
		Non - Armoured LV Control Cables				
		XLPE Insulated, Cu, EVA Bedding, EVA Sheath 600/ 1000V Cables. Note: (1) Additional specific compliance stated next to each item with additional SANS/IEC/ BS EN requirements and make up as applicable. (2) Where PVC type cables can comply fully with the stated additional requirements they may be used				
		a) 4mm^2, 4 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
DY		i) Supply	m			Rate only
DZ		ii) Install	m			Rate only
		b) 2.5mm^2, 4 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved).**				
EA		i) Supply	m			Rate only
EB		ii) Install	m			Rate only
		c) 2.5mm^2, 12 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
EC		i) Supply	m			Rate only
ED		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) 2.5mm^2, 19 core, Cu, 600/1000V XLPE cable. **Note: To be of the fire retardant, self-extinguishing, zero toxic emissions type - (White stripe or equal approved)**				
EE		i) Supply	m			Rate only
EF		ii) Install	m			Rate only
		Armoured LV Control Cables - Eskom Specification **PVC Insulated, PVC Bedded, SWA, PVC Sheathed 600/1000V Cables** a) 35mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**				
EG		i) Supply	m			Rate only
EH		ii) Install	m			Rate only
		b) 16mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**				
EI		i) Supply	m			Rate only
EJ		ii) Install	m			Rate only
		c) 4mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
EK		i) Supply	m	3 500		
EL		ii) Install	m	3 500		
		d) 2.5mm^2, 4 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
EM		i) Supply	m	2 850		
EN		ii) Install	m	2 850		
		e) 4mm^2, 2 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
EO		i) Supply	m	550		
EP		ii) Install	m	550		
		f) 2.5mm^2, 12 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
EQ		i) Supply	m	4 150		
ER		ii) Install	m	4 150		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		g) 2.5mm^2, 19 core, Cu, SWA, 600/1000V PVC cable. **Note: To be of the fire retardant, self-extinguishing general purpose type - (Red Stripe)**		.		
ES		i) Supply	m	1 500		
ET		ii) Install	m	1 500		
		Armoured LV Signal Cables - Eskom Specification				
		Polyethylene (PE) Insulated, Overall Screened, SWA, 300/500V, Aluminium/Polyethylene Laminate (APL) Moisture/Water Barrier, Polyethylene (PE) Sheathed Communications Cable				
		a) 10 Pair, 0.5mm Dia. Cu, TPH10AX cable		.		
EU		i) Supply	m	900		
EV		ii) Install	m	900		
		FIBRE OPTIC CABLES				
		Polyethylene sheathed, corrugated steel tape armouring, polyethylene bedded fibre optic cables. All cables to be of the UV stabilised, fire retardant, self-extinguishing, zero toxic emission type				
		Single Mode Fibre Optic (SMFO) Armoured Cable		.		
		a) 48 core				
EW		i) Supply	m			Rate Only
EX		ii) Install	m			Rate Only
		b) 48 core		.		
EY		i) Supply	m	12 763		
EZ		ii) Install	m	12 763		
		c) 12 core		.		
FA		i) Supply	m	244		
FB		ii) Install	m	244		
		CONDUCTORS AND OPGW				
		a) Bull AAC, 38.25mm dia. Conductor		.		
FC		i) Supply	m	520		
FD		ii) Install	m	520		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) Centipede AAC, 26,46mm dia. Conductor. **Note: Eskom spec type**		.		
FE		i) Supply	m	1 200		
FF		ii) Install	m	1 200		
		c) Chicadee ACSR, 18.87mm dia. Conductor. **Note: Eskom spec type**				
FG		i) Supply	m			Rate Only
FH		ii) Install	m			Rate Only
		d) OPGW Prysmian 16kA 48 core. **Note: Eskom spec greased type**				
FI		i) Supply	m			Rate Only
FJ		ii) Install	m			Rate Only
		MEDIUM VOLTAGE CABLE TERMINATIONS				
		<u>Indoor Switchgear Terminations</u>				
		a) 12kV, 70mm² - 300mm² cable conductor size, L - Shape 630A screened separable connector single cable termination complete with mechanical lugs, torque shear bolts etc. for MV XLPE cable. **Note: Terminations to be fully and compliantly compatible with equipment they connect onto**		.		
FK		i) Supply	No.	3		
FL		ii) Install	No.	3		
		b) 12kV, 185mm² - 300mm² cable conductor size, T - Shape 2 x Cable 1250A screened separable connector single cable termination complete with mechanical lugs, torque shear bolts etc. for MV XLPE cable. **Note: The terminations to be fully and compliantly compatible with equipment they connect onto**		.		
FM		i) Supply	No.	3		
FN		ii) Install	No.	3		
		c) 12kV, 185mm² - 300mm² cable conductor size, T-Shape 3 x Cable 1250A screened separable connector single cable termination complete with mechanical lugs, torque shear bolts etc. for MV XLPE cable. **Note: The terminations to be fully and compliantly compatible with equipment they connect onto**				
FO		i) Supply	No.			Rate only
FP		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) 12kV, 120mm² - 240mm² cable conductor size, heat shrink indoor termination for 1 core screened MV XLPE cable, complete with mechanical lugs, bolts, nuts, all additional busbar insulating tape etc. **Note: Terminations to be fully and compliantly compatible with equipment they connect onto**				
FQ		i) Supply	No.			Rate only
FR		ii) Install	No.			Rate only
		e) 12kV, 120mm² - 240mm² cable conductor size, heat shrink indoor termination for 3 core screened MV XLPE cable, complete with mechanical lugs, bolts, nuts, all additional busbar insulating tape etc.		.		
FS		i) Supply	No.	3		
FT		ii) Install	No.	3		
		f) 12kV, 70mm² - 120mm² cable conductor size, inner cone plug-in type termination for 1 core screended MV XLPE cable, complete with accessories etc. **Note: Inner cone termination to be in accordance with switchgear final bushings sizes and current ratings**		.		
FU		i) Supply	No.	15		
FV		ii) Install	No.	15		
		g) 12kV, 150mm² - 300mm² cable conductor size, inner cone plug-in type termination for 1 core screended MV XLPE cable, complete with accessories etc. **Note: The inner cone termination to be in accordance with switchgear final bushings sizes and current ratings**		.		
FW		i) Supply	No.	60		
FX		ii) Install	No.	60		
		h) 12kV, 300mm² - 630mm² cable conductor size, inner cone plug-in type termination for screended MV XLPE cable, complete with accessories etc. **Note: Inner cone termination to be in accordance with switchgear final bushings sizes and current ratings**		.		
FY		i) Supply	No.	24		
FZ		ii) Install	No.	24		
		<u>Indoor Transformer Terminations</u>				
		a) 12kV, plug-in type termination onto top entry MV side plug-in type bushing of transformer enclosure box for 70mm² screened MV XLPE cable. **Note: The termination to be in accordance with OEM(s) requirements and shall be completely touch safe etc.**		.		
GA		i) Supply	No.	9		
GB		ii) Install	No.	9		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) 12kV, plug-in type termination onto top entry MV side plug-in type bushing of transformer enclosure box for 95mm² screened MV XLPE cable. **Note: The termination to be in accordance with OEM(s) requirements and shall be completely touch safe etc.**		.		
GC		i) Supply	No.	3		
GD		ii) Install	No.	3		
		c) 12kV, plug-in type termination onto top entry MV side plug-in type bushing of transformer enclosure box for 120mm² screened MV XLPE cable. **Note: The termination to be in accordance with OEM(s) requirements and shall be completely touch safe etc.**		.		
GE		i) Supply	No.	3		
GF		ii) Install	No.	3		
		d) 12kV, 95mm² cable conductor size, heat shrink indoor termination for 3 core screened MV XLPE cable, complete with mechanical lugs, bolts, nuts, IP 66 rated gland, all additional busbar insulating tape etc. **Note: At NECRT**				
GG		i) Supply	No.			Rate only
GH		ii) Install	No.			Rate only
		e) 12kV, plug-in type termination onto top entry MV side plug-in type bushing of transformer enclosure box for 185mm² screened MV XLPE cable. **Note: The termination to be in accordance with OEM(s) requirements and shall be completely touch safe etc.**		.		
GI		i) Supply	No.	6		
GJ		ii) Install	No.	6		
		f) 12kV, plug-in type termination onto top entry MV side plug-in type bushing of transformer enclosure box for 300mm² screened MV XLPE cable. **Note: The termination to be in accordance with OEM(s) requirements and shall be completely touch safe etc.**		.		
GK		i) Supply	No.	3		
GL		ii) Install	No.	3		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Outdoor Terminations				
		a) 12kV, 70mm² - 120mm² cable conductor size. UV stabilised high pollution area (31mm/kV) rated heat shrink outdoor cable termination for 3 core screened MV XLPE cable, complete with mechanical clamps, lugs, bolts, nuts, any additional sheds etc.		.		
GM		i) Supply	No.	4		
GN		ii) Install	No.	4		
		b) 12kV, 500mm² cable conductor size. UV stabilised high pollution area (31mm/kV) rated heat shrink outdoor cable termination for 1 core screened MV XLPE cable, complete with mechanical clamps, lugs, bolts, nuts, any additional sheds etc.				
GO		i) Supply	No.			Rate only
GP		ii) Install	No.			Rate only
		c) 12kV, 630mm² cable conductor size. UV stabilised high pollution area (31mm/kV) rated heat shrink outdoor cable termination for 1 core screened MV XLPE cable, complete with mechanical clamps, lugs, bolts, nuts, any additional sheds etc.		.		
GQ		i) Supply	No.	12		
GR		ii) Install	No.	12		
		LOW VOLTAGE CABLE TERMINATIONS				
		Complete termination kit for low voltage 600/1000V armoured or non - armoured Cu cables with tinned lugs, glands, shrouds, any other accessories as per the specifications and cable manufacturer(s) requirements etc. Note: Shrouds and any associated material as applicable shall be of the same material as the cable				
		a) 300mm^2 x 1 core indoor termination		.		
GS		i) Supply	No.	64		
GT		ii) Install	No.	64		
		b) 185mm^2 x 4 core outdoor termination. **Note: IP66 minimum rated gland**		.		
GU		i) Supply	No.	4		
GV		ii) Install	No.	4		
		c) 185mm^2 x 4 core indoor termination		.		
GW		i) Supply	No.	4		
GX		ii) Install	No.	4		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) 185mm^2 x 1 core outdoor termination. **Note: IP66 minimum rated gland**				
GY		i) Supply	No.			Rate only
GZ		ii) Install	No.			Rate only
		e) 185mm^2 x 1 core indoor termination		.		
HA		i) Supply	No.	8		
HB		ii) Install	No.	8		
		f) 150mm^2 x 4 core indoor termination				
HC		i) Supply	No.			Rate only
HD		ii) Install	No.			Rate only
		g) 150mm^2 x 3 core indoor termination		.		
HE		i) Supply	No.	2		
HF		ii) Install	No.	2		
		h) 150mm^2 x 1 core indoor termination		.		
HG		i) Supply	No.	40		
HH		ii) Install	No.	40		
		i) 120mm^2 x 1 core indoor termination				
HI		i) Supply	No.			Rate only
HJ		ii) Install	No.			Rate only
		j) 95mm^2 x 4 core indoor termination				
HK		i) Supply	No.			Rate only
HL		ii) Install	No.			Rate only
		k) 95mm^2 x 1 core outdoor termination. **Note: IP66 minimum rated gland**				
HM		i) Supply	No.			Rate only
HN		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		l) 95mm^2 x 1 core indoor termination		.		
HO		i) Supply	No.	8		
HP		ii) Install	No.	8		
		m) 70mm^2 x 4 core indoor termination				
HQ		i) Supply	No.			Rate only
HR		ii) Install	No.			Rate only
		n) 70mm^2 x 3 core indoor termination		.		
HS		i) Supply	No.	4		
HT		ii) Install	No.	4		
		o) 70mm^2 x 1 core indoor termination				
HU		i) Supply	No.			Rate only
HV		ii) Install	No.			Rate only
		p) 50mm^2 x 1 core indoor termination				
HW		i) Supply	No.			Rate only
HX		ii) Install	No.			Rate only
		q) 50mm^2 x 4 core indoor termination				
HY		i) Supply	No.			Rate only
HZ		ii) Install	No.			Rate only
		r) 50mm^2 x 3 core indoor termination				
IA		i) Supply	No.			Rate only
IB		ii) Install	No.			Rate only
		s) 35mm^2 x 4 core indoor termination				
IC		i) Supply	No.	2		
ID		ii) Install	No.	2		
		t) 25mm^2 x 1 core indoor termination				
IE		i) Supply	No.			Rate only
IF		ii) Install	No.			Rate only
		u) 25mm^2 x 3 core indoor termination				
IG		i) Supply	No.			Rate only
IH		ii) Install	No.			Rate only
		v) 16mm^2 x 4 core indoor termination		.		
II		i) Supply	No.	18		
IJ		ii) Install	No.	18		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		w) 16mm^2 x 3 core indoor termination				
IK		i) Supply	No.			Rate only
IL		ii) Install	No.			Rate only
		x) 16mm^2 x 1 core indoor termination				
IM		i) Supply	No.			Rate only
IN		ii) Install	No.			Rate only
		y) 10mm^2 x 4 core indoor termination		.		
IO		i) Supply	No.	12		
IP		ii) Install	No.	12		
		z) 10mm^2 x 1 core indoor termination				
IQ		i) Supply	No.			Rate only
IR		ii) Install	No.			Rate only
		aa) 6mm^2 x 4 core outdoor termination. **Note: IP66 minimum rated gland**				
IS		i) Supply	No.			Rate only
IT		ii) Install	No.			Rate only
		ab) 6mm^2 x 4 core indoor termination				
IU		i) Supply	No.			Rate only
IV		ii) Install	No.			Rate only
		ac) 6mm^2 x 3 core indoor termination				
IW		i) Supply	No.			Rate only
IX		ii) Install	No.			Rate only
		ad) 6mm^2 x 1 core indoor termination				
IY		i) Supply	No.			Rate only
IZ		ii) Install	No.			Rate only
		ae) 4mm^2 x 4 core outdoor termination. **Note: IP66 minimum rated gland**		.		
JA		i) Supply	No.	160		
JB		ii) Install	No.	160		
		af) 4mm^2 x 4 core indoor termination		.		
JC		i) Supply	No.	3		
JD		ii) Install	No.	3		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ag) 4mm^2 x 3 core outdoor termination. **Note: IP66 minimum rated gland**				
JE		i) Supply	No.			Rate only
JF		ii) Install	No.			Rate only
		ah) 4mm^2 x 3 core indoor termination		.		
JG		i) Supply	No.	40		
JH		ii) Install	No.	40		
		ai) 4mm^2 x 2 core outdoor termination. **Note: IP66 minimum rated gland**				
JI		i) Supply	No.			Rate only
JJ		ii) Install	No.			Rate only
		aj) 4mm^2 x 2 core indoor termination				
JK		i) Supply	No.			Rate only
JL		ii) Install	No.			Rate only
		LOW VOLTAGE CONTROL CABLE TERMINATIONS				
		Complete termination kit for low voltage 600/1000V armoured or non - armoured Cu cables with tinned lugs, glands, shrouds, any other accessories as per the specifications and cable manufacturer(s) requirements etc. Note: Shrouds and any associated material as applicable shall be of the same material as the cable				
		a) 35mm^2 x 4 core indoor termination		.		
JM		i) Supply	No.	1		
JN		ii) Install	No.	1		
		b) 35mm^2 x 4 core outdoor termination. **Note: IP66 minimum rated gland**		.		
JO		i) Supply	No.	1		
JP		ii) Install	No.	1		
		c) 16mm^2 x 4 core indoor termination		.		
JQ		i) Supply	No.	4		
JR		ii) Install	No.	4		
		d) 16mm^2 x 4 core outdoor termination. **Note: IP66 minimum rated gland**		.		
JS		i) Supply	No.	8		
JT		ii) Install	No.	8		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) 4mm^2 x 4 core indoor termination		.		
JU		i) Supply	No.	506		
JV		ii) Install	No.	506		
		f) 4mm^2 x 4 core outdoor termination. **Note: IP66 minimum rated gland**		.		
JW		i) Supply	No.	78		
JX		ii) Install	No.	78		
		g) 2.5mm^2 x 4 core indoor termination		.		
JY		i) Supply	No.	40		
JZ		ii) Install	No.	40		
		h) 2.5mm^2 x 4 core outdoor termination. **Note: IP66 minimum rated gland**		.		
KA		i) Supply	No.	46		
KB		ii) Install	No.	46		
		i) 4mm^2 x 2 core indoor termination		.		
KC		i) Supply	No.	11		
KD		ii) Install	No.	11		
		j) 4mm^2 x 2 core outdoor termination. **Note: IP66 minimum rated gland**		.		
KE		i) Supply	No.	9		
KF		ii) Install	No.	9		
		k) 2.5mm^2 x 12 core indoor termination		.		
KG		i) Supply	No.	32		
KH		ii) Install	No.	32		
		l) 2.5mm^2 x 12 core outdoor termination. **Note: IP66 minimum rated gland**		.		
KI		i) Supply	No.	156		
KJ		ii) Install	No.	156		
		m) 2.5mm^2 x 19 core indoor termination		.		
KK		i) Supply	No.	30		
KL		ii) Install	No.	30		
		n) 2.5mm^2 x 19 core outdoor termination. **Note: IP66 minimum rated gland**		.		
KM		i) Supply	No.	38		
KN		ii) Install	No.	38		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		LOW VOLTAGE SIGNAL CABLE TERMINATIONS				
		Complete termination kit for low voltage Cu signal cables with tinned lugs etc.				
		a) 10 Pair, 0.5mm Dia. Cu, TPH10AX indoor cable termination		.		
KO		i) Supply	No.	139		
KP		ii) Install	No.	139		
		b) 10 Pair, 0.5mm Dia. Cu, TPH10AX cable outdoor termination. **Note: IP66 minimum rated gland**		.		
KQ		i) Supply	No.	13		
KR		ii) Install	No.	13		
		FIBRE OPTIC CABLE TERMINATIONS				
		Complete termination kits for fibre optic cable, including connectors, shrouds, fixing materials and all other accessories				
		Single Mode Fibre Optic Armoured Cable				
		a) 48 core LC type indoor termination for SMFO cable				
KS		i) Supply	No.			Rate only
KT		ii) Install	No.			Rate only
		b) 48 core LC type indoor termination for SMFO cable		.		
KU		i) Supply	No.	38		
KV		ii) Install	No.	38		
		c) 12 core LC type indoor termination for SMFO cable		.		
KW		i) Supply	No.	2		
KX		ii) Install	No.	2		
		MEDIUM VOLTAGE CABLE JOINTS				
		In-Line Joints				
		a) 12kV, 95mm² - 185mm² cable conductor size heat shrink joint for 3 core screened MV XLPE cable complete with torque shear connectors and all other accessories etc.		.		
KY		i) Supply	No.	4		
KZ		ii) Install	No.	4		
		b) 12kV, 185mm² - 300mm² cable conductor size heat shrink joint for 3 core screened MV XLPE cable complete with torque shear connectors and all other accessories etc.		.		
LA		i) Supply	No.	41		
LB		ii) Install	No.	41		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) 12kV, 400mm² - 630mm² cable conductor size heat shrink joint for 1 core screened **Armoured** MV XLPE cable complete with torque shear connectors and all other accessories etc. **Note: To be used on explicit approval only from the *Employer***		.		
LC		i) Supply	No.			Rate only
LD		ii) Install	No.			Rate only
		d) 12kV, 400mm² - 630mm² cable conductor size heat shrink joint for 1 core screened **Armoured** MV XLPE to **Non - Armoured** 1 core MV XLPE cable complete with torque shear connectors and all other accessories etc.				
LE		i) Supply	No.			Rate only
LF		ii) Install	No.			Rate only
		Trifurcating Joints				
		a) 12kV, 95mm² - 185mm² cable conductor size, trifurcating heat shrink joint for 3 core screened **Armoured** MV XLPE to 3 x 1 core screened **Non - Armoured** MV XLPE cable, complete with torque shear connectors and all other accessories etc.		.		
LG		i) Supply	No.	6		
LH		ii) Install	No.	6		
		b) 12kV, 185mm² - 300mm² cable conductor size, trifurcating heat shrink joint for 3 core screened **Armoured** MV XLPE to 3 x 1 core screened **Non - Armoured** MV XLPE cable, complete with torque shear connectors and all other accessories etc.		.		
LI		i) Supply	No.	16		
LJ		ii) Install	No.	16		
		Transition Joints				
		a) 12kV, 95mm² - 185mm² cable conductor size, transition heat shrink joint for 3 core screened MV XLPE to screened and/or belted 3 core PILC cable, complete with torque shear connectors and all other accessories etc.				
LK		i) Supply	No.	2		
LL		ii) Install	No.	2		
		b) 12kV, 185mm² - 300mm² cable conductor size, transition heat shrink joint for 3 core screened MV XLPE to screened and/or belted 3 core PILC cable, complete with torque shear connectors and all other accessories etc.		.		
LM		i) Supply	No.	6		
LN		ii) Install	No.	6		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		LOW VOLTAGE JOINTS				
		a) 600/1000V, 185mm² cable conductor size heat shrink joint for 4 core **Armoured** LV cable to **Non - Armoured** 4 core LV cable complete with torque shear connectors and all other accessories etc.		.		
LO		i) Supply	No.	4		
LP		ii) Install	No.	4		
		FIBRE OPTIC CABLE JOINTS				
		Complete outdoor heat shrink joint kit for SMFO armoured type cables, complete with all material and accessories as required, in accordance with the cable manufacturer's requirements etc. **Note: No joints allowed in cables unless approval has been obtained from the *Employer***				
		a) 48 core outdoor joint for SMFO cable				
LQ		i) Supply	No.			Rate only
LR		ii) Install	No.			Rate only
		b) 48 core outdoor joint for SMFO cable				
LS		i) Supply	No.			Rate only
LT		ii) Install	No.			Rate only
		c) 12 core outdoor joint for SMFO cable				
LU		i) Supply	No.			Rate only
LV		ii) Install	No.			Rate only
		CABLE END CAPS				
		a) 12kV, 120mm² - 240mm² cable conductor size, heat shrink end cap (black colour type) for 3 core MV XLPE or PILC cable complete with all other accessories etc.		.		
LW		i) Supply	No.	10		
LX		ii) Install	No.	10		
		b) Lead ball type sealing of 12kV, 95mm² - 240mm² conductor size MV XLPE or PILC cable complete with all other accessories etc.		.		
LY		i) Supply	No.	60		
LZ		ii) Install	No.	60		
		c) 600/1000V, 185mm² cable conductor size, heat shrink end cap for 4 core PVC Insulated, PVC Bedded, SWA, PVC Sheathed cable complete with all other accessories etc.				
MA		i) Supply	No.			Rate only
MB		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ELECTRICAL WARNING/DANGER TAPE				
		a) Orange, 450mm wide, 150mm micron thick electrical warning/danger tape, with thunder flash triangle (or skull bone triangle) and wording “DANGER/INGOZI/GEVAAR”		.		
MC		i) Supply	m	28 500		
MD		ii) Install	m	28 500		
		b) Eskom specification yellow electrical warning/danger tape or other as per their requirements		.		
ME		i) Supply	m	1 550		
MF		ii) Install	m	1 550		
		CONCRETE COVER SLABS/TILES				
		a) 450mm x 230mm x 50mm Concrete cover slab/tiles. **Note: Eskom spec type (D-DT-5246 SH1A3)**		.		
MG		i) Supply	No.	45 990		
MH		ii) Install	No.	45 990		
		b) 1440mm x 300mm x 40mm vibracrete wall concrete cover slab/tiles				
MI		i) Supply	No.			Rate only
MJ		ii) Install	No.			Rate only
		LABELLING				
MK		a) Labelling of this section of the installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
		TESTING AND COMMISSIONING				
ML		a) Complete testing and commissioning of this section of the installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment / installations**	Sum	1		
		SUNDRY ITEMS				
MM		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
MN		b) Inspection of all **Type Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
MO		c) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
MP		d) Inspection of all **Routine Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
MQ		e) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
MR		f) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
MS		g) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
MT		h) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
MU		i) Provision of all manufacturer(s) prescribed critical and recommended spares	Sum	1		
MV		j) High melting point, non-oxidant electrical contact grease. **Note: Eskom requirements to be included**	Sum	1		
MW		k) Complete loading, offloading, rigging, transport, labour etc. to *Employer*'s storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
MX		l) Complete loading, offloading, rigging, transport, labour etc. to Eskom Brackenfell depot of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
MY		m) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
3		**SECTION 3 : EARTHING AND LIGHTNING PROTECTION SYSTEMS** **NOTE** This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc. **EARTHING AND LIGHTNING PROTECTION SYSTEMS DESIGNS** **Substation M**				
A		a) Allow for the appointment of a SANS approved/accredited Earthing and Lightning Protection Systems specialist sub - contractor to undertake the **Lightning Risk Assessment** and compile an associated **Lightning Risk Report** for the approval by the *Employer* , to determine the extent of the Earthing/Lighting Protection System required, as per the specifications and any relevant SANS Code of Practice(s). **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
B		b) Allow for the appointment of a SANS approved/accredited Earthing and Lightning Protection Systems specialist sub - contractor/OEM to take take over the existing Earthing design , installation and complete with testing and allowance to design the entire newLightning Protection System, for approval by the *Employer,* in accordance with any relevant SANS Code of Practice(s), the Lightning Risk Report and the specifications/drawings. It shall include for all necessary designs for approval, construction drawings, statutory, local authority and *Employer* requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables. The final resistance not to exceed 1 ohm**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Substation N				
C		a) Allow for the appointment of a SANS approved/accredited Earthing and Lightning Protection Systems specialist subcontractor to undertake the **Lightning Risk Assessment** and compile an associated **Lightning Risk Report** for the approval by the *Employer*, to determine the extent of the Earthing/Lighting Protection System required, as per the specifications and any relevant SANS Code of Practice(s). **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
D		b) Allow for the appointment of a SANS approved/accredited Earthing and Lightning Protection Systems specialist sub - contractor/OEM to take take over the existing Earthing design , installation and complete with testing and allowance to design the entire new Lightning Protection System, for approval by the *Employer*, in accordance with any relevant SANS Code of Practice(s), the Lightning Risk Report and the specifications/drawings. It shall include for all necessary designs for approval, construction drawings, statutory, local authority and *Employer* requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables. The final resistance not to exceed 1 ohm**	Sum	1		
		New Main Intake Substation **Note that for this section Eskom's earthing and lightning protection systems standards and specifications must be taken into account as well**				
E		a) Allow for the appointment of a SANS approved/accredited Earthing and Lightning Protection Systems specialist subcontractor to undertake the **Lightning Risk Assessment** and compile an associated **Lightning Risk Report** for the approval by the *Employer*, to determine the extent of the Earthing/Lighting Protection System required, as per the specifications and any relevant SANS Code of Practice(s). **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
F		b) Allow for the appointment of a SANS approved/accredited Earthing and Lightning Protection Systems specialist sub - contractor/OEM to take take over the existing Earthing design , installation and complete with testing and allowance to design the entire new Lightning Protection System, for approval by the *Employer,* in accordance with any relevant SANS Code of Practice(s), the Lightning Risk Report and the specifications/drawings. It shall include for all necessary designs for approval, construction drawings, statutory, local authority and *Employer* requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables. The final resistance not to exceed 1 ohm** **EARTHING AND LIGHTNING PROTECTION SYSTEMS INSTALLATION** All earthing insulated conductors shall be of the 600/1000V yellow/green single core cables with Cu stranded conductors. All cables shall be **tinned**, with all the other accessories, terminations etc. included in rate. **Note: All lugs, bolts/nuts and any other associated termination materials to be of the tinned type unless specified differently further in this BoQ, drawings and/or the technical specifications** a) 185mm^2 x 1 core Cu tinned ICEW earth cable	Sum	1		
G		i) Supply	m			Rate only
H		ii) Install	m			Rate only
		b) 150mm^2 x 1 core Cu tinned ICEW earth cable				
I		i) Supply	m			Rate only
J		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) 120mm^2 x 1 core Cu tinned ICEW earth cable				
K		i) Supply	m	90		
L		ii) Install	m	90		
		d) 95mm^2 x 1 core Cu tinned ICEW earth cable		.		
M		i) Supply	m			Rate only
N		ii) Install	m			Rate only
		e) 70mm^2 x 1 core Cu tinned ICEW earth cable		.		
O		i) Supply	m	3 900		
P		ii) Install	m	3 900		
		f) 50mm^2 x 1 core Cu tinned ICEW earth cable		.		
Q		i) Supply	m	60		
R		ii) Install	m	60		
		g) 35mm^2 x 1 core Cu tinned ICEW earth cable		.		
S		i) Supply	m	90		
T		ii) Install	m	90		
		h) 25mm^2 x 1 core Cu tinned ICEW earth cable		.		
U		i) Supply	m	1 350		
V		ii) Install	m	1 350		
		i) 16mm^2 x 1 core Cu tinned ICEW earth cable		.		
W		i) Supply	m	150		
X		ii) Install	m	150		
		j) 10mm^2 x 1 core Cu tinned ICEW earth cable				
Y		i) Supply	m			Rate only
Z		ii) Install	m			Rate only
		k) 6mm^2 x 1 core Cu tinned ICEW earth cable		.		
AA		i) Supply	m	330		
AB		ii) Install	m	330		
		l) 4mm^2 x 1 core Cu tinned ICEW earth cable		.		
AC		i) Supply	m	1 300		
AD		ii) Install	m	1 300		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		m) 2.5mm^2 x 1 core Cu tinned ICEW earth cable		.		
AE		i) Supply	m	220		
AF		ii) Install	m	220		
		n) 50mm (wide) x 3mm (thick) tinned copper strap		.		
AG		i) Supply	m	1 141		
AH		ii) Install	m	1 141		
		o) 20 Φ mm annealed tinned bare solid copper rods		.		
AI		i) Supply	m	750		
AJ		ii) Install	m	750		
		p) 1.5m long, 16mm dia. tinned copper earth spike, with drive-in front cap, couplings etc.		.		
AK		i) Supply	No.	55		
AL		ii) Install	No.	55		
		q) 3m long, 16mm dia. copper earth spike, with drive-in front cap, couplings etc.		.		
AM		i) Supply	No.	21		
AN		ii) Install	No.	21		
		r) 50mm² Flexible tinned copper earth braids with boltable end pieces		.		
AO		i) Supply	m	50		
AP		ii) Install	m	50		
		s) Copper tinned earthing strap, 12mm (wide) x 0.4mm (thick) with 7 Φ mm holes				
AQ		i) Supply	m			Rate only
AR		ii) Install	m			Rate only
		t) 1500mm, 57kg Rail section sacrificial earth anode		.		
AS		i) Supply	No.	90		
AT		ii) Install	No.	90		
		u) Complete 4m long, 1m tapering, 16mm dia., 3mm WL 316L stainless steel tubular air termination/finial, with wall/surface mounting adjustable bracket and all 316L stainless steel fixing material and all other accessories etc.		.		
AU		i) Supply	No.	9		
AV		ii) Install	No.	9		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Eskom Earthing and LPS Installation Equipment Specifications				
		a) 40mm (wide) x 3mm (thick) galvanised mild steel strap				
AW		i) Supply	m			Rate only
AX		ii) Install	m			Rate only
		b) 50mm (wide) x 3mm (thick) black annealed copper strap		.		
AY		i) Supply	m	2 595		
AZ		ii) Install	m	2 595		
		c) 20 Φ mm black annealed bare solid copper rods		.		
BA		i) Supply	m	600		
BB		ii) Install	m	600		
		d) 1.5m long, 16mm dia. copper earth spike, with drive-in front cap, couplings etc.				
BC		i) Supply	No.			Rate only
BD		ii) Install	No.			Rate only
		e) 3m long, 16mm dia. copper earth spike, with drive-in front cap, couplings etc.		.		
BE		i) Supply	No.	45		
BF		ii) Install	No.	45		
		f) 1500mm, 57kg Rail section sacrificial earth anode		.		
BG		i) Supply	No.	40		
BH		ii) Install	No.	40		
		g) 25mm^2 bare copper earth lead				
BI		i) Supply	m			Rate only
BJ		ii) Install	m			Rate only
		h) 16mm^2 bare copper earth lead		.		
BK		i) Supply	m	250		
BL		ii) Install	m	250		
		i) 65.4mm^2 bare copper earth lead				
BM		i) Supply	m			Rate only
BN		ii) Install	m			Rate only
		j) Kingbird ACSR conductor				
BO		i) Supply	m			Rate only
BP		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		k) 50mm² Flexible copper earth braids end pieces		.		
BQ		i) Supply	m	50		
BR		ii) Install	m	50		
		l) 25mm^2 PVC insulated copper earth lead				
BS		i) Supply	m			Rate only
BT		ii) Install	m			Rate only
		m) 16mm^2 PVC insulated copper earth lead		.		
BU		i) Supply	m	150		
BV		ii) Install	m	150		
		n) 10mm^2 PVC insulated copper earth lead		.		
BW		i) Supply	m	600		
BX		ii) Install	m	600		
		o) 6mm^2 PVC insulated copper earth lead				
BY		i) Supply	m			Rate only
BZ		ii) Install	m			Rate only
		p) 4mm^2 PVC insulated copper earth lead				
CA		i) Supply	m			Rate only
CB		ii) Install	m			Rate only
		q) 2.5mm^2 PVC insulated copper earth lead				
CC		i) Supply	m			Rate only
CD		ii) Install	m			Rate only
		r) 1.5mm^2 PVC insulated copper earth lead				
CE		i) Supply	m			Rate only
CF		ii) Install	m			Rate only
CG		s) Complete all other earthing material and equipment, including but not limited to bolts/nuts, ferrules, cable to rod clamps, heat shrink tubing, joints etc. as per Eskom requirements	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		EARTH BARS AND ASSOCIATED EQUIPMENT				
		Earth Bars				
		a) **Substation M** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned main earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CH		i) Supply	No.	14		
CI		ii) Install	No.	14		
		b) **Substation M** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned **'clean'** earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CJ		i) Supply	No.	14		
CK		ii) Install	No.	14		
		c) **Substation N** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned main earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CL		i) Supply	No.	14		
CM		ii) Install	No.	14		
		d) **Substation N** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned **'clean'** earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CN		i) Supply	No.	14		
CO		ii) Install	No.	14		
		e) **New Main Intake Substation** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned main earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CP		i) Supply	No.	24		
CQ		ii) Install	No.	24		
		f) **New Main Intake Substation** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned **'clean'** earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CR		i) Supply	No.	24		
CS		ii) Install	No.	24		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		g) **Tippler 3 Building Transformer Room** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned main earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CT		i) Supply	No.	2		
CU		ii) Install	No.	2		
		h) **Tippler 3 Building Transformer Room** - 50mm (wide) x 5mm (thick) x 600mm (length), 44kA for 1 second, 250mm², tinned **'clean'** earth bar, complete with surface mounting insulators, pre-drilled holes etc.		.		
CV		i) Supply	No.	2		
CW		ii) Install	No.	2		
		Earth Potential Equalizers				
		a) **Class 3** Earth potential equalizer (**Pontechoke**), with minimum ratings of 5A continuous current, > 5kA current withstand, 110V clamping voltage, for connection of the electronics earth bar to the raw mains earth bar, complete with all tinned lugs, bolts/nuts etc.		.		
CX		i) Supply	No.	54		
CY		ii) Install	No.	54		
		LPS Test Box				
		a) **Substation M:** Complete new 316L stainless steel, IP54, 100mm x 100mm x 100mm LPS test box flush/semi-flush mounted type, powder coated colour SANS (1091 'B26') electric orange, with 50mm (wide) x 5mm (thick) tinned earth bar including insulators (length to suite), box back plate, box earth stud, door with handle, 316L stainless steel fixing materials and all other accessories as required etc.		.		
CZ		i) Supply	No.	18		
DA		ii) Install	No.	18		
		b) **Substation N:** Complete new 316L stainless steel, IP54, 100mm x 100mm x 100mm LPS test box flush/semi-flush mounted type, powder coated colour SANS (1091 'B26') electric orange, with 50mm (wide) x 5mm (thick) tinned earth bar including insulators (length to suite), box back plate, box earth stud, door with handle, 316L stainless steel fixing materials and all other accessories as required etc.		.		
DB		i) Supply	No.	20		
DC		ii) Install	No.	20		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **New Main Intake Substation:** Complete new 316L stainless steel, IP54, 100mm x 100mm x 100mm LPS test box flush/semi-flush mounted type, powder coated colour SANS (1091 'B26') electric orange, with 50mm (wide) x 5mm (thick) tinned earth bar including insulators (length to suite), box back plate, box earth stud, door with handle, 316L stainless steel fixing materials and all other accessories as required etc.		.		
DD		i) Supply	No.	24		
DE		ii) Install	No.	24		
		Bonding Clamps and Strapping				
		a) U bolt clamp, bimetallic, adjustable size for insulated earth conductor to rebard and/or earth rod		.		
DF		i) Supply	No.	100		
DG		ii) Install	No.	100		
		b) Metalwork bond clamp, bimetallic, for connection of insulated earth conductor to any type of metal work		.		
DH		i) Supply	No.	500		
DI		ii) Install	No.	500		
		c) T - Clamp, multipurpose, bimetallic, adjustable for connections of solid copper rods and/or insulator conductors				
DJ		i) Supply	No.			Rate only
DK		ii) Install	No.			Rate only
		d) Cable to strap/tape, bimetallic adjustable clamp				
DL		i) Supply	No.			Rate only
DM		ii) Install	No.			Rate only
		e) 316L Stainless steel bandit strapping of width ± 19.05mm, buckles and all other accessories etc. (Price per roll of strapping)		.		
DN		i) Supply	m	300		
DO		ii) Install	m	300		
		WELDING				
DP		a) **Substation M** - Complete exothermic welding of earthing material as specified, including but not limited to moulds, shots, ignitors etc.	Sum	1		
DQ		b) **Substation N** - Complete exothermic welding of earthing material as specified, including but not limited to moulds, shots, ignitors etc.	Sum	1		
DR		c) **New Main Intake Substation** - Complete exothermic welding, and oxy-acetylene brazing where required, of earthing material as required, including but not limited to moulds, shots, ignitors, brazing rods etc. **Note: Eskom requirements to be included**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ELECTRODE ENHANCEMENT				
		Permanent Enhancement				
		a) Conductive concrete cement, non-corrosive type, with ≤ 10 ohm per meter resistivity after curing and minimum 20 year consistent performance/life span. **Note: To be supplied in 25kg bags**		.		
DS		i) Supply	kg	500		
DT		ii) Install	kg	500		
		b) Bentonite clay neutralised, non-corrosive type with ≤ 3 ohm per meter resistivity at dry state				
DU		i) Supply	m³			Rate only
DV		ii) Install	m³			Rate only
		Temporary Enhancement				
		a) Magnesium sulfate. **Note: Only to be used where specifically instructed by the *Employer***				
DW		i) Supply	kg			Rate only
DX		ii) Install	kg			Rate only
		LABELLING				
DY		a) Labelling of **Substation M's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
DZ		b) Labelling of **Substation N's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
EA		c) Labelling of **New Main Intake Substation's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete. **Note: Eskom requirements to be included**	Sum	1		
		TESTING AND COMMISSIONING				
EB		a) Complete testing and commissioning of **Substation M and Tippler 3 Building Transformer Room's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
EC		b) Complete testing and commissioning of **Substation N's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
ED		c) Complete testing and commissioning of the **New Main Intake Substation's** installation as required. **Note: Only suitably qualified and experienced personnel to test and commission the relevant equipment/installations. Eskom requirements to be included as well where applicable**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUNDRY ITEMS				
EE		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
EF		b) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
EG		c) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
EH		d) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
EI		e) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
EJ		f) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
EK		g) Bitumen, cold galv, aluminium spray, paint and all other associated material for earthing and lightning protection purposes etc.	Sum	1		
EL		h) High melting point, non-oxidant electrical contact grease. **Note: Eskom requirements to be included**	Sum	1		
EM		i) Provision of all manufacturer(s) prescribed critical and recommended spares	Sum	1		
EN		j) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
EO		k) Complete loading, offloading, rigging, transport, labour etc. to Eskom Brackenfell depot of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
EP		l) Accredited/certified operational and maintenance training of *Employer's* staff on the entire new earthing and lightning protection infrastructure/system	Sum	1		
EQ		m) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS a) b) c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
4		**SECTION 4 : SMALL POWER AND LIGHTING** **NOTE** This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified **All fixing materials shall be of the 316L stainless steel type** **DISTRIBUTION BOARDS** **Substation M** a) **Main Distribution Board (MDB) -** Complete new 35kA floor standing, 3CR12, IP54, 400Vac distribution board, powder coated general colour (SANS 1091 'B26') electric orange and UPS section ('F06') dark violet. Also including flush and/or surface mounted plastic conduit and inspection boxes, all switchgear (cascading type), busbars, surge protection, earth bar/bolt, gland late, hinged door(s), face plates, mounting boards, all wiring, trunking (colour hospital grey) between switchgear and equipment etc., legend card, free space for future use, fixing materials and all other equipment and accessories as required. **Note: Floor fixing materials shall be 316L stainless steel**				
A		i) Supply	No.	1		
B		ii) Install	No.	1		
		b) **Medium Voltage Equipment Sub Distribution Board (SDB-MVE) -** Complete new 15kA surface mounted, 3CR12, IP54, 400Vac distribution board, powder coated general colour (SANS 1091 'B26') electric orange and face plate ('F06') dark violet. Also including flush and/or surface mounted plastic conduit and inspection boxes, all switchgear (cascading type), busbars, surge protection, earth bar/bolt, gland late, hinged door(s), face plates, mounting boards, all wiring, trunking (colour hospital grey) between switchgear and equipment etc., legend card, free space for future use, fixing materials and all other equipment and accessories as required. **Note: Surface fixing materials shall be 316L stainless steel**				
C		i) Supply	No.	1		
D		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Substation N				
		a) **Main Distribution Board (MDB) -** Complete new 35kA floor standing, 3CR12, IP54, 400Vac distribution board, powder coated general colour (SANS 1091 'B26') electric orange and UPS section ('F06') dark violet. Also including flush and/or surface mounted plastic conduit and inspection boxes, all switchgear (cascading type), busbars, surge protection, earth bar/bolt, gland late, hinged door(s), face plates, mounting boards, all wiring, trunking (colour hospital grey) between switchgear and equipment etc., legend card, free space for future use, fixing materials and all other equipment and accessories as required. **Note: Floor fixing materials shall be 316L stainless steel**				
E		i) Supply	No.	1		
F		ii) Install	No.	1		
		b) **Medium Voltage Equipment Sub Distribution Board (SDB-MVE) -** Complete new 15kA surface mounted, 3CR12, IP54, 400Vac distribution board, powder coated general colour (SANS 1091 'B26') electric orange and face plate ('F06') dark violet. Also including flush and/or surface mounted plastic conduit and inspection boxes, all switchgear (cascading type), busbars, surge protection, earth bar/bolt, gland late, hinged door(s), face plates, mounting boards, all wiring, trunking (colour hospital grey) between switchgear and equipment etc., legend card, free space for future use, fixing materials and all other equipment and accessories as required. **Note: Surface fixing materials shall be 316L stainless steel**				
G		i) Supply	No.	1		
H		ii) Install	No.	1		
		New Main Intake Substation				
		a) **Main Distribution Board (MDB) -** Complete new 35kA floor standing, 3CR12, IP54, 400Vac distribution board, powder coated general colour (SANS 1091 'B26') electric orange and UPS section ('F06') dark violet. Also including flush and/or surface mounted plastic conduit and inspection boxes, all switchgear (cascading type), busbars, surge protection, earth bar/bolt, gland late, hinged door(s), face plates, mounting boards, all wiring, trunking (colour hospital grey) between switchgear and equipment etc., legend card, free space for future use, fixing materials and all other equipment and accessories as required. **Note: Floor fixing materials shall be 316L stainless steel**				
I		i) Supply	No.	1		
J		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **Medium Voltage Equipment Sub Distribution Board (SDB-MVE)** - Complete new 15kA surface mounted, 3CR12, IP54, 400Vac distribution board, powder coated general colour (SANS 1091 'B26') electric orange and face plate ('F06') dark violet. Also including flush and/or surface mounted plastic conduit and inspection boxes, all switchgear (cascading type), busbars, surge protection, earth bar/bolt, gland late, hinged door(s), face plates, mounting boards, all wiring, trunking (colour hospital grey) between switchgear and equipment etc., legend card, free space for future use, fixing materials and all other equipment and accessories as required. **Note: Surface fixing materials shall be 316L stainless steel**				
K		i) Supply	No.	1		
L		ii) Install	No.	1		
		UNINTERRUPTIBLE POWER SUPPLY (UPS)				
		<u>UPS Systems Designs</u>				
M		a) Allow for the appointment of a specialist subcontractor/ OEM to design all new UPS systems, for approval by the Employer, in accordance with Code of Practice(s), the specifications/drawings etc. It shall include for all necessary designs for approval, construction drawings, software programming (allow for 3 re-iterations), *Employer* and where applicable supply authority requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
		<u>UPS Systems Installations</u>				
		a) **Substation M: Building UPS** - Complete new custom build floor standing **20kVA UPS** system, consisting of 400Vac three phase input, 110Vdc, 24Vdc and 230Vac single phase outputs, **2h battery back-up** on 100% of full load, with all fully sealed, deep cycle, maintenance free type batteries, main and battery cabinets, LED screen, alarm functions, flush and/or surface mounted plastic conduit and inspection boxes, all wiring/cabling, any protocol interface cards, terminal blocks, fixing materials and all other associated equipment and accessories etc. **Note: (1) Both UPS and battery cabinets 3CR12, IP54 and powder coated ('F06') dark violet to SANS 1091. (2) Battery cabinet(s) floor standing. (3) Batteries to have minimum 15 - 20 year guaranteed life span. (4) Floor fixing materials shall be 316L stainless steel**				
N		i) Supply	No.	1		
O		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **Substation M: Medium Voltage Equipment UPS** - Complete new custom build floor standing **20kVA UPS** system, consisting of 400Vac three phase input, 110Vdc, 24Vdc and 230Vac single phase outputs, **2h battery back-up** on 100% of full load, with all fully sealed, deep cycle, maintenance free type batteries, main and battery cabinets, LED screen, alarm functions, flush and/or surface mounted plastic conduit and inspection boxes, all wiring/cabling, any protocol interface cards, terminal blocks, fixing materials and all other associated equipment and accessories etc. **Note: (1) Both UPS and battery cabinets 3CR12, IP54 and powder coated ('F06') dark violet to SANS 1091. (2) Battery cabinet(s) floor standing. (3) Batteries to have minimum 15 - 20 year guaranteed life span. (4) Floor fixing materials shall be 316L stainless steel**				
P		i) Supply	No.	1		
Q		ii) Install	No.	1		
		c) **Substation N: Building UPS** - Complete new custom build floor standing **20kVA UPS** system, consisting of 400Vac three phase input, 110Vdc, 24Vdc and 230Vac single phase outputs, **2h battery back-up** on 100% of full load, with all fully sealed, deep cycle, maintenance free type batteries, main and battery cabinets, LED screen, alarm functions, flush and/or surface mounted plastic conduit and inspection boxes, all wiring/cabling, any protocol interface cards, terminal blocks, fixing materials and all other associated equipment and accessories etc. **Note: (1) Both UPS and battery cabinets 3CR12, IP54 and powder coated ('F06') dark violet to SANS 1091. (2) Battery cabinet(s) floor standing. (3) Batteries to have minimum 15 - 20 year guaranteed life span. (4) Floor fixing materials shall be 316L stainless steel**				
R		i) Supply	No.	1		
S		ii) Install	No.	1		
		d) **Substation N: Medium Voltage Equipment UPS** - Complete new custom build floor standing **20kVA UPS** system, consisting of 400Vac three phase input, 110Vdc, 24Vdc and 230Vac single phase outputs, **2h battery back-up** on 100% of full load, with all fully sealed, deep cycle, maintenance free type batteries, main and battery cabinets, LED screen, alarm functions, flush and/or surface mounted plastic conduit and inspection boxes, all wiring/cabling, any protocol interface cards, terminal blocks, fixing materials and all other associated equipment and accessories etc. **Note: (1) Both UPS and battery cabinets 3CR12, IP54 and powder coated ('F06') dark violet to SANS 1091. (2) Battery cabinet(s) floor standing. (3) Batteries to have minimum 15 - 20 year guaranteed life span. (4) Floor fixing materials shall be 316L stainless steel**				
T		i) Supply	No.	1		
U		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) **New Main Intake Substation: Building UPS** - Complete new custom build floor standing **30kVA UPS** system, consisting of 400Vac three phase input, 110Vdc, 24Vdc and 230Vac single phase outputs, **2h battery back-up** on 100% of full load, with all fully sealed, deep cycle, maintenance free type batteries, main and battery cabinets, LED screen, alarm functions, flush and/or surface mounted plastic conduit and inspection boxes, all wiring/cabling, any protocol interface cards, terminal blocks, fixing materials and all other associated equipment and accessories etc. **Note: (1) Both UPS and battery cabinets 3CR12, IP54 and powder coated ('F06') dark violet to SANS 1091. (2) Battery cabinet(s) floor standing. (3) Batteries to have minimum 15 - 20 year guaranteed life span. (4) Floor fixing materials shall be 316L stainless steel**				
V		i) Supply	No.	1		
W		ii) Install	No.	1		
		f) **New Main Intake Substation: Medium Voltage Equipment UPS** - Complete new custom build floor standing **30kVA UPS** system, consisting of 400Vac three phase input, 110Vdc, 24Vdc and 230Vac single phase outputs, **2h battery back-up** on 100% of full load, with all fully sealed, deep cycle, maintenance free type batteries, main and battery cabinets, LED screen, alarm functions, flush and/or surface mounted plastic conduit and inspection boxes, all wiring/cabling, any protocol interface cards, terminal blocks, fixing materials and all other associated equipment and accessories etc. **Note: (1) Both UPS and battery cabinets 3CR12, IP54 and powder coated ('F06') dark violet to SANS 1091. (2) Battery cabinet(s) floor standing. (3) Batteries to have minimum 15 - 20 year guaranteed life span. (4) Floor fixing materials shall be 316L stainless steel**				
X		i) Supply	No.	1		
Y		ii) Install	No.	1		
		g) **UPS Live Visual Indication (Blue):** Harsh environment and dust proof, IP65, outdoor, LED visual alarm indicator, for indication that a UPS in the substation is live, complete with all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
Z		i) Supply	No.	6		
AA		ii) Install	No.	6		
		h) **UPS Live Audible Indication:** Harsh environment and dust proof, IP65, outdoor, audible alarm indicator, for indication that a UPS in the substation is live, with all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc. complete				
AB		i) Supply	No.	6		
AC		ii) Install	No.	6		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		LIGHTING INSTALLATIONS				
		Luminaires				
		a) **Type A** - Complete new 2 x 10W (4000 Kelvin), 230Vac (incl. power supply if needed), LED, up/down, diecast marine grade aluminium body, high-impact clear glass protector, wall mounted, IP65 luminaire, colour pearl light grey, complete with 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AD		i) Supply	No.	11		
AE		ii) Install	No.	11		
		b) **Type B** - Complete new 65W (4000 Kelvin), 230Vac (incl. power supply if needed), LED, vapour proof, polycarbonate body, opaque polycarbonate diffuser, surface/bracket mounted, IP65 luminaire, colour light grey, complete with 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L**				
AF		i) Supply	No.	250		
AG		ii) Install	No.	250		
		c) **Type C** - Complete new 5W/meter (4000 Kelvin), 230Vac (incl. power supply if needed), LED flexible strip light, silicon body, opaque silicon diffuser, surface mounted, IP65 luminaire, colour light grey, complete with aluminium clip(s) (quantity to suite installation), 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AH		i) Supply	m	125		
AI		ii) Install	m	125		
		d) **Type D** - Complete new 60W (4000 Kelvin), 230Vac (incl. power supply if needed), LED, 1200 x 600 panel, aluminium body, opaque polycarbonate diffuser, drop-in ceiling mounted, IP20 luminaire, colour white luminaire, complete with 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AJ		i) Supply	No.	261		
AK		ii) Install	No.	261		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) **Type E** - Complete new 18W (3000 Kelvin), 230Vac (incl. power supply if needed), LED, Bulkhead, high-pressure die-cast aluminium body, surface mounted, IP66, luminaire, colour black, complete with 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AL		i) Supply	No.	22		
AM		ii) Install	No.	22		
		f) **Type F1** - Complete new 210W (3000 Kelvin), 230Vac (incl. power supply if needed), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium, incorporated bird spike (unpainted 316L stainless steel or UV stabilized poly-carbonate type), complete with 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AN		i) Supply	No.	5		
AO		ii) Install	No.	5		
		g) **Type F2** - Complete new 120W (3000 Kelvin), 230Vac (incl. power supply if needed), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium, incorporated bird spike (unpainted 316L stainless steel or UV stabilized poly-carbonate type), complete with 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AP		i) Supply	No.			Rate only
AQ		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		New Main Intake Substation Yard Lighting				
		Eskom Section of Yard				
		Luminaires				
		a) **Type F1** - Complete new 210W (3000 Kelvin), 230Vac (incl. power supply if needed), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium, incorporated bird spike (unpainted 316L stainless steel or UV stabilized poly-carbonate type), 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AR		i) Supply	No.			Rate only
AS		ii) Install	No.			Rate only
		b) **Type F2** - Complete new 120W (3000 Kelvin), 230Vac (incl. power supply if needed), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium, incorporated bird spike (unpainted 316L stainless steel or UV stabilized poly-carbonate type), 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
AT		i) Supply	No.	40		
AU		ii) Install	No.	40		
		Junction Box (Distribution Board) at Masts Platform				
		a) Complete new 316L stainless steel, IP65, powder coated colour (SANS 1091 'G29') enclosure box complete with hinged door, pad-lockable lever lock and hinges, terminal rails and circuit breaker rails, circuit breakers, terminal blocks, including mounting bracket all fixing materials and all other accessories as required complete. **Note: This enclosure box shall be manufactured to Eskom requirements. All fixing materials to be 316L stainless steel**				
AV		i) Supply	No.	10		
AW		ii) Install	No.	10		
		Termination Board Inside/Bottom of Masts				
		a) Complete new 316L stainless steel, IP65, un-painted enclosure box complete with hinged door, pad-lockable lever lock and hinges, terminal rails and circuit breaker rails, circuit breakers, terminal blocks, including mounting brackets, all fixing materials and all other accessories as required complete. **Note: This enclosure box shall be manufactured and installed to Eskom standards and specifications**				
AX		i) Supply	No.	10		
AY		ii) Install	No.	10		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Cable Junction Boxes in Trenches a) Complete new 316L stainless steel, IP65, enclosure box with hinged door, pad-lockable lever lock and hinges, terminal rails and circuit breaker rails, circuit breakers, terminal blocks, including mounting brackets, all fixing materials and all other accessories as required complete. **Note: This enclosure box shall be manufactured and installed to Eskom standards and specifications. All fixing materials to be 316L stainless steel**				
AZ		i) Supply	No.	10		
BA		ii) Install	No.	10		
		Employer **Section of Yard** **Luminaires** a) **Type F1** - Complete new 210W (3000 Kelvin), 230Vac (incl. power supply if needed), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium, incorporated bird spike (unpainted 316L stainless steel or UV stabilized poly-carbonate type), 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
BB		i) Supply	No.	32		
BC		ii) Install	No.	32		
		b) **Type F2** - Complete new 120W (3000 Kelvin), 230Vac (incl. power supply if needed), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium, incorporated bird spike (unpainted 316L stainless steel or UV stabilized poly-carbonate type), 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire including fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
BD		i) Supply	No.			Rate only
BE		ii) Install	No.			Rate only
		Junction Box (Distribution Board) at Masts Platform a) Complete 316L stainless steel, IP65, powder coated colour (SANS 1091 'B26') enclosure box complete with hinged door, pad-lockable lever lock and hinges, terminal rails and circuit breaker rails, circuit breakers, terminal blocks, including mounting bracket, including mounting bracket, all fixing materials and all other accessories as required complete. **Note: All fixing materials, screws and accessories shall be 316L stainless steel**				
BF		i) Supply	No.	9		
BG		ii) Install	No.	9		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Termination Board Inside/Bottom of Masts a) Complete new 316L stainless steel, IP65, un-painted enclosure box complete with hinged door, pad-lockable lever lock and hinges, terminal rails and circuit breaker rails, circuit breakers, terminal blocks, including mounting brackets, all fixing materials and all other accessories as required complete. **Note: All fixing materials, screws and accessories shall be 316L stainless steel**				
BH		i) Supply	No.	9		
BI		ii) Install	No.	9		
		Cable Junction Boxes in Trenches a) Complete new 316L stainless steel, IP65, enclosure box with hinged door, pad-lockable lever lock and hinges, terminal rails and circuit breaker rails, circuit breakers, terminal blocks, including mounting brackets, all fixing materials and all other accessories as required complete. **Note: This enclosure box shall be manufactured and installed to Eskom standards and specifications. All fixing materials to be 316L stainless steel**				
BJ		i) Supply	No.	9		
BK		ii) Install	No.	9		
		Luminaires Mounting Brackets a) **90º Bracket** - 316L Stainless steel bracket to mount type B luminaire at a 90º angle complete including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
BL		i) Supply	No.	54		
BM		ii) Install	No.	54		
		b) **45º Bracket** - 316L Stainless steel bracket to mount type B luminaire at a 90º angle complete including all fixing materials and all other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
BN		i) Supply	No.	66		
BO		ii) Install	No.	66		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Light Switches a) Complete new indoor type flush mounted light switch, with 16A, **1 lever: normal (1 way) switch,** isolator/disconnector, powder coated cover, 100mm x 50mm outlet box, 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires including by-pass wiring, 1 x 2.5mm² Cu GPW earth wire, fixing materials including any other accessories as required. **Note: All fixing materials, housing boxes, including cradles, covers, screws and associated accessories shall be 316L**				
BP		i) Supply	No.	8		
BQ		ii) Install	No.	8		
		b) Complete new indoor type flush mounted light switch, with 16A, **1 lever: normal (2 way) switch,** isolator/disconnector, powder coated cover, 100mm x 50mm outlet box, 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires including by-pass wiring, 1 x 2.5mm² Cu GPW earth wire, fixing materials including any other accessories as required. **Note: All fixing materials, housing boxes, including cradles, covers, screws and associated accessories shall be 316L stainless steel**				
BR		i) Supply	No.	3		
BS		ii) Install	No.	3		
		c) Complete new indoor type flush mounted light switch, with 16A, **2 lever: (both levers) 2 way switch,** isolator/ disconnector, powder coated cover, 100mm x 100mm outlet box, 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires including by-pass wiring, 1 x 2.5mm² Cu GPW earth wire, fixing materials including any other accessories as required. **Note: All fixing materials, housing boxes, including cradles, covers, screws and associated accessories shall**				
BT		i) Supply	No.	3		
BU		ii) Install	No.	3		
		d) Complete new indoor type flush mounted light switch, with 16A, **2 lever: 1 x 2 way switch, 1 x Intermediate switch,** isolator/disconnector, powder coated cover, 100mm x 100mm outlet box, 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires including by-pass wiring, 1 x 2.5mm² Cu GPW earth wire, fixing materials including any other accessories as required. **Note: All fixing materials, housing boxes, including cradles, covers, screws and associated**				
BV		i) Supply	No.			Rate only
BW		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) Complete new indoor type flush mounted light switch, with 16A, **3 lever: (all levers) 2 way switch,** isolator/ disconnector, powder coated cover, 100mm x 150mm outlet box, 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires including by-pass wiring, 1 x 2.5mm² Cu GPW earth wire, fixing materials including any other accessories as required. **Note: All fixing materials, housing boxes, including cradles, covers, screws and associated accessories shall be 316L stainless steel**				
BX		i) Supply	No.	2		
BY		ii) Install	No.	2		
		Light Points				
		f) Lighting point complete with 20mm dia. side entry multiple spout round inspection box, 20mm dia. flush and/or surface mounted plastic conduit and inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire, fixing materials including any other accessories as required. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
BZ		i) Supply	No.			Rate only
CA		ii) Install	No.			Rate only
		Photocells (Daylight switches)				
		a) Complete new outdoor type fully sealed IP65 10A, 60 lux on/40 lux off photocell (daylight switch) unit, with L-bracket mounting arm, 20mm dia. flush and/or surface mounted plastic conduit and front loop-in and multiple side entry spout round inspection boxes, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire, fixing materials including any other accessories as required. **Note: Fixing materials, screws, L-bracket and all associated accessories shall be 316L stainless steel**				
CB		i) Supply	No.	4		
CC		ii) Install	No.	4		
		SMALL POWER INSTALLATION				
		Conventional Socket Outlet Installations				
		a) Complete new surface mounted combined 2 x SANS 164-1 type switched socket outlets and 2 x SANS 164-2 type switched socket outlets (Euro), with 4 x 1 lever switches, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel. (2) For service level inside Main Intake Substation switch house**				
CD		i) Supply	No.	7		
CE		ii) Install	No.	7		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) Complete new flush mounted combined 2 x SANS 164-1 type switched socket outlets and 2 x SANS 164-2 type switched socket outlets (Euro), with 4 x 1 lever switches, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CF		i) Supply	No.	44		
CG		ii) Install	No.	44		
		c) Complete new flush mounted **red (dedicated)** double switched socket outlet, with 16A, 1 Pole, 1 lever switches, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 100mm x 100mm outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CH		i) Supply	No.			Rate only
CI		ii) Install	No.			Rate only
		d) Complete new flush mounted **blue (UPS)** double switched socket outlet, with 16A, 1 Pole, 1 lever switches, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 100mm x 100mm outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CJ		i) Supply	No.	2		
CK		ii) Install	No.	2		
		e) Complete new surface mounted combined 2 x SANS 164-2 type switched socket outlets (Euro), with 2 x 1 lever switches, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CL		i) Supply	No.			Rate only
CM		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) Complete new flush mounted combined 2 x SANS 164-2 type switched socket outlets (Euro), with 2 x 1 lever switches, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CN		i) Supply	No.	2		
CO		ii) Install	No.	2		
		g) Complete new surface mounted 5A un-switched socket outlet, with 20mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 100mm x 50mm outlet box, 2 x 2.5mm² Cu GPW single core wires, 1 x 2.5mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CP		i) Supply	No.			Rate only
CQ		ii) Install	No.			Rate only
		<u>Power Skirting/Trunking Mounted Socket Outlet Installations</u>				
		a) Complete new power skirting/trunking mounted **blue top** single switched socket outlet, with 16A, 1 Pole, 1 lever switch, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CR		i) Supply	No.	41		
CS		ii) Install	No.	41		
		b) Complete new power skirting/trunking mounted **red (dedicated)** single switched socket outlet, with 16A, 1 Pole, 1 lever switch, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CT		i) Supply	No.			Rate only
CU		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) Complete new power skirting/trunking mounted **white (normal)** single switched socket outlet, with 16A, 1 Pole, 1 lever switch, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all other associated accessories shall be 316L stainless steel**				
CV		i) Supply	No.			Rate only
CW		ii) Install	No.			Rate only
		d) Complete new power skirting/trunking mounted **blue top** SANS 164-2 type switched socket outlet (Euro), with 1 lever switch, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
CX		i) Supply	No.	41		
CY		ii) Install	No.	41		
		<u>Outdoor Type Socket Outlet Installations</u>				
		a) Complete new outdoor flush mounted combined 1 x SANS 164-1 type switched socket outlet and 1 x SANS 164-2 type switched socket outlet (Euro), with 2 x 1 lever switches, powder coated cover, complete with and installed within purpose built, IP65, 316L stainless steel, powder coated lockable enclosure, complete with 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 100mm x 100mm outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, all the fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all other associated accessories shall be 316L stainless steel**				
CZ		i) Supply	No.	18		
DA		ii) Install	No.	18		
		<u>5 Pin Switched Socket Outlet Installations</u>				
		a) Complete new surface mounted, purpose engineered plastic, 32A, 5 pin, IP65, lockable socket outlet, with 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 6mm² Cu GPW single core wires, 1 x 6mm² Cu GPW earth wire, all the fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
DB		i) Supply	No.			Rate only
DC		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) Complete new surface mounted, purpose engineered plastic, 32A, 5 pin, IP65, lockable socket outlet, with 50mm dia. flush/or surface mounted plastic conduit and inspection boxes, all fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, screws and associated accessories shall be 316L stainless steel. (2) See SLDs for cable supplies**				
DD		i) Supply	No.			Rate only
DE		ii) Install	No.			Rate only
		c) Complete new purpose engineered plastic, 32A, 5 pin, IP65, lockable socket outlet, mounted withing purpose made surface mounted IP65 316L stainless steel enclosure, with 50mm dia. flush/or surface mounted plastic conduit and inspection boxes, all fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, screws and associated accessories shall be 316L stainless steel. (2) See SLDs for cable supplies**				
DF		i) Supply	No.	2		
DG		ii) Install	No.	2		
		d) Complete new surface mounted, purpose engineered plastic, 63A, 5 pin, IP65, lockable socket outlet, with 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 6mm² Cu GPW single core wires, 1 x 6mm² Cu GPW earth wire, all the fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
DH		i) Supply	No.			Rate only
DI		ii) Install	No.			Rate only
		e) Complete new surface mounted, purpose engineered plastic, 63A, 5 pin, IP65, lockable socket outlet, with 50mm dia. flush/or surface mounted plastic conduit and inspection boxes, all fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, screws and associated accessories shall be 316L stainless steel. (2) See SLDs for cable supplies**				
DJ		i) Supply	No.			Rate only
DK		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) Complete new semi-flush mounted, purpose engineered plastic, 32A, 5 pin, IP65, lockable socket outlet, with 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 6mm² Cu GPW single core wires, 1 x 6mm² Cu GPW earth wire, all the fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
DL		i) Supply	No.	6		
DM		ii) Install	No.	6		
		g) Complete new semi-flush mounted, purpose engineered plastic, 32A, 5 pin, IP65, lockable socket outlet, with 50mm dia. flush/or surface mounted plastic conduit and inspection boxes, all fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, screws and associated accessories shall be 316L stainless steel. (2) See SLDs for cable supplies**				
DN		i) Supply	No.			Rate only
DO		ii) Install	No.			Rate only
		h) Complete new semi-flush mounted, purpose engineered plastic, 63A, 5 pin, IP65, lockable socket outlet, with 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 2 x 6mm² Cu GPW single core wires, 1 x 6mm² Cu GPW earth wire, all the fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, screws and associated accessories shall be 316L stainless steel**				
DP		i) Supply	No.			Rate only
DQ		ii) Install	No.			Rate only
		i) Complete new semi-flush mounted, purpose engineered plastic, 63A, 5 pin, IP65, lockable socket outlet, with 50mm dia. flush/or surface mounted plastic conduit and inspection boxes, all fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, screws and associated accessories shall be 316L stainless steel. (2) See SLDs for cable supplies**				
DR		i) Supply	No.			Rate only
DS		ii) Install	No.			Rate only
		<u>Isolator Installations</u>				
		a) Complete new flush mounted 30-32A, double pole isolator, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 100mm x 100mm outlet box, 2 x 4mm² Cu GPW single core wires, 1 x 4mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
DT		i) Supply	No.	16		
DU		ii) Install	No.	16		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) Complete new flush mounted 60-63A, double pole isolator, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, 100mm x 100mm outlet box, 2 x 6mm² Cu GPW single core wires, 1 x 6mm² Cu GPW earth wire, fixing materials plus all other equipment and accessories etc. **Note: All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel**				
DV		i) Supply	No.			Rate only
DW		ii) Install	No.			Rate only
		c) Complete new flush mounted 30-32A, three pole isolator, powder coated cover, 25mm - 50mm dia. flush/or surface mounted plastic conduit and round inspection boxes, outlet box, fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel (2) See SLDs for cable supplies**				
DX		i) Supply	No.			Rate only
DY		ii) Install	No.			Rate only
		d) Complete new flush mounted 60-63A, three pole isolator, powder coated cover, 25mm dia. flush/or surface mounted plastic conduit and round inspection boxes, outlet box, fixing materials plus all other equipment and accessories etc. **Note: (1) All fixing materials, housing boxes, including cradles, covers, screws and all associated accessories shall be 316L stainless steel (2) See SLDs for cable supplies**				
DZ		i) Supply	No.	7		
EA		ii) Install	No.	7		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ESKOM 132kV CONTROL BUILDING (RELAY HOUSE) POWER AND LIGHTING				
		<u>Small Power and Lighting for Eskom 132kV Control Building</u>				
EB		a) Supply and install all small power and lighting (internal and external) equipment/infrastructure for the Eskom (Ystervark) 132kV control building complete, including but not limited to distribution board, socket outlets, luminaires, wiring, cable management systems etc. **Note: Entire infrastructure to fully comply with Eskom standards and specifications**	Sum	1		
		FIREMAN'S SWITCH				
		a) Complete surface/wall mounted, IP65, red colour, side arm operated, plastic enclosure, 32A, 4 pole, fireman's switch, with automatic 'off' locking device for prevention of accidental 'on' switching, all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit, fixing materials and all other equipment and accessories etc.				
EC		i) Supply	No.	6		
ED		ii) Install	No.	6		
		LABELLING				
EE		a) Labelling of **Substation M's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
EF		b) Labelling of **Substation N's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
EG		c) Labelling of **New Main Intake Substation's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
		TESTING AND COMMISSIONING				
EH		a) Complete testing and commissioning of **Substation M's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
EI		b) Complete testing and commissioning of **Substation N's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
EJ		c) Complete testing and commissioning of the **New Main Intake Substation's** installation as required. **Note: Only suitably qualified and experienced personnel to test and commission the relevant equipment/installations**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUNDRY ITEMS				
EK		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
EL		b) Inspection of all **Type Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
EM		c) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
EN		d) Inspection of all **Routine Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
EO		e) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
EP		f) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
EQ		g) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
ER		h) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
ES		i) Provision of all manufacturer(s) prescribed critical and recommended spares	Sum	1		
ET		j) All manufacturer(s) prescribed operating equipment, tools etc. for all the *Employer's* equipment etc.	Sum	1		
EU		k) Software and licenses where applicable for all relevant equipment, including programming and copies to the	Sum	1		
EV		l) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
EW		m) Complete loading, offloading, rigging, transport, labour etc. to Eskom Brackenfell depot of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
EX		n) Accredited/certified operational and maintenance training of *Employer's* staff on the entire new UPS infrastructure/ systems	Sum	1		
EY		o) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS a) b) c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
5		**SECTION 5 : CABLE MANAGEMENT SYSTEMS**				
		NOTE				
		This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc.				
		WIREWAYS AND EQUIPMENT				
		Trays, Ladders, Racks and Ducts				
		a) Cable tray, perforated heavy duty complete 610mm (wide) x 76mm (high) x 2mm (thick) 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus any other fixing materials and accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
A		i) Supply	m	470		
B		ii) Install	m	470		
		b) Cable tray, perforated heavy duty complete 200mm (wide) x 38mm (high) x 1.6mm (thick) 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus any other fixing materials and accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
C		i) Supply	m	470		
D		ii) Install	m	470		
		c) Cable ladder, heavy duty complete 600mm (wide) x 150mm (high/deep) x 4mm (thick) 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus any other fixing materials and accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
E		i) Supply	m	1 600		
F		ii) Install	m	1 600		
		d) Cable ladder, heavy duty complete 400mm (wide) x 150mm (high/deep) x 4mm (thick) 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus any other fixing materials and accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
G		i) Supply	m	850		
H		ii) Install	m	850		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		e) Cable ladder, heavy duty complete 200mm (wide) x 150mm (high/deep) x 4mm (thick) 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus any other fixing materials and accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
I		i) Supply	m	160		
J		ii) Install	m	160		
		f) Cable wire mesh, heavy duty complete 100mm (wide) x 76mm (high) x 5mm dia. wire 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus any other fixing materials and accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
K		i) Supply	m	380		
L		ii) Install	m	380		
		g) Cable duct, heavy duty complete 125mm (wide) x 76mm (high) x 1.5mm (thick) 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus all fixing materials and any other accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
M		i) Supply	m	240		
N		ii) Install	m	240		
		h) Cable duct, heavy duty complete 76mm (wide) x 76mm (high) x 1.5mm (thick) 316L stainless steel type, including all joints, tees, bends, covers, end pieces, side, vertical and horizontal supports, plus any other fixing materials and accessories as required. **Note: All steel material to be of the 316L stainless steel type**				
O		i) Supply	m	470		
P		ii) Install	m	470		
		<u>Power Skirting</u>				
		a) Power skirting, complete 2 x Channels of 72mm (High) x 54mm (Deep), hospital grey colour, including all joints, bends, covers, end pieces etc., plus any other fixing materials and accessories as required. **Note: Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. Any steel fixing materials to be of the 316L stainless steel type**				
Q		i) Supply	m	110		
R		ii) Install	m	110		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) Power skirting, complete 1 x Channel of 72mm (High) x 54mm (Deep), hospital grey colour, including all joints, bends, covers, end pieces etc., plus any other fixing materials and accessories as required. **Note: Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. Any steel fixing materials to be of the 316L stainless steel type**				
S		i) Supply	m			Rate only
T		ii) Install	m			Rate only
		c) Power skirting, complete 2 x Channels of 72mm (High) x 54mm (Deep) 316L stainless steel type, powder coated to colour 'G29' light grey, including for all the joints, bends, covers, end pieces etc., all fixing materials and any other accessories as required. **Note: All of the steel material to be 316L stainless steel type and powder coated**				
U		i) Supply	m			Rate only
V		ii) Install	m			Rate only
		d) Power skirting, complete 1 x Channel of 72mm (High) x 54mm (Deep) 316L stainless steel type, powder coated to colour 'G29' light grey, including for all the joints, bends, covers, end pieces etc., all fixing materials and accessories as required. **Note: All of the steel material to be of the 316L stainless steel type and powder coated**				
W		i) Supply	m			Rate only
X		ii) Install	m			Rate only
		Trunking				
		a) Trunking, complete 1 x Channel of 100mm (High) x 100mm (Deep), hospital grey colour, including all joints, bends, covers, end pieces etc., plus any other fixing materials and accessories as required. **Note: Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. Any steel fixing materials to be of the 316L stainless steel type**				
Y		i) Supply	m	80		
Z		ii) Install	m	80		
		b) Trunking, complete 1 x Channel of 100mm (High) x 50mm (Deep), hospital grey colour, including all joints, bends, covers, end pieces etc., plus any other fixing materials and accessories as required. **Note: Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. Any steel fixing materials to be of the 316L stainless steel type**				
AA		i) Supply	m			Rate only
AB		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) Trunking, complete 1 x Channel of 100mm (High) x 100mm (Deep) 316L stainless steel type, powder coated to colour 'G29' light grey, including for all the joints, bends, covers, end pieces etc., and all fixing materials and any accessories as required. **Note: All the steel material to be of the 316L stainless steel type and powder coated**				
AC		i) Supply	m			Rate only
AD		ii) Install	m			Rate only
		d) Trunking, complete 1 x Channel of 100mm (High) x 50mm (Deep) 316L stainless steel type, powder coated to colour 'G29' light grey, including for all the joints, bends, covers, end pieces etc., and all fixing materials and any accessories as required. **Note: All the steel material to be of the 316L stainless steel type and powder coated**				
AE		i) Supply	m			Rate only
AF		ii) Install	m			Rate only
		Conduits				
		a) Plastic, 50mm dia. flush mounted conduit, including inspection boxes, 316L stainless steel fixing materials and all other accessories as needed. **Note: (1) Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. (2) Inspection boxes internal of building only, unless otherwise specified by the *Employer***				
AG		i) Supply	m			Rate only
AH		ii) Install	m			Rate only
		b) Plastic, 32mm dia. flush mounted conduit, including inspection boxes, 316L stainless steel fixing materials and all other accessories as needed. **Note: (1) Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. (2) Inspection boxes internal of building only, unless otherwise specified by the *Employer***				
AI		i) Supply	m	470		
AJ		ii) Install	m	470		
		c) Plastic, 25mm dia. flush mounted conduit, including inspection boxes, 316L stainless steel fixing materials and all other accessories as needed. **Note: (1) Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. (2) Inspection boxes internal of building only, unless otherwise specified by the *Employer***				
AK		i) Supply	m	470		
AL		ii) Install	m	470		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) Plastic, 20mm dia. flush mounted conduit, including inspection boxes, 316L stainless steel fixing materials and all other accessories as needed. **Note: (1) Plastic material to be of the fire retardant, self-extinguishing, zero toxic emmissions type. (2) Inspection boxes internal of building only, unless otherwise specified by the *Employer***				
AM		i) Supply	m			Rate only
AN		ii) Install	m			Rate only
		e) 316L Stainless steel, 50mm dia. flush/or surface mounted conduit, including inspection boxes etc., plus all other fixing materials and accessories as needed. **Note: All of the steel material to be of the 316L stainless steel type unpainted**				
AO		i) Supply	m			Rate only
AP		ii) Install	m			Rate only
		f) 316L Stainless steel, 32mm dia. flush/or surface mounted conduit, including inspection boxes etc., plus all other fixing materials and accessories as needed. **Note: All of the steel material to be of the 316L stainless steel type unpainted**				
AQ		i) Supply	m			Rate only
AR		ii) Install	m			Rate only
		g) 316L Stainless steel, 25mm dia. flush/or surface mounted conduit, including inspection boxes etc., plus all other fixing materials and accessories as needed. **Note: All of the steel material to be of the 316L stainless steel type unpainted**				
AS		i) Supply	m			Rate only
AT		ii) Install	m			Rate only
		h) 316L Stainless steel, 20mm dia. flush/or surface mounted conduit, including inspection boxes etc., plus all other fixing materials and accessories as needed. **Note: All of the steel material to be of the 316L stainless steel type unpainted**				
AU		i) Supply	m			Rate only
AV		ii) Install	m			Rate only
		CABLE CLAMPS/CLEATS				
		a) 1 x 25mm-55mm Cable dia., 55mm (inner width.) cable clamp, polypropylene black colour, UV stabilised, fire and oil resistant, complete with removable EPDM rubber range taking inserts, stainless steel threaded rods, nuts/bolts, fixing materials and all other accessories. **Note: Eskom spec type (D-DT-8019)**				
AW		i) Supply	No.	58		
AX		ii) Install	No.	58		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) 1 x 50mm-75mm Cable dia., 75mm (inner width.) cable clamp, polypropylene black colour, UV stabilised, fire and oil resistant, complete with stainless steel threaded rods, nuts/bolts, fixing materials and all other accessories. **Note: Eskom spec type (D-DT-8019)**				
AY		i) Supply	No.			Rate only
AZ		ii) Install	No.			Rate only
		c) 1 x 75mm-110mm Cable dia., 100mm (inner width.) cable clamp, polypropylene black colour, UV stabilised, fire and oil resistant, complete with all stainless steel threaded rods, nuts/bolts, fixing materials and all other accessories. **Note: Eskom spec type (D-DT-8019)**				
BA		i) Supply	No.			Rate only
BB		ii) Install	No.			Rate only
		d) 4 x Bolted together 50mm-75mm Cable dia., 75mm (inner width.) cable clamp, polypropylene black colour, UV stabilised, fire and oil resistant, complete with stainless steel threaded rods, nuts/bolts, fixing materials and all other accessories. **Note: Eskom spec type (D-DT-8019)**				
BC		i) Supply	No.			Rate only
BD		ii) Install	No.			Rate only
		e) 5 x Bolted together 50mm-75mm Cable dia., 75mm (inner width.) cable clamp, polypropylene black colour, UV stabilised, fire and oil resistant, complete with stainless steel threaded rods, nuts/bolts, fixing materials and all other accessories. **Note: Eskom spec type (D-DT-8019)**				
BE		i) Supply	No.			Rate only
BF		ii) Install	No.			Rate only
		ADDITIONAL FIXING MATERIALS				
		a) 316L Stainless steel bandit strapping of width ± 19.05mm, buckles and all other accessories etc. (Price per roll of strapping)				
BG		i) Supply	m	300		
BH		ii) Install	m	300		
		b) Cable ties, 10mm width, black colour, heavy duty and UV stabilised fire retardant, self-extinguishing, zero toxic emmissions type				
BI		i) Supply	m			Rate only
BJ		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUNDRY ITEMS				
BK		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
BL		b) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
BM		c) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
BN		d) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
BO		e) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
BP		f) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
BQ		g) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
6		**SECTION 6 : FIRE DETECTION AND ACCESS CONTROL** **NOTE** This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc. **All fixing materials shall be of the 316L stainless steel type** **FIRE DETECTION SYSTEM** **Fire Detection Systems Designs**				
A		a) Allow for the appointment of a specialist subcontractor/ OEM to design all new fire detection systems, for approval by the Employer, in accordance with Code of Practice(s), the specifications/drawings etc. It shall include for all necessary designs for approval, construction drawings, software programming (allow for 3 re-iterations), *Employer* and where applicable supply authority requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
		Fire Detection Systems Installations **Main Control Panels**				
B		a) **Substation M:** Complete new main multi-zone, programmable, 230Vac input fire control panel with user interface, strobe/siren, extinguishing activation, emergency stop, all wiring and communications cabling, software, any additional power supplies if required, flush/or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials plus any other equipment and accessories etc. i) Supply	No.	1		
C		ii) Install	No.	1		
		b) **Substation N:** Complete new main multi-zone, programmable, 230Vac input fire control panel with user interface, strobe/siren, extinguishing activation, emergency stop, all wiring and communications cabling, software, any additional power supplies if required, flush /or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials plus any other equipment and accessories etc.				
D		i) Supply	No.	1		
E		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **New Main Intake Substation:** Complete new main multi-zone, programmable, 230Vac input fire control panel with user interface, strobe/siren, extinguishing activation, emergency stop, all wiring and communications cabling, software, any additional power supplies if required, flush/or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials plus any other equipment and accessories etc.				
F		i) Supply	No.	1		
G		ii) Install	No.	1		
		<u>Local Control Panels</u>				
		a) Complete new addressable, programmable, multi-zone, 230Vac input local fire control panel with user interface, strobe/siren, extinguishing activation, emergency stop, all wiring and communications cabling, software, any additional power supplies if required, flush/or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials plus any other equipment and accessories etc.				
H		i) Supply	No.	16		
I		ii) Install	No.	16		
		b) Complete new non-addressable/conventional, programmable multi-zone, 230Vac input local fire control panel with user interface, strobe/siren, extinguishing activation, emergency stop, all wiring and communications cabling, software, any additional power supplies if required, flush/or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials plus any other equipment and accessories etc.				
J		i) Supply	No.			Rate only
K		ii) Install	No.			Rate only
		<u>Fire Alarm Visual Indication (Red)</u>				
		a) Addressable, harsh environment and dust proof, IP65, outdoor, LED visual alarm indicator, for indication of fire alarm system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
L		i) Supply	No.	6		
M		ii) Install	No.	6		
		b) Non-addressable/conventional, harsh environment and dust proof, IP65, outdoor, LED visual alarm indicator, for indication of fire alarm system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
		i) Supply	No.			Rate only
		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Fire Alarm Audible Indication				
		a) Addressable, harsh environment and dust proof, IP65, outdoor, audible alarm indicator, for indication of fire alarm system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes with associated fixing materials and all other equipment and accessories etc.				
P		i) Supply	No.	6		
Q		ii) Install	No.	6		
		b) Non-addressable/conventional, harsh environment and dust proof, IP65, outdoor, audible alarm indicator, for indication of fire alarm system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes with associated fixing materials and all other equipment and accessories etc.				
		i) Supply	No.			Rate only
		ii) Install	No.			Rate only
		Multisensor Heat/Smoke Detectors				
		a) Harsh environment and dust proof, addressable, reduced false alarm multi-sensor heat/smoke type fire detector complete with LED indicator, power supply (if required), all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
T		i) Supply	No.	70		
U		ii) Install	No.	70		
		b) Harsh environment and dust proof, non-addressable/ conventional, reduced false alarm multi-sensor heat/smoke type fire detector complete with LED indicator, power supply (if required), all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
V		i) Supply	No.	27		
W		ii) Install	No.	27		
		Optical Smoke Detectors				
		a) Harsh environment and dust proof, addressable, reduced false alarm optical smoke type fire detector complete with LED indicator, power supply (if required), all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
X		i) Supply	No.			Rate only
Y		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) Harsh environment and dust proof, non-addressable/ conventional, reduced false alarm optical smoke type fire detector complete with LED indicator, power supply (if required), all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
Z		i) Supply	No.			Rate only
AA		ii) Install	No.			Rate only
		Heat Detectors				
		a) Harsh environment and dust proof, addressable, reduced false alarm heat type fire detector complete with LED indicator, power supply (if required), all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AB		i) Supply	No.			Rate only
AC		ii) Install	No.			Rate only
		b) Harsh environment and dust proof, non-addressable/ conventional, reduced false alarm heat type fire detector complete with LED indicator, power supply (if required), all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AD		i) Supply	No.			Rate only
AE		ii) Install	No.			Rate only
		Red Break Glass Unit (Manual Call Point)				
		a) Red break glass, addressable, resettable manual call point unit complete with LED indication, including all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AF		i) Supply	No.	35		
AG		ii) Install	No.	35		
		b) Red break glass, non-addressable/conventional, resettable manual call point unit complete with LED indication, including all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AH		i) Supply	No.			Rate only
AI		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Relay Interface Unit				
		a) Complete automatic activating/deactivating of peripheral devices relay interface unit, with manual test button, 5A @ 220Vac/24Vdc high current activation contacts, 24Vdc power input, 24Vdc alarm signal input, including all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AJ		i) Supply	No.			Rate only
AK		ii) Install	No.			Rate only
		System Input/Output (IO) Interface Unit				
		a) Input/Output interface unit complete with voltage free double pole changeover relay output, single monitored switch input, including all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AL		i) Supply	No.	10		
AM		ii) Install	No.	10		
		Line/Loop Isolator				
		a) Complete line/loop isolator unit for loop overload and short-circuit protection, with LED isolation condition indication and automatic restore after fault correction ability, IP55 enclosure, including all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AN		i) Supply	No.			Rate only
AO		ii) Install	No.			Rate only
		Suppression System Activation Visual Indication				
		a) Addressable, harsh environment and dust proof, IP65, outdoor, LED visual alarm indicator, for indication of suppression system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AP		i) Supply	No.	16		
AQ		ii) Install	No.	16		
		b) Non-addressable/convetional, harsh environment and dust proof, IP65, outdoor, LED visual alarm indicator, for indication of suppression system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AR		i) Supply	No.			Rate only
AS		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Suppression System Activation Audible Indication				
		a) Addressable, harsh environment and dust proof, IP65, outdoor, audible alarm indicator, for indication of suppression system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes with associated fixing materials and all other equipment and accessories etc.				
AT		i) Supply	No.	16		
AU		ii) Install	No.	16		
		b) Non-addressable/conventional, harsh environment and dust proof, IP65, outdoor, audible alarm indicator, for indication of suppression system activation, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes with associated fixing materials and all other equipment and accessories etc.				
AV		i) Supply	No.			Rate only
AW		ii) Install	No.			Rate only
		Suppression System Emergency Stop				
		a) Emergency stop push button, for cancelation of suppression system activation sequence, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
AX		i) Supply	No.	16		
AY		ii) Install	No.	16		
		Suppression System Gas Container Activation Interface Cabling				
AZ		a) Supply and install all interface cabling for activation of the suppression system gas containers, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.	Sum	1		
		Actuated HVAC Vent Shut-off Interface Cabling				
BA		a) Supply and install all interface cabling for activation of the actuated ventilation shut-off units, complete with all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ACCESS CONTROL SYSTEM				
		Access Control Systems Designs				
BB		a) Allow for the appointment of a specialist subcontractor/ OEM to design all new access control systems, for approval by the Employer, in accordance with Code of Practice(s), the specifications/drawings etc. It shall include for all necessary designs for approval, construction drawings, software programming (allow for 3 re-iterations), *Employer* and where applicable supply authority requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
		Access Control Systems Installations				
		Control Panels				
		a) **Substation M:** Complete new 230Vac input (including power supply if required) programmable, access control panel with compatible interface to allow remote programming and data capturing, with all wiring and communications cabling as required, software, flush/or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials and all other equipment and accessories as required etc.				
BC		i) Supply	No.	1		
BD		ii) Install	No.	1		
		b) **Substation N:** Complete new 230Vac input (including power supply if required) programmable, access control panel with compatible interface to allow remote programming and data capturing, with all wiring and communications cabling as required, software, flush/or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials and all other equipment and accessories as required etc.				
BE		i) Supply	No.	1		
BF		ii) Install	No.	1		
		c) **New Main Intake Substation:** Complete new 230Vac input (including power supply if required) programmable, access control panel with compatible interface to allow remote programming and data capturing, with all wiring and communications cabling as required, software, flush/ or surface mounted 25mm dia. 316L stainless steel conduit, round inspection boxes, fixing materials and all other equipment and accessories as required etc.				
BG		i) Supply	No.	1		
BH		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Setup and Monitor Station				
		a) **Substation M:** New laptop PC, complete with the selected system software and associated licencing (Licencing shall be a once off cost and shall be included in the tender pricing). PC minimum specification: i7 Processor, 8GB memory, 2TB hard drive, graphics accelerator and operation system as required by the access control system, including all other accessories etc.				
BI		i) Supply	No.	1		
BJ		ii) Install	No.	1		
		b) **Substation N:** New laptop PC, complete with the selected system software and associated licencing (Licencing shall be a once off cost and shall be included in the tender pricing). PC minimum specification: i7 Processor, 8GB memory, 2TB hard drive, graphics accelerator and operation system as required by the access control system, including all other accessories etc.				
BK		i) Supply	No.	1		
BL		ii) Install	No.	1		
		c) **New Main Intake Substation:** New laptop PC, complete with the selected system software and associated licencing (Licencing shall be a once off cost and shall be included in the tender pricing). PC minimum specification: i7 Processor, 8GB memory, 2TB hard drive, graphics accelerator and operation system as required by the access control system, including all other accessories etc.				
BM		i) Supply	No.	1		
BN		ii) Install	No.	1		
		Door Controller				
		a) Complete new door controller, compatible with the access control system, with all I/O's required, all associated equipment, all wiring and communications cabling, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other accessories etc.				
BO		i) Supply	No.	11		
BP		ii) Install	No.	11		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Door Equipment a) Complete new wall mounted external proximity card reader reader compatible with the access control system, with LED and tone indication, IP65 316L stainless steel powder coated colour (SANS 1091 'B26') openable enclosure (to serve as dust/moisture protection when not used), all wiring and communications cabling, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other accessories etc.				
BQ		i) Supply	No.	0		Rate Only
BR		ii) Install	No.	0		Rate Only
		b) Complete new wall mounted door release button compatible with the access control system, with LED and tone indications, all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other accessories etc.				
BS		i) Supply	No.	0		Rate Only
BT		ii) Install	No.	0		Rate Only
		c) 500kg magnetic door lock complete with LED and tone indication, bracket installed into door frame by door manufacturer (as specified by the architect), compatible with the access control system, all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
BU		i) Supply	No.	11		
BV		ii) Install	No.	11		
		d) Complete door position (open or closed) indication magnets installed into door frame by door manufacturer (as specified by the architect), compatible with the access control system, all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
BW		i) Supply	No.	11		
BX		ii) Install	No.	11		
		e) External IP65 wall mounted heavy duty, metal, door buzzer button compatible with the access control system, complete with LED indication, all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
BY		i) Supply	No.	11		
BZ		ii) Install	No.	11		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) Complete conventional type green break glass resettable manual call point unit with additional I/Os, LED indication, all wiring and communications cabling, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
CA		i) Supply	No.	11		
CB		ii) Install	No.	11		
		g) Complete conventional type green break glass resettable manual call point unit with LED indication, all wiring, flush/or surface mounted 25mm dia. 316L stainless steel conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
CC		i) Supply	No.			Rate only
CD		ii) Install	No.			Rate only
		LABELLING				
CE		a) Labelling of **Substation M's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
CF		b) Labelling of **Substation N's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
CG		c) Labelling of **New Main Intake Substation's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
		TESTING AND COMMISSIONING				
CH		a) Complete testing and commissioning of **Substation M's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
CI		b) Complete testing and commissioning of **Substation N's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
CJ		c) Complete testing and commissioning of the **New Main Intake Substation's** installation as required. **Note: Only suitably qualified and experienced personnel to test and commission the relevant equipment/installations**	Sum	1		
		SUNDRY ITEMS				
CK		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
CL		b) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
CM		c) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
CN		d) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
CO		e) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
CP		f) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
CQ		g) Provision of all manufacturer(s) prescribed critical and recommended spares	Sum	1		
CR		h) All manufacturer(s) prescribed operating equipment, tools etc. for all the *Employer's* equipment etc.	Sum	1		
CS		i) Software and licenses where applicable for all relevant equipment, including programming and copies to the *Employer*	Sum	1		
CT		j) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
CU		k) Accredited/certified operational and maintenance training of *Employer's* staff on the entire new fire detection and access control infrastructure/systems	Sum	1		
CV		l) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
7		**SECTION 7 : HVAC**				
		NOTE This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, and associated operational and maintenance training for *Employer* staff where specified etc.				
		HVAC SYSTEMS DESIGNS				
A		a) Allow for the appointment of a specialist subcontractor/ OEM to design the entire electrical and electronic infrastructure for the new HVAC systems, for acceptance by the *Employer* in accordance with Code(s) of Practice, the specifications/ drawings etc. It shall include for all necessary designs for review, construction drawings, software programming (allow for 3 re-iterations), *Employer* and where applicable supply authority requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
		HVAC SYSTEMS INSTALLATIONS **All equipment/infrastructure shall come complete and fully functional as required, including wiring where applicable, any additional equipment, fixing materials and all other accessories etc.**				
		New Main Intake Substation: Air Handling Unit - AHU 01				
B		a) Air Handling Unit - Supply	No.	1		
C		b) Build unit in position	Sum	1		
D		c) Coil / Fin Treatment (e.g. BuChem or Finguard or equal accepted)	Sum	1		
E		d) Extra over for IE2 (or better) Motors	Sum	1		
F		e) Spare Filters for Return Air Mixing Box	Sum	1		
G		f) Supply Air Attenuator (for 550 x 550 duct)	No.	1		
H		g) Supply Air Duct Manufacture	Sum	1		
I		h) Supply Air Duct Installation	Sum	1		
J		i) Supply Air Duct Insulation	Sum	1		
K		j) Supply Air Grille - SAG 03 - Europair type DD + OBD (250 mm x 150 mm)	No.	4		
L		k) Supply Air Grille - SAG 04 - Europair type DD + OBD (300 mm x 250 mm)	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
M		l) Supply Air Grille - SAG 08 - Europair type DD + OBD (300 mm x 250 mm)	No.	3		
N		m) Motorized Fire Damper (550 mm x 550 mm)	No.	1		
O		n) Motorized Fire Damper (500 mm x 500 mm)	No.	1		
P		o) Motorized Fire Damper (500 mm x 450 mm)	No.	1		
Q		p) Motorized Fire Damper (400 mm x 400 mm)	No.	1		
R		q) Return-air Attenuator (for 350 x 350 duct)	No.	1		
S		r) Return air duct Manufacture	Sum	1		
T		s) Return air duct Installation	Sum	1		
U		t) Return Air Grille - RAG 01 - Europair type RA + OBD (250 mm x 200 mm)	No.	1		
V		u) Return Air Grille - RAG 02 - Europair type RA + OBD (300 mm x 250 mm)	No.	2		
W		v) Motorized Fire Damper (350 mm x 350 mm)	No.	3		
X		w) Motorized Fire Damper (300 mm x 300 mm)	No.	1		
		New Main Intake Substation: Air Handling Unit - AHU 02				
Y		a) Air Handling Unit - Supply	No.	1		
Z		b) Build unit in position	Sum	1		
AA		c) Coil / Fin Treatment (e.g. BuChem or Finguard or equal accepted)	Sum	1		
AB		d) Extra over for IE2 (or better) Motors	Sum	1		
AC		e) Spare Filters for Return Air Mixing Box	Sum	1		
AD		f) Supply-air Attenuator (for 700 x 650 ducting)	No.	1		
AE		g) Supply Air Duct Manufacture	Sum	1		
AF		h) Supply Air Duct Installation	Sum	1		
AG		i) Supply Air Duct Insulation	Sum	1		
AH		j) Supply Air Grille - SAG 09 Europair type DD + OBD (525 mm x 300 mm)	No.	6		
AI		k) Motorized Fire Damper (700 mm x 650 mm)	No.	2		
AJ		l) Return Air Attenuator (for 700 x 650 duct)	No.	1		
AK		m) Return Air Duct Manufacture	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
AL		n) Return Air Duct Installation	Sum	1		
AM		o) Return Air Grille - RAG 03 - Europair type RA + OBD (400 mm x 350 mm)	No.	5		
AN		p) Motorized Fire Damper (650 mm x 600 mm)	No.	2		
		New Main Intake Substation: Air Handling Unit - AHU 03				
AO		a) Air Handling Unit - Supply	No.	1		
AP		b) Build unit in position	Sum	1		
AQ		c) Coil / Fin Treatment (e.g. BuChem or Finguard or equal accepted)	Sum	1		
AR		d) Extra over for IE2 (or better) Motors	Sum	1		
AS		e) Spare Filters for Return Air Mixing Box	Sum	1		
AT		f) Supply-air Attenuator (for 700 x 650 ducting)	No.	1		
AU		g) Supply Air Duct Manufacture	Sum	1		
AV		h) Supply Air Duct Installation	Sum	1		
AW		i) Supply Air Duct Insulation	Sum	1		
AX		j) Supply Air Grille - SAG 09 Europair type DD + OBD (525 mm x 300 mm)	No.	6		
AY		k) Motorized Fire Damper (700 mm x 650 mm)	No.	2		
AZ		l) Return Air Attenuator (for 700 x 650 duct)	No.	1		
BA		m) Return Air Duct Manufacture	Sum	1		
BB		n) Return Air Duct Installation	Sum	1		
BC		o) Return Air Grille - RAG 03 - Europair type RA + OBD (400 mm x 350 mm)	No.	5		
BD		p) Motorized Fire Damper (650 mm x 600 mm)	No.	2		
		New Main Intake Substation: Fresh Air Fan - FAF 01				
BE		a) Supply & install fan, mounts etc. Make and Model as per Fan Schedule	No.	1		
BF		b) Attenuator - By Fan Supplier	No.	1		
BG		c) Flex collars - By Fan Supplier	No.	2		
BH		d) Spin Filter Unit with Purge Fan	No.	1		
BI		e) Duct manufacture	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
BJ		f) Duct installation	Sum	1		
BK		g) Supply Air Grille - SAG 06 / SAG 07 - Europair type DD + OBD (375 mm x 200 mm)	No.	4		
BL		h) Supply Air Grille - SAG 02 - Europair type DD + OBD (250 mm x 150 mm)	No.	1		
BM		i) Supply Air Grille - SAG 04 / SAG 05 - Europair type DD + OBD (300 mm x 250 mm)	No.	3		
BN		j) Supply Air Grille - SAG 01 - Europair type DD + OBD (300 mm x 300 mm)	No.	1		
BO		k) Weather Louvre - 1500 x 1500 complete with 12 x 12 mm stainless steel wire mess screen	No.	1		
BP		l) Connect F/A Ducting to Return Air Ducting	Sum	1		
BQ		m) Motorized Fire Damper - 400 mm x 300 mm	No.	1		
BR		n) Motorized Fire Damper - 250 mm x 250 mm	No.	2		
BS		o) Motorized Fire Damper - 200 mm x 200 mm	No.	2		
		New Main Intake Substation: Chillers				
BT		a) Chiller ACC 01 - Supply	No.	1		Rate Only
BU		b) Chiller ACC 02 - Supply	No.	1		Rate Only
BV		c) Chillers supplied by others to be FAT tested to determine usability	Sum	1		
BW		d) Condenser Coil / Fin Treatment (e.g. Bluchem or Finguard or equal accepted) - per Unit	Sum	2		
BX		e) Chiller Installation - per Unit	Sum	2		
BY		f) Chiller inlet filter - Arkal Type or similar accepted.	No.	2		
BZ		g) Transport & Rigging on Site	Sum	1		
		New Main Intake Substation: Chilled Water Pumps				
CA		a) Chilled Water Pump: CWP 01A & CWP 01B (constant flow)	No.	2		
CB		b) Inertia base (Concrete fill by others)	Sum	2		
CC		c) AVM - Springs	Sum	2		
CD		d) Chilled Water Pump: CWP 02 (constant flow)	No.	1		
CE		e) Inertia base (Concrete fill by others)	Sum	1		
CF		f) AVM - Springs	Sum	1		
CG		g) Variable Speed Drive for pumps CWP 01 & CWP 02	No.	3		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		New Main Intake Substation: Buffer Tank(s)				
CH		a) Supply and installation of new 875 L CW Buffer Tank	Sum	1		
CI		b) Tank insulation	Sum	1		
		New Main Intake Substation: Chemical Dosing Pot				
CJ		a) Supply and installation of new 5 L Chemical Dosing Pot	No.	1		
		New Main Intake Substation: Piping				
CK		a) Piping - Chilled water (to AHUs etc.). Including all valves	Sum	1		
CL		b) Insulation - For chilled water piping and valves	Sum	1		
CM		c) Piping - Potable make-up water. Including all valves	Sum	1		
CN		d) Expansion Tank - bladder type - for potable make-up water	No.	1		
		New Main Intake Substation: HVAC Electrics				
CO		a) Electrical Panel ACP-L0-01. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
CP		b) Electrical Panel ACP-L0-02. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
CQ		c) Site wiring and all other equipment/materials. **Note: To be fully compliant to electrical specifications**	Sum	1		
		New Main Intake Sub: Controls - See BMS Points List				
CR		a) Supply & Installation of HVAC Control Panel. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
CS		b) Interface with BMS (BMS front end by Electrical Contractor)	Sum	1		
		Substation M: Air Handling Unit - AHU 01				
CT		a) Air Handling Unit - Supply	No.	1		
CU		b) Build unit in position	Sum	1		
CV		c) Coil / Fin Treatment (e.g. BuChem or Finguard or equal accepted)	Sum	1		
CW		d) Extra over for IE2 (or better) Motors	Sum	1		
CX		e) Spare Filters for Return Air Mixing Box	Sum	1		
CY		f) Supply Air Attenuator (ATT 03)	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
CZ		g) Supply Air Duct Manufacture	Sum	1		
DA		h) Supply Air Duct Installation	Sum	1		
DB		i) Supply Air Duct Insulation	Sum	1		
DC		j) Supply Air Grille - SAG 01 - TROX Type TR (1125 mm x 325 mm)	No.	10		
DD		k) Balancing damper - BDA 02 - 1125 mm x 325 mm	No.	10		
DE		l) Motorized Fire Damper (1600 mm x 600 mm)	No.	2		
DF		m) Return Air Attenuator (ATT 02)	No.	1		
DG		n) Return Air Duct Manufacture	Sum	1		
DH		o) Return Air Duct Installation	Sum	1		
DI		p) Return Air Grille - RAG 01 - TROX Type TR (800 mm x 300 mm)	No.	10		
DJ		q) Balancing damper - BDA 01 - 850 mm x 300 mm	No.	10		
DK		r) Motorized Fire Damper (850 mm x 600 mm)	No.	2		
DL		s) Motorized Fire Damper (1500 mm x 600 mm)	No.	1		
		Substation M: Air Handling Unit - AHU 02				
DM		a) Air Handling Unit - Supply	No.	1		
DN		b) Build unit in position	Sum	1		
DO		c) Coil / Fin Treatment (e.g. BuChem or Finguard or equal accepted)	Sum	1		
DP		d) Extra over for IE2 (or better) Motors	Sum	1		
DQ		e) Spare Filters for Return Air Mixing Box	Sum	1		
DR		f) Supply Air Attenuator (ATT 04)	No.	1		
DS		g) Supply Air Duct Manufacture	Sum	1		
DT		h) Supply Air Duct Installation	Sum	1		
DU		i) Supply Air Duct Insulation	Sum	1		
DV		j) Supply Air Grille - SAG 02 - Europair Type DD+OBD (480 mm x 250 mm)	No.	5		
DW		k) Motorized Fire Damper (600 mm x 500 mm)	No.	1		
DX		l) Motorized Fire Damper (450 mm x 450 mm)	No.	1		
DY		m) Return Air Attenuator (ATT 01)	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
DZ		n) Return Air Duct Manufacture	Sum	1		
EA		o) Return Air Duct Installation	Sum	1		
EB		p) Return Air Grille - RAG 02 - Europair - (450 mm x 250 mm)	No.	3		
EC		q) Motorized Fire Damper (400 mm x 300 mm)	No.	1		
ED		r) Motorized Fire Damper (450 mm x 400 mm)	No.	1		
		Substation M: Fresh Air Fan - FAF 01				
EE		a) Supply & install fan, mounts etc. Make and Model as per Fan Schedule	No.	1		
EF		b) Attenuators - By Fan Supplier	No.	1		
EG		c) Flex collars - By Fan Supplier	No.	2		
EH		d) Spin Filter Unit with Purge Fan	No.	1		
EI		e) Duct manufacture	Sum	1		
EJ		f) Duct installation	Sum	1		
EK		g) Supply Air Grille - SAG 03 - Europair type DD + OBD (480 mm x 250 mm)	No.	1		
EL		h) Weather Louvre - 1200 x 1200 complete with 12 x 12 mm stainless steel wire mess screen	No.	1		
EM		i) Balancing Damper - BDA 03 - 400 mm x 350 mm	No.	1		
EN		j) Balancing Damper - BDA 04 - 350 mm x 300 mm	No.	1		
EO		k) Connect F/A to Return Air Ducting	Sum	1		
		Substation M: Chillers				
EP		a) Chiller ACC 01 - Supply	No.	1		
EQ		b) Chiller ACC 02 - Supply	No.	1		
ER		c) Chillers supplied by others to be FAT tested to determine usability	Sum	1		
ES		d) Condenser Coil / Fin Treatment (e.g. Bluchem or Finguard or equal accepted) - per Unit	Sum	2		
ET		e) Chiller Installation - per Unit	Sum	2		
EU		f) Chiller inlet filter - Arkal Type or similar accepted.	No.	2		
EV		g) Transport & Rigging on Site	Sum	1		
		Substation M: Chilled Water Pumps				
EW		a) Chilled Water Pump: CWP 01 & CWP 02	No.	2		
EX		b) Inertia base (Concrete fill by others)	Sum	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
EY		c) AVM - Springs	Sum	2		
EZ		d) Variable Speed Drive for pumps CWP 01 & CWP 02	No.	2		
		Substation M: Buffer Tank(s)				
FA		a) Supply and installation of new 1240 L CW Buffer Tank	Sum	1		
FB		b) Tank insulation	Sum	1		
		New Main Intake Substation: Chemical Dosing Pot				
FC		a) Supply and installation of new 5 L Chemical Dosing Pot	No.	1		
		Substation M: Piping				
FD		a) Piping - Chilled water (to AHUs etc.). Including all valves	Sum	1		
FE		b) Insulation - For chilled water piping and valves	Sum	1		
FF		c) Piping - Potable make-up water. Including all valves	Sum	1		
FG		d) Expansion Tank - bladder type - for potable make-up water	No.	1		
		Substation M: HVAC Electrics				
FH		a) Electrical Panel ACP-L0-01. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
FI		b) Electrical Panel ACP-L0-02. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
FJ		c) Site wiring and all other equipment/materials. **Note: To be fully compliant to electrical specifications**	Sum	1		
		Substation M: Controls - See BMS Points List				
FK		a) Supply & Installation of HVAC Control Panel. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
FL		b) Interface with BMS (BMS front end by Electrical Contractor)	Sum	1		
		Substation N: Air Handling Unit - AHU 01				
FM		a) Air Handling Unit - Supply	No.	1		
FN		b) Build unit in position	Sum	1		
FO		c) Coil / Fin Treatment (e.g. BuChem or Finguard or equal accepted)	Sum	1		
FP		d) Extra over for IE2 (or better) Motors	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
FQ		e) Spare Filters for Return Air Mixing Box	Sum	1		
FR		f) Supply Air Attenuator (ATT 04)	No.	1		
FS		g) Supply Air Duct Manufacture	Sum	1		
FT		h) Supply Air Duct Installation	Sum	1		
FU		i) Supply Air Duct Insulation	Sum	1		
FV		j) Supply Air Grille - SAG 01 - TROX Type TR (1125 mm x 325 mm)	No.	12		
FW		k) Balancing damper - BDA 02 - 1125 mm x 325 mm	No.	12		
FX		l) Motorized Fire Damper (2150 mm x 600 mm)	No.	2		
FY		m) Return Air Attenuator (ATT 03)	No.	1		
FZ		n) Return Air Duct Manufacture	Sum	1		
GA		o) Return Air Duct Installation	Sum	1		
GB		p) Return Air Grille - RAG 01 - TROX Type TR (800 mm x 300 mm)	No.	12		
GC		q) Balancing damper - BDA 01 - 850 mm x 300 mm	No.	12		
GD		r) Motorized Fire Damper (1100 mm x 600 mm)	No.	2		
GE		s) Motorized Fire Damper (2000 mm x 600 mm)	No.	1		
		Substation N: Air Handling Unit - AHU 02				
GF		a) Air Handling Unit - Supply	No.	1		
GG		b) Build unit in position	Sum	1		
GH		c) Coil / Fin Treatment (e.g. BuChem or Finguard or equal accepted)	Sum	1		
GI		d) Extra over for IE2 (or better) Motors	Sum	1		
GJ		e) Spare Filters for Return Air Mixing Box	Sum	1		
GK		f) Supply Air Attenuator (ATT 02)	No.	1		
GL		g) Supply Air Duct Manufacture	Sum	1		
GM		h) Supply Air Duct Installation	Sum	1		
GN		i) Supply Air Duct Insulation	Sum	1		
GO		j) Supply Air Grille - SAG 02 - Europair Type DD+OBD (480 mm x 250 mm)	No.	3		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
GP		k) Supply Air Grille - SAG 03 - Europair Type DD+OBD (480 mm x 250 mm)	No.	2		
GQ		l) Motorized Fire Damper (600 mm x 500 mm)	No.	1		
GR		m) Motorized Fire Damper (450 mm x 450 mm)	No.	1		
GS		n) Return Air Attenuator (ATT 01)	No.	1		
GT		o) Return Air Duct Manufacture	Sum	1		
GU		p) Return Air Duct Installation	Sum	1		
GV		q) Return Air Grille - RAG 02 - Europair - (450 mm x 250 mm)	No.	3		
GW		s) Motorized Fire Damper (400mm x 300mm)	No.	1		
GX		t) Motorized Fire Damper (450mm x 400mm)	No.	1		
		Substation N: Fresh Air Fan - FAF 01				
GY		a) Supply & install fan, mounts etc. Make and Model as per Fan Schedule	No.	1		
GZ		b) Attenuators - By Fan Supplier	No.	1		
HA		c) Flex collars - By Fan Supplier	No.	2		
HB		d) Spin Filter Unit with Purge Fan	No.	1		
HC		e) Duct manufacture	Sum	1		
HD		f) Duct installation	Sum	1		
HE		g) Supply Air Grille - SAG 04 - Europair type DD+OBD (250 mm x 200 mm)	No.	1		
HF		h) Weather Louvre - 1200 x 1200 complete with 12 x 12 mm stainless steel wire mess screen	No.	1		
HG		i) Balancing Damper - BDA 03 - 400 mm x 400 mm	No.	1		
HH		j) Balancing Damper - BDA 04 - 450 mm x 350 mm	No.	1		
HI		k) Connect F/A to Return Air Ducting	No.	1		
		Substation N: Chillers				
HJ		a) Chiller ACC 01 - Supply	No.	1		
HK		b) Chiller ACC 02 - Supply	No.	1		
HL		c) Chillers supplied by others to be FAT tested to determine usability	Sum	1		
HM		d) Condenser Coil / Fin Treatment (e.g. Bluchem or Finguard or equal accepted) - per Unit	Sum	2		
HN		e) Chiller Installation - per Unit	Sum	2		
HO		f) Chiller inlet filter - Arkal Type or similar accepted.	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
HP		g) Transport & Rigging on Site	Sum	1		
		Substation N: Chilled Water Pumps				
HQ		a) Chilled Water Pump: CWP 01 & CWP 02	No.	2		
HR		b) Inertia base (Concrete fill by others)	Sum	2		
HS		c) AVM - Springs	Sum	2		
HT		d) Variable Speed Drive for pumps CWP 01 & CWP 02	No.	2		
		Substation N: Buffer Tank(s)				
HU		a) Supply and installation of new 1585 L CW Buffer Tank	Sum	1		
HV		b) Tank insulation	Sum	1		
		New Main Intake Substation: Chemical Dosing Pot				
HW		a) Supply and installation of new 5 L Chemical Dosing Pot	No.	1		
		Substation N: Piping				
HX		a) Piping - Chilled water (to AHUs etc.). Including all valves	Sum	1		
HY		b) Insulation - For chilled water piping and valves	Sum	1		
HZ		c) Piping - Potable make-up water. Including all valves	Sum	1		
IA		d) Expansion Tank - bladder type - for potable make-up water	No.	1		
		Substation N: HVAC Electrics				
IB		a) Electrical Panel ACP-L0-01. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
IC		b) Electrical Panel ACP-L0-02. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
ID		c) Site wiring and all other equipment/materials. **Note: To be fully compliant to electrical specifications**	Sum	1		
		Substation N: Controls - See BMS Points List				
IE		a) Supply & Installation of HVAC Control Panel. **Note: Panel 3CR12 or 316L S/S, IP54 or IP65 depending on location and powder coated SANS 1091 'B26' electric orange colour - See electrical specifications**	Sum	1		
IF		b) Interface with BMS (BMS front end by Electrical Contractor)	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		LABELLING				
IG		a) Labelling of **Substation M's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
IH		b) Labelling of **Substation N's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
II		c) Labelling of **New Main Intake Substation's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
		TESTING AND COMMISSIONING				
IJ		a) Complete testing and commissioning of **Substation M's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
IK		b) Complete testing and commissioning of **Substation N's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
IL		c) Complete testing and commissioning of the **New Main Intake Substation's** installation as required. **Note: Only suitably qualified and experienced personnel to test and commission the relevant equipment/installations**	Sum	1		
		SUNDRY ITEMS				
IM		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
IN		b) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
IO		c) Factory acceptance tests	Sum	1		
IP		d) Site acceptance tests	Sum	1		
IQ		e) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
IR		f) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
IS		g) Cold galv, aluminium spray, paint and all other associated material for repair to any steel equipment etc.	Sum	1		
IT		h) Provision of any additional manufacturer(s) prescribed critical and recommended spares	Sum	1		
IU		i) All manufacturer(s) prescribed operating equipment, tools etc. for all the *Employer's* equipment where applicable etc.	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
IV		j) Software and licenses where applicable for all relevant equipment, including programming and copies to the client	Sum	1		
IW		k) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
IX		l) Accredited/certified operational and maintenance training of *Employer's* staff on the entire HVAC infrastructure/system	Sum	1		
IY		m) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
8		**SECTION 8 : FIRE SUPPRESSION**				
		NOTE				
		This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, and associated operational and maintenance training for *Employer* staff where specified etc.				
		All equipment/infrastructure shall come complete and fully functional as required, including wiring where applicable, any additional equipment, fixing materials and all other accessories etc.				
		SUBSTATION M - VSD AND TRANSFORMER ROOM FIRE SUPPRESSION				
A		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
B		b) Installation Fees	Sum	1		
C		c) Warning Signs	Sum	1		
D		d) Interface with Fire Detection System	Sum	1		
		SUBSTATION M - MV SWITCHGEAR ROOM FIRE SUPPRESSION				
E		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
F		b) Installation Fees	Sum	1		
G		c) Warning Signs	Sum	1		
H		d) Interface with Fire Detection System	Sum	1		
		SUBSTATION M - LV AND ELECTRONICS ROOM FIRE SUPPRESSION				
I		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
J		b) Installation Fees	Sum	1		
K		c) Warning Signs	Sum	1		
L		d) Interface with Fire Detection System	Sum	1		
		SUBSTATION M - FIRE EXTINGUISHERS				
M		a) Supply, delivery, and installation of 4.5 kg DCP extinguishers as indicated on the Fire Plan, complete with chevron type backing boards	No.	2		
N		b) Supply, delivery, installation of 5 kg CO_2 extinguishers as indicated on the Fire Plan, complete with chevron type backing boards	No.	3		

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
O		c) Supply, delivery, installation of 25 kg Mobile DCP extinguishers as indicated on the Fire Plan	No.	1		
		SUBSTATION M - FIRE SAFETY SIGNAGE				
P		a) Supply and mounting of the escape signage (White on Green) as per the Fire Plan, 150 x 150, in accordance with SANS 1186:	No.	10		
Q		b) Supply and mounting of the Exit signs (Red on White) as per the Fire Plan, 150 high, in accordance with SANS 1186:	No.	8		
R		c) Supply and mounting of the information signage (Red on White) as per the Fire Plan, 150 x 150 in accordance with SANS 1186:	No.	12		
		SUBSTATION N - VSD AND TRANSFORMER ROOM FIRE SUPPRESSION				
S		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
T		b) Installation Fees	Sum	1		
U		c) Warning Signs	Sum	1		
V		d) Interface with Fire Detection System	Sum	1		
		SUBSTATION N - MV SWITCHGEAR ROOM FIRE SUPPRESSION				
W		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
X		b) Installation Fees	Sum	1		
Y		c) Warning Signs	Sum	1		
Z		d) Interface with Fire Detection System	Sum	1		
		SUBSTATION N - LV AND ELECTRONICS ROOM FIRE SUPPRESSION				
AA		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
AB		b) Installation Fees	Sum	1		
AC		c) Warning Signs	Sum	1		
AD		d) Interface with Fire Detection System	Sum	1		
		SUBSTATION N - FIRE EXTINGUISHERS				
AE		a) Supply, delivery, and installation of 4.5 kg DCP extinguishers as indicated on the Fire Plan, complete with chevron type backing boards	No.	2		
AF		b) Supply, delivery, installation of 5 kg CO_2 extinguishers as indicated on the Fire Plan, complete with chevron type backing boards	No.	3		
AG		c) Supply, delivery, installation of 25 kg Mobile DCP extinguishers as indicated on the Fire Plan	No.	1		

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUBSTATION N - FIRE SAFETY SIGNAGE				
AH		a) Supply and mounting of the escape signage (White on Green) as per the Fire Plan, 150 x 150, in accordance with SANS 1186:	No.	10		
AI		b) Supply and mounting of the Exit signs (Red on White) as per the Fire Plan, 150 high, in accordance with SANS 1186:	No.	8		
AJ		c) Supply and mounting of the information signage (Red on White) as per the Fire Plan, 150 x 150 in accordance with SANS 1186:	No.	12		
		NEW MAIN INTAKE SUBSTATION - MV SWITCHGEAR ROOM FIRE SUPPRESSION				
AK		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
AL		b) Installation Fees	Sum	1		
AM		c) Warning Signs	Sum	1		
AN		d) Interface with Fire Detection System	Sum	1		
		NEW MAIN INTAKE SUBSTATION - RELAY ROOM FIRE SUPPRESSION				
AO		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
AP		b) Installation Fees	Sum	1		
AQ		c) Warning Signs	Sum	1		
AR		d) Interface with Fire Detection System	Sum	1		
		NEW MAIN INTAKE SUBSTATION - METERING ROOM FIRE SUPPRESSION				
AS		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
AT		b) Installation Fees	Sum	1		
AU		c) Warning Signs	Sum	1		
AV		d) Interface with Fire Detection System	Sum	1		
		NEW MAIN INTAKE SUBSTATION - SCADA ROOM FIRE SUPPRESSION				
AW		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
AX		b) Installation Fees	Sum	1		
AY		c) Warning Signs	Sum	1		
AZ		d) Interface with Fire Detection System	Sum	1		

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		NEW MAIN INTAKE SUBSTATION - LV ROOM FIRE SUPPRESSION				
BA		a) Design and supply of a comprehensive fire protection system utilising a full flood gas suppression system	Sum	1		
BB		b) Installation Fees	Sum	1		
BC		c) Warning Signs	Sum	1		
BD		d) Interface with Fire Detection System	Sum	1		
		NEW MAIN INTAKE SUBSTATION - FIRE EXTINGUISHERS				
BE		a) Supply, delivery, and installation of 4.5 kg DCP extinguishers as indicated on the Fire Plan, complete with chevron type backing boards	No.	6		
BF		b) Supply, delivery, installation of 5 kg CO2 extinguishers as indicated on the Fire Plan, complete with chevron type backing boards	No.	6		
BG		c) Supply, delivery, installation of 25 kg Mobile DCP extinguishers as indicated on the Fire Plan	No.	2		
		NEW MAIN INTAKE SUBSTATION - FIRE SAFETY SIGNAGE				
BH		a) Supply and mounting of the escape signage (White on Green) as per the Fire Plan, 150 x 150, in accordance with SANS 1186:	No.	44		
BI		b) Supply and mounting of the Exit signs (Red on White) as per the Fire Plan, 150 high, in accordance with SANS 1186:	No.	2		
BJ		c) Supply and mounting of the information signage (Red on White) as per the Fire Plan, 150 x 150 in accordance with SANS 1186:	No.	16		
		ESKOM 132kV CONTROL BUILDING - FIRE PROTECTION				
BK		a) Supply, delivery, and installation of 4.5 kg DCP extinguishers within the Control Room, complete with chevron type backing boards	No.	1		
BL		b) Supply and mounting of the Exit signs (Red on White) as per the Fire Plan, 150 high, in accordance with SANS 1186:	No.	2		
		CERTIFICATION BY INSTALLER				
BM		a) **Substation M:** Certification of system and components on completion of work in terms of SANS 10400 Part T for the fire protection equipment	Sum	1		
BN		b) **Substation M:** Completion certificate and documentation satisfying the requirements of SANS 15779	Sum	1		
BO		c) **Substation N:** Certification of system and components on completion of work in terms of SANS 10400 Part T for the fire protection equipment	Sum	1		

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
BP		d) **Substation N:** Completion certificate and documentation satisfying the requirements of SANS 15779	Sum	1		
BQ		e) **New Main Intake Substation:** Certification of system and components on completion of work in terms of SANS 10400 Part T for the fire protection equipment	Sum	1		
BR		f) **New Main Intake Substation:** Completion certificate and documentation satisfying the requirements of SANS 15779	Sum	1		
		LABELLING AND SIGNAGE				
BS		a) Any additional labelling and signage of **Substation M's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
BT		b) Any additional labelling and signage of **Substation N's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
BU		c) Any additional labelling and signage of **New Main Intake Substation's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
BV		d) Any additional labelling and signage of **Eskom 132kV Control Building's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete. **Note: Eskom requirements to be included**	Sum	1		
		TESTING AND COMMISSIONING				
BW		a) Complete testing and commissioning of **Substation M's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
BX		b) Complete testing and commissioning of **Substation N's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
BY		c) Complete testing and commissioning of the **New Main Intake Substation's** installation as required. **Note: Only suitably qualified and experienced personnel to test and commission the relevant equipment/installations**	Sum	1		
BZ		d) Complete testing and commissioning of the **Eskom 132kV Control Building's** installation as required. **Note: Only suitably qualified and experienced personnel to test and commission the relevant equipment/ installations. Eskom requirements to be included as well if applicable**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUNDRY ITEMS				
CA		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		Rate Only
CB		b) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		Rate Only
CC		c) Factory acceptance tests	Sum	1		Rate Only
CD		d) Site acceptance tests	Sum	1		Rate Only
CE		e) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. required as part of the fire suppression installation, if any. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
CF		f) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
CG		g) Cold galv, aluminium spray, paint and all other associated material for repair to any steel equipment etc.	Sum	1		
CH		h) All manufacturer(s) prescribed operating equipment, tools etc. for all the Employer's equipment where applicable etc.	Sum	1		
CI		i) Provision of any additional manufacturer(s) prescribed critical and recommended spares	Sum	1		
CJ		j) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
CK		k) Accredited/certified operational and maintenance training of *Employer's* staff on the entire fire suppression/protection systems. **Note: Excludes Eskom portions**	Sum	1		
CL		l) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
CM		a)				
CN		b)				
CO		c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9		**SECTION 8 : PROTECTION AND METERING** **NOTE** This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc. **All steel fixing materials to be of the 316L stainless steel type, unless otherwise specified and/or required to sections of supply authority** **PROTECTION AND METERING SYSTEMS DESIGNS**				
A		a) Allow for the appointment of a specialist subcontractor/OEM to design the entire new protection and metering systems, including interlocking, for approval by the *Employer* in accordance with Code of Practice(s), the specifications/ drawings etc. It shall include for all necessary designs for approval, construction drawings, software programming (allow for 3 re-iterations), *Employer* and where applicable supply authority requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PROTECTION AND METERING SYSTEMS INSTALLATIONS **<u>New Main Intake Substation</u>** a) **Transformer Protection Scheme:** Complete and fully functional, in swing frame panel, including but not limited to the following equipment/functionality: - 110V DC supply voltage - 1 A rated secondary current - Overcurrent and Earth Fault (Hi-set & IDMT), Sustained Earth Fault - Two-winding Differential, including HV & MV Restricted Earth Fault - Over-Flux Protection - Tap Change Overcurrent Blocking - Over-/Under Voltage - Over-/Under Frequency - Arc-flash detection in all air-insulated compartments of indoor-switchgear panels - Voltage Selection - Unit Protection including Buchholtz, Pressure Relief, Oil and Winding Temperature for transformer and OLTC - Circuit Breaker Fail - Master Trip - Hardwired Protection Not Healthy - Remote Control of all MV (indoor) disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Unscaled, Transducer-drive Ammeter (0-5 mA) - Include all station earthing, wiring, materials, blanking plates, panels, fixing materials and all other accessories as required. **Note: (1) ABB RET 630 or equal approved (2) Panel 3CR12 and powder coated SANS 1091 'B26' Electric Orange colour**				
B		i) Supply	No.	2		
C		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **Tap Changer Protection & Control Scheme:** Complete and fully functional, mounted in transformer protection swing frame panel, including but not limited to the following equipment/functionality: - 110V DC supply voltage - 1 A rated secondary current - Manual, Remote and Auto Voltage Regulation Capability - Overcurrent Blocking - Voltage Selection - Tap Change Panel/Drive Not Healthy - BCD tap position indicator and encoder - With RJ45 and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant (Ethernet) - Include all station earthing, wiring, materials, blanking plates, fixing materials and all other accessories as required. **Note: Eberle REG-DA or equal approved**				
D		i) Supply	No.	2		
E		ii) Install	No.	2		
		c) **Meter Panel:** Complete and fully functional, including but not limited to 6 x Schneider ION8800 or equal approved PW Class 0.2S 1A 110Vdc input meters, all with RJ45 and USB connector ports, ethernet comms ability, any protocol interface cards, all station earthing, wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses, panel, fixing materials and all other accessories as required etc. **Note: (1) Include IEC 61850 communication option. (2) Include EtherGate communication option. (3) Include 3 x Essailec Racks for ION8800. (4) Include inter-meter wiring for EtherGate communication. (5) Panel 3CR12 and powder coated SANS 1091 'B26' Electric Orange colour (6) All panels may not require the full quantities of meters as specified, this shall be taken into account in the rates as not to have more meters than required**				
F		i) Supply	No.	3		
G		ii) Install	No.	3		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) **Feeder Protection Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Cable Differential - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - Voltage selection for protection and metering circuits - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - To be installed on the switchgear front-panel of the LV compartment - Include all wiring, materials, blanking plates, fixing materials and all other accessories as required etc. **Note: ABB RED 615 or equal approved**				
H		i) Supply	No.	4		
I		ii) Install	No.	4		
		e) Feeder Protection Scheme: Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Cable Differential - **Additional Siemens (Reyrolle) 7SG18 Solkor-N Current Differential Protection relay with hardwired (RS485) communication and fibre differential communication** - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Voltage selection for protection and metering circuits - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - To be installed on the switchgear front-panel of the LV compartment - Include all wiring, materials, blanking plates, fixing materials and all other accessories as required etc. **Note: ABB RED 615 or equal approved**				
J		i) Supply	No.	8		
K		ii) Install	No.	8		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) **Bus Section protection and Control Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - To be installed on the switchgear front-panel of the LV compartment - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Include all wiring, materials, blanking plates, fixing materials and all other accessories as required etc. **Note: ABB REF 615 or equal approved**				
L		i) Supply	No.	4		
M		ii) Install	No.	4		
N		g) Complete automatic load management system to ensure load is evenly distributed between the two busbars of the double busbar systems, including control module, protocol and conversion module(s), wiring and all other equipment and accessories etc.	Sum	1		
		h) **Junction Box:** Complete VRW20 unit with 6 circuit CT insert (Fitted), wiring, fixing materials and all other accessories in accordance with Eskom specifications. **Note: Panel 316L stainless steel and powder coated SANS 1091 'B26' Electric Orange colour**				
O		i) Supply	No.	2		
P		ii) Install	No.	2		
		i) **Plug Box:** Complete VRW20 unit, with 1 x 3-phase, 5 Pin 32A welding socket, 2 x 16A switched sockets, 1 x 63A ELU, internal wiring, fixing materials and all other accessories in accordance with Eskom specifications. **Note: Panel 316L stainless steel and powder coated SANS 1091 'B26' Electric Orange colour**				
Q		i) Supply	No.	2		
R		ii) Install	No.	2		
		j) **Interface Junction Box:** Complete VRW20 unit with double busbar isolator insert CT & VT tray (Fitted) and additional 63A three-pole isolator, including wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing D-DT-5403 SAP Number 0185255. **Note: Panel 316L stainless steel and powder coated/painted SANS 1091 'B26' Electric Orange colour**				
S		i) Supply	No.	1		
T		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Eskom (Ystervark) Substation a) **132/66kV Feeder Protection & Control Scheme:** Complete and fully functional in accordance with Eskom requirements, including but not limited to the following equipment/ functionality: **4FZD3920** Production Unit Scheme Three-Pole for 110V DC With 1A CT Inputs, with options, and as detailed in design drawings and to Eskom Buyers Guide Specification No. **D-DT-9051 Set 29 Sht 3.** SAP Numbers: - **0248558:** 4FZD3920 Production unit for 110Vdc (THREE-POLE) with 1550nm F/O Teleprotection and attenuators (if required) - **0248588:** Busbar Voltage selection relays for double busbar VT selection - **0248585:** IEC 61850 Remote Engineering Access Via Ethernet And Local Testing Option - **0248587:** Three-terminal Differential option with additional fibre teleprotection and communication card. **- 048564**: Installation of scheme into Swing-frame Panel complete with blanking plates - Include panel earthing as per D-DT-5240				
U		i) Supply	No.	2		
V		ii) Install	No.	2		
		b) **132/66kV Feeder Protection & Control Scheme:** Feeder protection panels equipped with 4RF1100 Production Scheme modified for IPP applications for 110V DC With 1A CT Inputs, complete with options, complete, to specification and as detailed in design drawings and to Eskom Buyers Guide Specification No. D-DT-9048 Set 15 Sht 12. SAP Numbers: - 0583094: 4RF1101 Production unit for 110Vdc with serial supervisory & control and hardwired PNH - 0224951: Panel, Swing-frame including planking plates - 0224955: Optional second rear communication port for MiCOM P145 relay. - 0404056: USB to DB9 male "straight through" serial communication cable - MIMIC Board added as per IPP modifications - Include panel earthing as per D-DT-5240				
W		i) Supply	No.	3		
X		ii) Install	No.	3		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **132/66kV Buszone Scheme:** Complete and fully functional in accordance with Eskom requirements, including but not limited to the following equipment/ functionality: **4BZ5700** scheme mounted in a dual entry swing frame panel with blanking plates. - Two zone high imp BZ prot scheme c/w check zone for double BB with 8 bays + a bus coupler bay. - Scheme suitable for 110 Vdc voltage supply. Wired for 1 Amp Current Transformer rating. (May be modified on site for 5A). - Scheme Master drawings: **D-DT-9049 Set 14 Sht 4.** SAP Number: **0224971** - Include panel earthing as per D-DT-5240				
Y		i) Supply	No.	1		
Z		ii) Install	No.	1		
		d) **AC/DC Distribution Panel:** Complete and fully functional with swing frame cabinet and blanking plates, panel earthing as per D-DT-5240, to specification and as indicated on drawings and to Eskom Buyers Guide, and procured from an Eskom-approved Supplier. Include the following modules: I) **1 x 110V to 50V Duel Converter**				
AA		i) Supply	No.	1		
AB		ii) Install	No.	1		
		II) **1 x 230V 3-phase AC Module complete** ESKOM DRAWING **D-DT-9203 Set 4 Sht 4** SAP Number: **0216215**				
AC		i) Supply	No.	2		
AD		ii) Install	No.	2		
		III) **1 x AC Supply Module complete** ESKOM DRAWING **D-DT-9203 Set 4 Sht 3** SAP Number: **0175669**				
AE		i) Supply	No.	1		
AF		ii) Install	No.	1		
		IV) **1 x 110V DC Distribution Module complete** ESKOM DRAWING **D-DT-9203 Set 4 Sht 4** SAP Number: **0216216**				
AG		i) Supply	No.	2		
AH		ii) Install	No.	2		
		V) **1 x DC Interface Module complete** ESKOM DRAWING **D-DT-9203 Set 4 Sht 3** SAP Number: **0185229**				
AI		i) Supply	No.	1		
AJ		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		VI) **1 x 110V to 50 V DC Supply Module complete**				
AK		i) Supply	No.	1		
AL		ii) Install	No.	1		
		VII) **1 x Battery Charger Module complete** ESKOM DRAWING **D-DT-9243 Set 14 Sht 1** SAP Number: **0217235**				
AM		i) Supply	No.	1		
AN		ii) Install	No.	1		
		VIII) **1 x 110V, 1.1kW SMR Module, complete** ESKOM DRAWING **D-DT-9243 Set 14 Sht 10** SAP Number: **0217242**				
AO		i) Supply	No.	1		
AP		ii) Install	No.	1		
		d) **Batteries**				
		I) **Cell, NICD 1.2V 95AH VTX1 L95 D9308** SAP Number **0256091**				
AQ		i) Supply	No.	85		
AR		ii) Install	No.	85		
		II) **Cabinet, Batt NICD 88C SA Type 3** Standalone Cabinet with fixed steps suitable for 88 of the following cells: VTX1 L: 95 Ah, 140 Ah, 185 Ah VTX1 M: 75 - 150 Ah Combination of 2 x battery cabinets Dimensions: 2 x 650 W x 650 D x 1925 H Safety Sign DCSS 2 (0186196) included SAP Number **0256354**				
AS		i) Supply	No.	1		
AT		ii) Install	No.	1		
		III) **Connectors, VTX Batt Link Set 3** Suitable for connecting 85 - 88 of the following cells in a standalone battery cabinet (0256354): VTX1 L: 95Ah, 140Ah, 185Ah VTX1 M: 75 - 150Ah SAP Number **0256348**				
AU		i) Supply	No.	1		
AV		ii) Install	No.	1		
		e) **Accessories**				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Jug SAP Number **14404** Funnel SAP Number **14405** Hydrometer SAP Number **14402** Thermometer SAP Number **14403** NiCad 90 cell logbook SAP Number **209845** Eyewash Bottle - sealed SAP Number **256069** Faceshield SAP Number **16897** Acid resistant apron - white SAP Number **16895**				
AW		i) Supply	No.	1		
AX		ii) Install	No.	1		
		e) **Metering Panel:** Statistical metering complete to Eskom specifications and **D-DT-9400 Sht 1**. Include: - 1 x 3MM01C SAP number: **0175685** - 2 x Landis Gyr AMD 1&5A Cl 0.5 meter SAP number: **0242582** - 1 x Smartoo GPRS Modem SAP number: **0223364** - 1 x GSM Cellular Patch Antenna SAP number: **0246200** All test blocks, wiring, terminations fused protection swing frame cabinet etc. - Include panel earthing as per D-DT-5240				
AY		i) Supply	No.	1		
AZ		ii) Install	No.	1		
		f) **Metering Panel:** Tariff metering complete to Eskom specifications and **D-DT-9400 Sht 1**. Include: - 3 x 3MM01C SAP number: **0175685** - 6 x Landis Gyr AMD 1A 3Phase Aux meter B2 SAP number: **0242587** - 1 x Smartoo GPRS Modem SAP number: **0223364** - 1 x GSM Cellular Patch Antenna SAP number: **0246200** - 1 x Quality of Supply Module with a Vecto II and summation CTs All test blocks, wiring, terminations fused protection swing frame cabinet etc. - Include panel earthing as per D-DT-5240				
BA		i) Supply	No.	1		
BB		ii) Install	No.	1		
		g) **Junction Box:** Complete VRW20 unit with 8 circuit VT insert (Fitted), wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing **D-DT-5405 SAP Number 0186950. Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
BC		i) Supply	No.	2		
BD		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		h) **Junction Box:** Complete VRW20 unit with metering insert and MCBs rated for Power VT (Fitted), wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing **D-DT-5402 SAP Number 0011623. Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
BE		i) Supply	No.	2		
BF		ii) Install	No.	2		
		i) **Junction Box:** Complete VRW20 unit with 6 circuit CT insert (Fitted), wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing **D-DT-5404 SAP Number 0186961. Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
BG		i) Supply	No.	7		
BH		ii) Install	No.	7		
		j) **Interface Junction Box:** Complete VRW20 unit with double busbar isolator insert CT & VT tray (Fitted), with additional 63A three-pole isolator, including wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing **D-DT-5403 SAP Number 0185255**. **Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
BI		i) Supply	No.	1		
BJ		ii) Install	No.	1		
		k) **Junction Box:** Complete VRW20 unit with double busbar isolator insert CT & VT tray (Fitted), including wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing **D-DT-5403 SAP Number 0185255. Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
BK		i) Supply	No.	5		
BL		ii) Install	No.	5		
		l) **Plug Box:** Complete VRW20 unit, with 1 x 3-phase, 5 Pin 32A welding socket, 2 x 16A switched sockets, 1 x 63A ELU, internal wiring, fixing materials and all other accessories in accordance with Eskom specifications. **Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
BM		i) Supply	No.	6		
BN		ii) Install	No.	6		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		m) **RTU:** Complete and fully functional free standing RTU (GE D20) to Eskom requirements with the following items: 1 x SAP Number **0248402** 110V DC PSU High Power 1 x SAP Number **559974** Config 07 10m VME D20 RTU, 1 D20C, 1 D20S 1 x SAP Number **213368** PB6 800Wx600D cabinet with removable sides, swing frame, "G" rails, earth studs, louvers, 18 holes top and bottom gland with plugs 1 x SAP Number **0248415** D20 EME 10Base-T media interface card 1 x SAP Number **0248413** D20 EME Internal interconnect cable 1 x SAP Number **0248410** D20 EME Ethernet Memory Card, 8MB 1 x SAP Number **0250319** Serial Expansion Kit with MOXA 4 x SAP Number **0250320** Moxa Expansion Kit 2 x SAP Number **248456** Cable Assy, D.20 (M+) 120 inch 2 x SAP Number **0246067** SEL 2830 RS232 to 1300 nm single mode fibre optic transceiver for ranges up to 80 km - Include panel earthing as per D-DT-5240				
BO		i) Supply	No.	1		
BP		ii) Install	No.	1		
		n) **Intermediate Distribution Frame (IDF):** Complete and fully functional Krone Frame 1600Pr IDF C/W 2 x 80W/ 49mm/10Pr BMF unit, including for all frame-mounted fixings, Disconnect Blocks, Label Holders, Disconnect Plugs, wiring etc., complete to Eskom Specification				
BQ		i) Supply	No.	1		
BR		ii) Install	No.	1		
		o) **Switches:** Complete and fully functional RuggedCom RS900 switch with RuggedCom RS416NC-F-RM-HI-XX-3R -3R-3R-3R-TX01-TX01-XX (16 Ports), in accordance with Eskom specifications etc.				
BS		i) Supply	No.	1		
BT		ii) Install	No.	1		
		p) **Substation Data Concentrator (Automation Gateway):** Complete and fully functional Communication Gateway, as per Eskom specifications, with: PassThru SNTP Agent Client/Master - Category 1: MODBUS Client/Master - Category 1: DNP3.0 Client/Master - Category 1: Courier with K-BUS Client/Master - Category 2: IEC 61850 MMS Client Server/Slave - Category 1: DNP3.0 Server/Slave - Category 1:SMP Interconnection to OSIsoft PI				
BU		i) Supply	No.	1		
BV		ii) Install	No.	1		
		q) **Historian:** Complete and fully functional historian unit, as per Eskom specification, with Point Count of 585				
BW		i) Supply	No.	1		
BX		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		r) **Telecontrol:** Complete and fully functional equipment mounted in the Substation Automation/Telecomms cabinet, to Eskom specification, including but not limited to: 1 x SPO 1410 A-DPP OTP (incl. 4x STMn SC module, 8 x STMn module, 10 x GE mapper module, 63 x EI module SAP) Number **554014** 1 x RPM 119 0235/10m LFH Cable SAP Number **554030** 1 x Patch Panel SAP Number **256328** 1 x RDH901 20/C0213 SFP S4.1 SAP Number **249785** 1 x ROA 128 3719/1 SAP Number **553983** 8 x RDH901 20/49800 SFP GP TX SAP Number **249791** 1 x Duplex Patch Lead 10/125 4m Rugged				
BY		i) Supply	No.	1		
BZ		ii) Install	No.	1		
		s) **Substation Automation/Telecommunications Panel:** Complete and fully functional 96-way fibre optic patch panel (ODF) in Telecommunication Cabinet (Glass door, 42U, 600W x 800D) to Eskom specification, with: 1 x 5U Blanking Plate 2 x Brush Plates 1 x 1U Document Tray 1 x 20m Spragg (20mm flexible white tubing)				
CA		i) Supply	No.	1		
CB		ii) Install	No.	1		
		t) Fibre optic 15m ST-ST multimode 2 core fibre patch leads, complete with terminations				
CC		i) Supply	No.	10		
CD		ii) Install	No.	10		
		u) Fibre optic 8m ST-ST multimode 2 core fibre patch leads, complete with terminations				
CE		i) Supply	No.	5		
CF		ii) Install	No.	5		
		v) Fibre optic 30m FC-LC singlemode 2 core fibre patch leads, complete				
CG		i) Supply	No.	10		
CH		ii) Install	No.	10		
		w) Ethernet cable CAT5-E FTP solid core, complete				
CI		i) Supply	m	500		
CJ		ii) Install	m	500		
		x) Ethernet cable CAT5-E FTP solid core terminations, complete (plug and boot)				
		i) Supply	No.	100		
CL		ii) Install	No.	100		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		y) RJ45 to DB9M Converter				
CM		i) Supply	No.	5		
CN		ii) Install	No.	5		
		z) RJ45 to DB9F Converter				
CO		i) Supply	No.	5		
CP		ii) Install	No.	5		
		aa) 16A Double-pole MCBs				
CQ		i) Supply	No.	5		
CR		ii) Install	No.	5		
		Eskom Iscor Substation a) **66kV Feeder Protection & Control Scheme:** **-** Modify on site the existing protection & control scheme to interface with the new 66 kV circuit breakers. Include for all wiring, fixing, lugging, looming, and any other accessories, in accordance with Eskom requirements. - Upgrade the existing protection relays to include the following option: **SAP Number 0248587:** Three-terminal Differential option with additional fibre teleprotection and communication card. Include all costs of supplier of scheme for to travel, accommodation, labour, engineering, etc. - Include training of key Eskom staff and assistance of scheme supplier during testing and commissioning to ensure a fully functional protection system prior to handover.				
CS		i) Supply	No.	2		
CT		ii) Install	No.	2		
		b) **Junction Box:** Complete VRW20 unit with 8 circuit VT insert (Fitted), wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing **D-DT-5405 SAP Number 0186950. Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
CU		i) Supply	No.	2		
CV		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **Junction Box:** Complete VRW20 unit with 6 circuit CT insert (Fitted), wiring, fixing materials and all other accessories in accordance with Eskom specifications - drawing **D-DT-5405 SAP Number 0186950. Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
CW		i) Supply	No.	2		
CX		ii) Install	No.	2		
		d) **Plug Box:** Complete VRW20 unit, with 1 x 3-phase, 5 Pin 32A welding socket, 2 x 16A switched sockets, 1 x 63A ELU, internal wiring, fixing materials and all other accessories in accordance with Eskom specifications. **Note: Panel 316L stainless steel and powder coated SANS 1091 'G29' light grey colour**				
CY		i) Supply	No.	2		
CZ		ii) Install	No.	2		
		e) **Substation Automation/Telecommunications Panel:** Complete and fully functional 96-way fibre optic patch panel (ODF) in Telecommunication Cabinet (Glass door, 42U, 600W x 800D) to Eskom specification, with: 1 x 5U Blanking Plate 2 x Brush Plates 1 x 1U Document Tray 1 x 20m Spragg (20mm flexible white tubing) 20 x Cage Nuts, Bolts with sealing washer 6mm - Include panel earthing as per D-DT-5240				
DA		i) Supply	No.	1		
DB		ii) Install	No.	1		
		f) Fibre optic 15m ST-ST multimode 2 core fibre patch leads, complete with terminations				
DC		i) Supply	No.	10		
DD		ii) Install	No.	10		
		g) Fibre optic 30m FC-LC singlemode 2 core fibre patch leads, complete				
DE		i) Supply	No.	10		
DF		ii) Install	No.	10		
		h) Ethernet cable CAT5-E FTP solid core, complete				
DG		i) Supply	m	100		
DH		ii) Install	m	100		
		i) Ethernet cable CAT5-E FTP solid core terminations, complete				
DI		i) Supply	No.	50		
DJ		ii) Install	No.	50		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Eskom Blouwater Substation a) 66kV Feeder Protection & Control Scheme: - Modify on site the existing protection & control scheme to upgrade the existing protection relays to include the following option: **SAP Number 0248587:** Three-terminal Differential option with additional fibre teleprotection and communication card. Include all costs of supplier of scheme for to travel, accommodation, labour, engineering, etc. - Include training of key Eskom staff and assistance of scheme supplier during testing and commissioning to ensure a fully functional protection system prior to handover.				
DK		i) Supply	No.	2		
DL		ii) Install	No.	2		
		b) Fibre optic 30m FC-LC singlemode 2 core fibre patch leads, complete				
DM		i) Supply	No.	10		
DN		ii) Install	No.	10		
		Substation M a) **Transformer Protection Scheme:** Complete and fully functional, including but not limited to the following equipment/functionality: - 110V DC supply voltage - 1 A rated secondary current - Overcurrent and Earth Fault (Hi-set & IDMT), Sustained Earth Fault - Two-winding Differential, including HV & MV Restricted Earth Fault - Over-Flux Protection - Over-/Under Voltage - Over-/Under Frequency - Arc-flash detection in all air-insulated compartments of indoor-switchgear panels - Unit Protection including Winding Temperature for transformer - Circuit Breaker Fail - Master Trip - Hardwired Protection Not Healthy - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - To be installed on the switchgear front-panel of the LV compartment - Unscaled, Transducer-drive Ammeter (0-5 mA) - Include all wiring, fixing materials and all other accessories etc. **Note: ABB RET 615 or equal approved**				
DO		i) Supply	No.	1		
DP		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **Feeder Protection Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Cable Differential - Over-/Under Voltage - Over-/Under Frequency - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - To be installed on the switchgear front-panel of the LV compartment - Include all wiring, fixing materials and all other accessories etc. **Note: ABB RED 615 or equal approved**				
DQ		i) Supply	No.	7		
DR		ii) Install	No.	7		
		c) **Feeder Protection Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Cable Differential - Over-/Under Voltage - Over-/Under Frequency - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Mirrored/Remote I/O Device for remote tripping from Tippler 3 Transformer protection. Include all required supplies, wiring, fixing, etc. - To be installed on the switchgear front-panel of the LV compartment - Include all wiring, fixing materials and all other accessories etc. **Note: ABB RED 615 or equal approved**				
DS		i) Supply	No.	1		
DT		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) **Feeder Protection Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Arc-flash detection in all air-insulated compartments - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - To be installed on the switchgear front-panel of the LV compartment - Include all wiring, fixing materials and all other accessories etc. **Note: ABB REF 615 or equal approved**				
DU		i) Supply	No.	1		
DV		ii) Install	No.	1		
		e) **Bus Section protection and Control Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - To be installed on the switchgear front-panel of the LV compartment - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Include all wiring, fixing materials and all other accessories etc. **Note: ABB REF 615 or equal approved. For 11 kV bus section**				
DW		i) Supply	No.	1		
DX		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) **Bus Section Control Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - To be installed on the switchgear front-panel of the LV compartment - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - Include all wiring, fixing materials and all other accessories etc. **Note: For 3.3 kV bus section. No incomers or feeders after bus section panel, and as such no protection is specified for this bus section as it is not required currently. It is also assumed that no extension of the 3.3 kV busbar will be required and this section is required only for busbar earthing purposes. Should extension be required in future, a REF 615 or equal approved relay will be required.**				
DY		i) Supply	No.	1		
DZ		ii) Install	No.	1		
		g) **Meter Panel:** Complete and fully functional, including but not limited to 6 x Schneider ION8800 or equal approved PW Class 0.2S 1A 110Vdc input meters, all with RJ45 and USB connector ports, ethernet comms ability, any protocol interface cards, all station earthing, wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses, panel, fixing materials and all other accessories as required etc. **Note: (1) Include IEC 61850 communication option. (2) Include EtherGate communication option. (3) Include 3 x Essailec Racks for ION8800. (4) Include inter-meter wiring for EtherGate communication. (5) Panel 3CR12 and powder coated SANS 1091 'B26' Electric Orange colour (6) All panels may not require the full quantities of meters as specified, this shall be taken into the rates as not to have more meters than required**				
EA		i) Supply	No.	2		
EB		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Substation N a) **Transformer Protection Scheme:** Complete and fully functional, including but not limited to the following equipment/functionality: - 110V DC supply voltage - 1 A rated secondary current - Overcurrent and Earth Fault (Hi-set & IDMT), Sustained Earth Fault - Two-winding Differential, including HV & MV Restricted Earth Fault - Over-Flux Protection - Over-/Under Voltage - Over-/Under Frequency - Arc-flash detection in all air-insulated compartments of indoor-switchgear panels - Unit Protection including Winding Temperature for transformer - Circuit Breaker Fail - Master Trip - Hardwired Protection Not Healthy - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - To be installed on the switchgear front-panel of the LV compartment - Unscaled, Transducer-drive Ammeter (0-5 mA) - Include all wiring, fixing materials and all other accessories etc. **Note: ABB RET 615 or equal approved**				
EC		i) Supply	No.	1		
ED		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **Feeder Protection Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Cable Differential - Over-/Under Voltage - Over-/Under Frequency - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - To be installed on the switchgear front-panel of the LV compartment - Include all wiring, fixing materials and all other accessories etc. **Note: ABB RED 615 or equal approved**				
EE		i) Supply	No.	8		
EF		ii) Install	No.	8		
		c) **Feeder Protection Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Arc-flash detection in all air-insulated compartments - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - To be installed on the switchgear front-panel of the LV compartment - Include all wiring, fixing materials and all other accessories etc. **Note: ABB REF 615 or equal approved**				
EG		i) Supply	No.	1		
EH		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) **Bus Section protection and Control Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Directional & Non-directional Over-current and Earth Fault (Instantaneous & IDMT) - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - To be installed on the switchgear front-panel of the LV compartment - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Include all wiring, fixing materials and all other accessories etc. **Note: ABB REF 615 or equal approved. For 11 kV bus section**				
EI		i) Supply	No.	1		
EJ		ii) Install	No.	1		
		e) **Bus Section Control Scheme:** Complete and fully functional including but not limited to the following equipment/ functionality: - Arc-flash detection in all air-insulated compartments - Remote Control of all disconnectors/breakers by means of remote pendant control unit - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - To be installed on the switchgear front-panel of the LV compartment - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - Include all wiring, fixing materials and all other accessories etc. **Note: For 3.3 kV bus section. No incomers or feeders after bus section panel, and as such protection is specified for this bus section as it is not required currently. It is also assumed that no extension of the 3.3 kV busbar will be required and this section is required only for busbar earthing purposes. Should extension be required in future, a REF 615 or equal approved relay will be required.**				
EK		i) Supply	No.	1		
EL		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) **Meter Panel:** Complete and fully functional, including but not limited to 6 x Schneider ION8800 or equal approved PW Class 0.2S 1A 110Vdc input meters, all with RJ45 and USB connector ports, ethernet comms ability, any protocol interface cards, all station earthing, wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses, panel, fixing materials and all other accessories as required etc. **Note: (1) Include IEC 61850 communication option. (2) Include EtherGate communication option. (3) Include 3 x Essailec Racks for ION8800. (4) Include inter-meter wiring for EtherGate communication. (5) Panel 3CR12 and powder coated SANS 1091 'B26' Electric Orange colour (6) All panels may not require the full quantities of meters as specified, this shall be taken into the rates as not to have more meters than required**				
EM		i) Supply	No.	2		
EN		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Tippler 3 Substation a) **Transformer Protection Scheme:** Complete and fully functional, including but not limited to the following equipment/functionality: - 110V DC supply voltage - 1 A rated secondary current - Overcurrent and Earth Fault (Hi-set & IDMT), Sustained Earth Fault - Two-winding Differential, including HV & MV Restricted Earth Fault - Over-Flux Protection - Over-/Under Voltage - Over-/Under Frequency - Arc-flash detection in all air-insulated compartments of indoor-switchgear panels - Unit Protection including Winding Temperature for transformer - Circuit Breaker Fail - Master Trip - Hardwired Protection Not Healthy - Include all hardware required for interface with pendant control unit, refer to specifications for details of pendant control unit - With RJ45, fibre and USB connector ports, ethernet comms ability, any protocol interface cards, all wiring, LED status indication lights, selector switches, terminal blocks, meter HRC fuses etc. - IEC 61850 compliant - Unscaled, Transducer-drive Ammeter (0-5 mA) - Include all wiring, fixing materials and all other accessories etc. - Mirrored/Remote I/O Device for remote tripping of upstream breaker. Include all required supplies, station earthing, wiring, fixing, etc. - Installed in separate, suitably sized enclosure mounted on the main transformer enclosure. All supplies, equipment, wiring, patch panels, etc. required to be installed in this enclosure. **Note: (1) ABB RET 615 or equal approved (2) See specifications for additional requirements**				
EO		i) Supply	No.	1		
EP		ii) Install	No.	1		
		Substation A a) **Differential Protection:** Siemens (Reyrolle) 7SG18 Solkor-N Current Differential Protection relay with hardwired (RS485) communication and fibre differential communication and fibre differential. Retrofitted to existing switchgear. Allow for decommissioning of existing Solkor Relay, cutting of faceplate of switchgear to fit new relay, installation, all wiring, terminals, test blocks, etc. complete with any other equipment and/or accessories as needed - Allow for local circuit breaker status indication to remote station.				
EQ		i) Supply	No.	2		
ER		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Substation H				
		a) **Differential Protection:** Siemens (Reyrolle) 7SG18 Solkor-N Current Differential Protection relay with hardwired (RS485) communication and fibre differential communication and fibre differential. Retrofitted to existing switchgear. Allow for decommissioning of existing Solkor Relay, cutting of faceplate of switchgear to fit new relay, installation, all wiring, terminals, test blocks, etc. complete with any other equipment and/or accessories as needed. - Allow for local circuit breaker status indication to remote station.				
ES		i) Supply	No.	2		
ET		ii) Install	No.	2		
		Substation J				
		a) **Differential Protection:** Siemens (Reyrolle) 7SG18 Solkor-N Current Differential Protection relay with hardwired (RS485) communication and fibre differential communication and fibre differential. Retrofitted to existing switchgear. Allow for decommissioning of existing Solkor Relay, cutting of faceplate of switchgear to fit new relay, installation, all wiring, terminals, test blocks, etc. complete with any other equipment and/or accessories as needed. - Allow for local circuit breaker status indication to remote station.				
EU		i) Supply	No.	2		
EV		ii) Install	No.	2		
		Substation K				
		a) **Differential Protection:** Siemens (Reyrolle) 7SG18 Solkor-N Current Differential Protection relay with hardwired (RS485) communication and fibre differential communication and fibre differential. Retrofitted to existing switchgear. Allow for decommissioning of existing Solkor Relay, cutting of faceplate of switchgear to fit new relay, installation, all wiring, terminals, test blocks, etc. complete with any other equipment and/or accessories as needed. - Allow for local circuit breaker status indication to remote station.				
EW		i) Supply	No.	2		
EX		ii) Install	No.	2		
		LABELLING				
EY		a) Labelling of this section of the installation as specified and/or required by any applicable SANS standard(s), supply authority requirements including all necessary and correct fixing materials etc. complete	Sum	1		
		TESTING AND COMMISSIONING				
EZ		a) Complete testing and commissioning of this section of the installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment / installations**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUNDRY ITEMS				
FA		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
FB		b) Inspection of all **Type Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
FC		c) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
FD		d) Inspection of all **Routine Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
FE		e) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
FF		f) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
FG		g) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
FH		h) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
FI		i) Provision of all manufacturer(s) prescribed critical and recommended spares. **Note: Excludes Eskom portions**	Sum	1		
FJ		j) All manufacturer(s) prescribed operating equipment, tools etc. for all the *Employer's* equipment etc. **Note: Excludes Eskom portions**	Sum	1		
FK		k) Software and licenses where applicable for all relevant equipment, including programming and copies to the *Employer*	Sum	1		
FL		l) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
FM		m) Complete loading, offloading, rigging, transport, labour etc. to Eskom Brackenfell depot of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
FN		n) Accredited/certified operational and maintenance training of *Employer's* staff on all protection and metering installations with associated equipment etc. **Note: Excludes Eskom portions**	Sum	1		
FO		o) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS a) b) c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
9		**SECTION 9 : MONITORING AND CONTROL**				
		NOTE This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc. **All steel fixing materials to be of the 316L stainless steel type, unless otherwise specified and/or required** **MONITORING AND CONTROL SYSTEMS DESIGNS**				
A		a) Allow for the appointment of a specialist subcontractor/ OEM to design the entire new monitoring and control infrastructure, including but not limited to data networks, BMS, intruder alarm systems, CCTV, VOIP telephone systems if specified, associated equipment etc., for approval by the *Employer* in accordance with Code of Practice(s), the specifications/ drawings etc. It shall include for all necessary designs for approval, construction drawings, software programming (allow for 3 re-iterations), *Employer* and where applicable supply authority requirements etc. complete. **Note: All costs to be included for the provision of services and associated deliverables**	Sum	1		
		SCADA SYSTEMS INSTALLATIONS **Substation M Monitoring and Control and Associated Infrastructure** a) **Metering Panel Switch:** Hirschmann Gigabit Ethernet DIN rail switch or equal approved, with FW release 9 with 9-10 ports: RSR30-0603CCO7T1SC CHPHH09.0 with 3 x singlemode Gigabit ports and 6 x 10/100BASE TX RJ45 ports. Installed in each metering panel, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
A		i) Supply	No.	2		
B		ii) Install	No.	2		
		b) **BMS/MV Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
C		i) Supply	No.	1		
D		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **Plant Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
E		i) Supply	No.	1		
F		ii) Install	No.	1		
		d) **MV Switchgear Switch:** Hirschmann Gigabit Ethernet DIN rail RSP switch or equal approved, 11 ports: RSP-3508033O6ZTEK9V9HPE3S. With 3 x Gigabit SFP/SM-LC ports, 4 x 100BASE SFP/SM-LC and/or 100BASE SFP/MM-LC (pending final design) ports and 4 x 10/100BASE TX RJ45 ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
G		i) Supply	No.	2		
H		ii) Install	No.	2		
		e) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
I		i) Supply	No.	1		
J		ii) Install	No.	1		
		f) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
K		i) Supply	No.			Rate only
L		ii) Install	No.			Rate only
		g) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
M		i) Supply	No.	1		
N		ii) Install	No.	1		
		h) **Power Supply Unit:** For Hirschmann, or equal approved Gigabit Ethernet DIN rail RSP switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
O		i) Supply	No.			Rate only
P		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		i) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
Q		i) Supply	No.	3		
R		ii) Install	No.	3		
		j) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
S		i) Supply	No.	1		
T		ii) Install	No.	1		
		k) **RIO:** Complete and fully functional Siemens ET200, or equal approved, installed in purpose-built cabinet, including but not limited to the following equipment/ functionality:				
		I) DIN rail for active bus modules, 482 mm (19") 6ES7195-1GA00-0XA0				
U		i) Supply	No.	1		
V		ii) Install	No.	1		
		II) IM 153-4 for ET 200M, PROFINET - 6ES7153-4AA01-0XB0				
W		i) Supply	No.	1		
X		ii) Install	No.	1		
		III) Digital Input, 16 DI, 24V DC, isolated - 6ES7321-1BH02-0AA0				
Y		i) Supply	No.	4		
Z		ii) Install	No.	4		
		IV) Digital output, 16 DO, 24V DC, 0.5A, isolated - 6ES7322-1BH01-0AA0				
AA		i) Supply	No.	2		
AB		ii) Install	No.	2		
		V) CP 341 with 1 interface RS 422/485, with config. Package 6ES7341-1CH02-0AE0				
AC		i) Supply	No.	1		
AD		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		VI) Front connector module for digital 16 I/O modules, power supply via spring-loaded terminals - 6ES7921-3AA00-0AA0				
AE		i) Supply	No.	6		
AF		ii) Install	No.	6		
		VII) Micro memory card 6ES7953-8LP31-0AA0				
AG		i) Supply	No.	1		
AH		ii) Install	No.	1		
		VIII) Connecting cable 16-pin shielded with IDC connectors - 6ES7923-0BB00-0DB0				
AI		i) Supply	No.	14		
AJ		ii) Install	No.	14		
		IX) PROFIBUS FC Robust Cable - 6XV1 830-0JH10				
AK		i) Supply	m	900		
AL		ii) Install	m	900		
		X) PROFIBUS FastConnect bus connector RS485 with 90° cable outlet - 6ES7 972-0BB52-0XA0				
AM		i) Supply	No.	20		
AN		ii) Install	No.	20		
		XI) Analog module 4 AI, 4 AO; isolated, alarm, diagnostics – 6ES7335-7HG02-OABO				
AO		i) Supply	No.	1		
AP		ii) Install	No.	1		
		XII) Supply and install enclosure panels complete with hinged door(s), face plates, mounting boards, all wiring, station earthing, terminals, drilled gland plates, circuit breakers, interposing relays on digital outputs and fuses on digital inputs, trunking (colour hospital grey) between equipment and terminals etc., legend card, free space for future use, earth bar/bolt, fixing materials, all other equipment and accessories as required. Each panel to be fully operable and fit for function. RIO enclosures to be 2mm 316L stainless steel, powder coated G29 light grey. Note: Floor fixing materials shall be 316L stainless steel.				
AQ		i) Supply	No.	1		
AR		ii) Install	No.	1		
		XIII) Active bus module for power supply and interface module 153 6ES7195-7HA00-0XA0				
AS		i) Supply	No.	1		
AT		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		XIV) Active bus module for 2 modules 40 mm wide 6ES7195-7HB00-0XA0				
AU		i) Supply	No.	4		
AV		ii) Install	No.	4		
		XV) Load current supply PS 307; AC 120/230V, DC 24V, 2A 6ES7307-1BA01-0AA0				
AW		i) Supply	No.	1		
AX		ii) Install	No.	1		
		XVI) Front connector module for analog modules, power supply via spring-loaded terminals 6ES7921-3AF00-0AA0				
AY		i) Supply	No.	1		
AZ		ii) Install	No.	1		
		XVII) Terminal module TP1 push-in terminals, 8 I/O 6ES7924-0AA20-0AC0				
BA		i) Supply	No.	12		
BB		ii) Install	No.	12		
		XVIII) Terminal module TPA push-in terminals, 16-pin 6ES7924-0CC21-0AC0				
BC		i) Supply	No.	2		
BD		ii) Install	No.	2		
BE		l) Supply and install all wiring, fixing materials and any other equipment and accessories as required etc.	Sum	1		
		m) **Pendant Control Unit:** Remote pendant control switch for remote circuit breaker control. Complete with wiring, fixing materials and all other accessories etc.				
BF		i) Supply	No.	1		
BG		ii) Install	No.	1		
		n) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
BH		i) Supply	No.	4		
BI		ii) Install	No.	4		
		o) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
BJ		i) Supply	No.	5		
BK		ii) Install	No.	5		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		p) **Rack Enclosures:** 47U, 19", floor standing rack enclosure (Maximum height = 2m), with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour Light Grey (G29) Powder Coated**				
BL		i) Supply	No.	4		
BM		ii) Install	No.	4		
		q) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode 50 m				
BN		i) Supply	No.	85		
BO		ii) Install	No.	85		
		II) LC - LC Multi-mode patch lead 25m				
BP		i) Supply	No.	15		
BQ		ii) Install	No.	15		
		III) LC - LC Single-mode patch lead 200m				
BR		i) Supply	No.	15		
BS		ii) Install	No.	15		
		IV) Shielded twisted pair CAT 6A RJ45 patch lead 2.5m				
BT		i) Supply	No.	15		
BU		ii) Install	No.	15		
		Substation N Monitoring and Control and Associated Infrastructure				
		a) **Metering Panel Switch:** Hirschmann Gigabit Ethernet DIN rail switch or equal approved, with FW release 9 with 9-10 ports: RSR30-0603CCO7T1SC CHPHH09.0 with 3 x singlemode Gigabit ports and 6 x 10/100BASE TX RJ45 ports. Installed in each metering panel, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
BV		i) Supply	No.	2		
BW		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **BMS/MV Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
BX		i) Supply	No.	1		
BY		ii) Install	No.	1		
		c) **Plant Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
BZ		i) Supply	No.	1		
CA		ii) Install	No.	1		
		d) **MV Switchgear Switch:** Hirschmann Gigabit Ethernet DIN rail RSP switch or equal approved, 11 ports: RSP-3508033O6ZTEK9V9HPE3S. With 3 x Gigabit SFP/SM-LC ports, 4 x 100BASE SFP/SM-LC and/or 100BASE SFP/MM-LC (pending final design) ports and 4 x 10/100BASE TX RJ45 ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
CB		i) Supply	No.	2		
CC		ii) Install	No.	2		
		e) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
CD		i) Supply	No.	1		
CE		ii) Install	No.	1		
		f) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
CF		i) Supply	No.			Rate only
CG		ii) Install	No.			Rate only
		g) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
CH		i) Supply	No.	1		
CI		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		h) **Power Supply Unit:** For Hirschmann, or equal approved Gigabit Ethernet DIN rail RSP switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
CJ		i) Supply	No.			Rate only
CK		ii) Install	No.			Rate only
		i) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
CL		i) Supply	No.	3		
CM		ii) Install	No.	3		
BX		j) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with CCTV switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
CN		i) Supply	No.	1		
CO		ii) Install	No.	1		
		k) **RIO:** RIO: Complete and fully functional Siemens ET200, or equal approved, installed in purpose-built cabinet, including but not limited to the following equipment/ functionality:				
		I) DIN rail for active bus modules, 482 mm (19") 6ES7195-1GA00-0XA0				
CP		i) Supply	No.	1		
CQ		ii) Install	No.	1		
		II) IM 153-4 for ET 200M, PROFINET - 6ES7153-4AA01-0XB0				
CR		i) Supply	No.	2		
CS		ii) Install	No.	2		
		III) Digital Input, 16 DI, 24V DC, isolated - 6ES7321-1BH02-0AA0				
CT		i) Supply	No.	4		
CU		ii) Install	No.	4		
		IV) Digital output, 16 DO, 24V DC, 0.5A, isolated - 6ES7322-1BH01-0AA0				
CV		i) Supply	No.	2		
CW		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		V) CP 341 with 1 interface RS 422/485, with config. Package 6ES7341-1CH02-0AE0				
CX		i) Supply	No.	1		
CY		ii) Install	No.	1		
		VI) Front connector module for digital 16 I/O modules, power supply via spring-loaded terminals - 6ES7921-3AA00-0AA0				
CZ		i) Supply	No.	6		
DA		ii) Install	No.	6		
		VII) Micro memory card 6ES7953-8LP31-0AA0				
DB		i) Supply	No.	1		
DC		ii) Install	No.	1		
		VIII) Connecting cable 16-pin shielded with IDC connectors - 6ES7923-0BB00-0DB0				
DD		i) Supply	No.	14		
DE		ii) Install	No.	14		
		IX) PROFIBUS FC Robust Cable - 6XV1 830-0JH10				
DF		i) Supply	m	900		
DG		ii) Install	m	900		
		X) PROFIBUS FastConnect bus connector RS485 with 90° cable outlet - 6ES7 972-0BB52-0XA0				
DH		i) Supply	No.	20		
DI		ii) Install	No.	20		
		XI) Analog module 4 AI, 4 AO; isolated, alarm, diagnostics – 6ES7335-7HG02-OABO				
DJ		i) Supply	No.	1		
DK		ii) Install	No.	1		
		XII) Supply and install enclosure panels complete with hinged door(s), face plates, mounting boards, all wiring, station earthing, terminals, drilled gland plates, circuit breakers, interposing relays on digital outputs and fuses on digital inputs, trunking (colour hospital grey) between equipment and terminals etc., legend card, free space for future use, earth bar/bolt, fixing materials, all other equipment and accessories as required. Each panel to be fully operable and fit for function. RIO enclosures to be 2mm 316L stainless steel, powder coated G29 light grey. Note: Floor fixing materials shall be 316L stainless steel				
DL		i) Supply	No.	1		
DM		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		XIII) Active bus module for power supply and interface module 153 6ES7195-7HA00-0XA0				
DN		i) Supply	No.	1		
DO		ii) Install	No.	1		
		XIV) Active bus module for 2 modules 40 mm wide 6ES7195-7HB00-0XA0				
DP		i) Supply	No.	4		
DQ		ii) Install	No.	4		
		XV) Load current supply PS 307; AC 120/230V, DC 24V, 2A 6ES7307-1BA01-0AA0				
DR		i) Supply	No.	1		
DS		ii) Install	No.	1		
		XVI) Front connector module for analog modules, power supply via spring-loaded terminals 6ES7921-3AF00-0AA0				
DT		i) Supply	No.	1		
DU		ii) Install	No.	1		
		XVII) Terminal module TP1 push-in terminals, 8 I/O 6ES7924-0AA20-0AC0				
DV		i) Supply	No.	12		
DW		ii) Install	No.	12		
		XVIII) Terminal module TPA push-in terminals, 16-pin 6ES7924-0CC21-0AC0				
DX		i) Supply	No.	2		
DY		ii) Install	No.	2		
DZ		l) Supply and install all wiring, fixing materials and any other equipment and accessories as required etc.	Sum	1		
		m) **Pendant Control Unit:** Remote pendant control switch for remote circuit breaker control. Complete with wiring, fixing materials and all other accessories etc.				
EA		i) Supply	No.	1		
EB		ii) Install	No.	1		
		n) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
EC		i) Supply	No.	4		
ED		ii) Install	No.	4		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		o) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
EE		i) Supply	No.	5		
EF		ii) Install	No.	5		
		p) **Rack Enclosures:** 47U, 19", floor standing rack enclosure (Maximum height = 2m), with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour Light Grey (G29) Powder Coated**				
EG		i) Supply	No.	4		
EH		ii) Install	No.	4		
		q) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode 50 m				
EI		i) Supply	No.	85		
EJ		ii) Install	No.	85		
		II) LC - LC Multi-mode patch lead 25m				
EK		i) Supply	No.	15		
EL		ii) Install	No.	15		
		III) LC - LC Single-mode patch lead 200m				
EM		i) Supply	No.	15		
EN		ii) Install	No.	15		
		IV) Shielded twisted pair CAT 6A RJ45 patch lead 2.5m				
EO		i) Supply	No.	15		
EP		ii) Install	No.	15		
		New Main Intake Substation Monitoring and Control and Associated Infrastructure				
		a) **Metering/Protection Panel Switch:** Hirschmann Gigabit Ethernet DIN rail switch or equal approved, with FW release 9 with 9-10 ports: RSR30-0603CCO7T1SC CHPHH09.0 with 3 x singlemode Gigabit ports and 6 x 10/100BASE TX RJ45 ports. Installed in each metering panel, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
EQ		i) Supply	No.	5		
ER		ii) Install	No.	5		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **BMS/MV Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
ES		i) Supply	No.	1		
ET		ii) Install	No.	1		
		c) **MV Switchgear Switch:** Hirschmann Gigabit Ethernet DIN rail RSP switch or equal approved, 11 ports: RSP-3508033O6ZTEK9V9HPE3S. With 3 x Gigabit SFP/SM-LC ports, 4 x 100BASE SFP/SM-LC and/or 100BASE SFP/MM-LC (pending final design) ports and 4 x 10/100BASE TX RJ45 ports. Installed in each switchboard, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
EU		i) Supply	No.	1		
EV		ii) Install	No.	1		
		d) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
EW		i) Supply	No.	1		
EX		ii) Install	No.	1		
		e) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
EY		i) Supply	No.			Rate only
EZ		ii) Install	No.			Rate only
		f) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
FA		i) Supply	No.	1		
FB		ii) Install	No.	1		
		g) **Power Supply Unit:** For Hirschmann, or equal approved Gigabit Ethernet DIN rail RSP switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
FC		i) Supply	No.			Rate only
FD		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		h) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
FE		i) Supply	No.	6		
FF		ii) Install	No.	6		
		i) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with PC and switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
FG		i) Supply	No.	1		
FH		ii) Install	No.	1		
		j) **RIO:** Complete and fully functional Siemens ET200, or equal approved, installed in purpose-built cabinet, including but not limited to the following equipment/ functionality:				
		k) DIN rail for active bus modules, 482 mm (19") 6ES7153-4AA01-0XB0				
FI		i) Supply	No.	1		
FJ		ii) Install	No.	1		
		II) IM 153-4 for ET 200M, PROFINET - 6ES7153-4AA01-0XB0				
FK		i) Supply	No.	1		
FL		ii) Install	No.	1		
		III) Digital Input, 16 DI, 24V DC, isolated - 6ES7321-1BH02-0AA0				
FM		i) Supply	No.	4		
FN		ii) Install	No.	4		
		IV) Digital output, 16 DO, 24V DC, 0.5A, isolated - 6ES7322-1BH01-0AA0				
FO		i) Supply	No.	2		
FP		ii) Install	No.	2		
		V) CP 341 with 1 interface RS 422/485, with config. Package 6ES7341-1CH02-0AE0				
FQ		i) Supply	No.	1		
FR		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		VI) Front connector module for digital 16 I/O modules, power supply via spring-loaded terminals - 6ES7921-3AA00-0AA0				
FS		i) Supply	No.	7		
FT		ii) Install	No.	7		
		VII) Micro memory card 6ES7953-8LP31-0AA0				
FU		i) Supply	No.	1		
FV		ii) Install	No.	1		
		VIII) Connecting cable 16-pin shielded with IDC connectors - 6ES7923-0BB00-0DB0				
FW		i) Supply	No.	14		
FX		ii) Install	No.	14		
		IX) PROFIBUS FC Robust Cable - 6XV1 830-0JH10				
FY		i) Supply	m	1 200		
FZ		ii) Install	m	1 200		
		X) PROFIBUS FastConnect bus connector RS485 with 90° cable outlet - 6ES7 972-0BB52-0XA0				
GA		i) Supply	No.	20		
GB		ii) Install	No.	20		
		XI) Analog module 4 AI, 4 AO; isolated, alarm, diagnostics – 6ES7335-7HG02-OABO				
GC		i) Supply	No.	1		
GD		ii) Install	No.	1		
		XII) Supply and install enclosure panels complete with hinged door(s), face plates, mounting boards, all wiring, station earthing, terminals, drilled gland plates, circuit breakers, interposing relays on digital outputs and fuses on digital inputs, trunking (colour hospital grey) between equipment and terminals etc., legend card, free space for future use, earth bar/bolt, fixing materials, all other equipment and accessories as required. Each panel to be fully operable and fit for function. RIO enclosures to be 2mm 316L stainless steel, powder coated G29 light grey. Note: Floor fixing materials shall be 316L stainless steel.				
GE		i) Supply	No.	1		
GF		ii) Install	No.	1		
GG		XII) Supply and install all wiring, fixing materials and any other equipment and accessories as required etc.	Sum	1		
		IV) Active bus module for power supply and interface module 153 6ES7195-7HA00-0XA0				
GH		i) Supply	No.	1		
GI		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		V) Active bus module for 2 modules 40 mm wide 6ES7195-7HB00-0XA0				
GJ		i) Supply	No.	4		
GK		ii) Install	No.	4		
		VI) Load current supply PS 307; AC 120/230V, DC 24V, 2A 6ES7307-1BA01-0AA0				
GL		i) Supply	No.	1		
GM		ii) Install	No.	1		
		VII) Front connector module for analog modules, power supply via spring-loaded terminals 6ES7921-3AF00-0AA0				
GN		i) Supply	No.	1		
GO		ii) Install	No.	1		
		IX) Terminal module TP1 push-in terminals, 8 I/O 6ES7924-0AA20-0AC0				
GP		i) Supply	No.	12		
GQ		ii) Install	No.	12		
		X) Terminal module TPA push-in terminals, 16-pin 6ES7924-0CC21-0AC0				
GR		i) Supply	No.	2		
GS		ii) Install	No.	2		
		XI) Optical Link Module (OLM) G12 1300 series complete with interface module, Profibus Cu cable and connectors (OLM to ET200 RIO), single-mode patch leads and connectors (patch panels to OLM, power supply unit, switchgear, fixing materials and all other associated accessories and equipment etc.				
GT		i) Supply	No.	1		
GU		ii) Install	No.	1		
		l) **Pendant Control Unit:** Remote pendant control switch for remote circuit breaker control. Complete with wiring, fixing materials and all other accessories etc.				
GV		i) Supply	No.	1		
GW		ii) Install	No.	1		
		m) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
GX		i) Supply	No.	6		
GY		ii) Install	No.	6		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		n) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
GZ		i) Supply	No.	7		
HA		ii) Install	No.	7		
		o) **Rack Enclosures:** 47U, 19", floor standing rack enclosure (Maximum height = 2m), with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour Light Grey (G29) Powder Coated**				
HB		i) Supply	No.	4		
HC		ii) Install	No.	4		
		p) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Multi-mode patch lead 25m				
HD		i) Supply	No.	25		
HE		ii) Install	No.	25		
		II) ST-LC Single-mode patch lead 200m				
HF		i) Supply	No.	10		
HG		ii) Install	No.	10		
		III) LC - LC Single-mode patch lead 200m				
HH		i) Supply	No.	20		
HI		ii) Install	No.	20		
		IV) LC - LC Single-mode patch lead 50m				
HJ		i) Supply	No.	125		
HK		ii) Install	No.	125		
		V) Shielded twisted pair CAT 6A RJ45 patch lead 2.5m				
HL		i) Supply	No.	25		
HM		ii) Install	No.	25		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Electronics Workshop				
		a) **Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 4 x RJ45 ports, 12 x Singlemode M-SFP-LX/LC ports, mounted in rack/cabinet with switch. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
HN		i) Supply	No.	1		
HO		ii) Install	No.	1		
		b) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
HP		i) Supply	No.			Rate only
HQ		ii) Install	No.			Rate only
		c) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
HR		i) Supply	No.			Rate only
HS		ii) Install	No.			Rate only
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
HT		i) Supply	No.			Rate only
HU		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
HV		i) Supply	No.	1		
HW		ii) Install	No.	1		
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
HX		i) Supply	No.			Rate only
HY		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		g) **Substation PC:** 19" Rack mountable industrial substation PC, completely configured. Solid state drives 250GB min., 110V DC, i3 Processor min., 8GB RAM min., 2 x serial ports, 4 USB 2.0 ports, 2 x 1GB Ethernet LAN ports. All communication software for remote interrogation of IEDs installed and communication interfaces configured for automated download and storage of events, all wiring, fixing materials and any other equipment and accessories as required complete				
HZ		i) Supply	No.	1		
IA		ii) Install	No.	1		
		h) **Peripherals Combo Tray:** 19" Rack mountable 1U screen, mouse, keyboard combo tray, mounted in rack/ cabinet with PC, complete with wiring, fixing materials and all other accessories etc.				
IB		i) Supply	No.	1		
IC		ii) Install	No.	1		
		i) **Time Synchronisation:** LANTIME M600/MRS/PTP: PTPv2/IEEE 1588-2008 ordinary clock and NTP (GPS antenna included) 19" rack mountable, or equal approved, all wiring, fixing materials and any other equipment and accessories as required complete				
ID		i) Supply	No.	1		
IE		ii) Install	No.	1		
		j) **Storage:** IBM Storwize V7000 10TB, or equal approved, 19" rack mountable storage, with SAN-attached 8 Gbps and 16 Gbps fibre channel, 1 Gbps iSCSI and 10 Gbps iSCSI/ FCoE NAS-attached, 1 Gbps and 10 Gbps Ethernet, HMI, software, including all wiring, fixing materials and any other equipment and accessories as required complete				
IF		i) Supply	No.	1		
IG		ii) Install	No.	1		
		k) **Server:** Dell PowerEdge R930 or equal approved 19" rack mountable server, including all wiring, fixing materials and any other equipment and accessories as required complete				
IH		i) Supply	No.	2		
II		ii) Install	No.	2		
		l) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
IJ		i) Supply	No.	4		
IK		ii) Install	No.	4		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		m) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
IL		i) Supply	No.	5		
IM		ii) Install	No.	5		
		n) **Rack Enclosures:** 47U, 19", floor standing rack enclosure (Maximum height = 2m), with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour black powder coated**				
IN		i) Supply	No.	3		
IO		ii) Install	No.	3		
		o) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 2.5m				
IP		i) Supply	No.	30		
IQ		ii) Install	No.	30		
		II) LC - LC Single-mode patch lead 25m				
IR		i) Supply	No.	30		
IS		ii) Install	No.	30		
		III) LC - LC Single-mode patch lead 100m				
IT		i) Supply	No.	15		
IU		ii) Install	No.	15		
		IV) Shielded twisted pair CAT 6A RJ45 patch lead 1m				
IV		i) Supply	No.	15		
IW		ii) Install	No.	15		
		V) Shielded twisted pair CAT 6A RJ45 patchlead 2.5m				
IX		i) Supply	No.	15		
IY		ii) Install	No.	15		
		VI) Shielded twisted pair CAT 6A RJ45 patch lead 25m				
IZ		i) Supply	No.	15		
JA		ii) Install	No.	15		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Central Control Room (CCR)				
		a) **Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 4 x RJ45 ports, 12 x Singlemode M-SFP-LX/LC ports, mounted in rack/cabinet with switch. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
JB		i) Supply	No.	1		
JC		ii) Install	No.	1		
		b) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
JD		i) Supply	No.			Rate only
JE		ii) Install	No.			Rate only
		c) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
JF		i) Supply	No.	1		
JG		ii) Install	No.	1		
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
JH		i) Supply	No.			Rate only
JI		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
JJ		i) Supply	No.	1		
JK		ii) Install	No.	1		
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
JL		i) Supply	No.	1		
JM		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		g) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
JN		i) Supply	No.	1		
JO		ii) Install	No.	1		
		h) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
JP		i) Supply	No.	2		
JQ		ii) Install	No.	2		
		i) **Rack Enclosures: 47**U, 19", wall mounting rack enclosure, with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour black powder coated**				
JR		i) Supply	No.	2		
JS		ii) Install	No.	2		
		j) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 2.5m				
JT		i) Supply	No.	15		
JU		ii) Install	No.	15		
		II) LC - LC Single-mode patch lead 25m				
JV		i) Supply	No.	15		
JW		ii) Install	No.	15		
		III) LC - LC Single-mode patch lead 100m				
JX		i) Supply	No.	1		
JY		ii) Install	No.	1		
		IV) Shielded twisted pair CAT 6A RJ45 patch lead 1m				
JZ		i) Supply	No.	10		
KA		ii) Install	No.	10		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		V) Shielded twisted pair CAT 6A RJ45 patchlead 2.5m				
KB		i) Supply	No.	10		
KC		ii) Install	No.	10		
		VI) Shielded twisted pair CAT 6A RJ45 patch lead 25m				
KD		i) Supply	No.	10		
KE		ii) Install	No.	10		
		Substation A				
		a) **Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/ cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
KF		i) Supply	No.	1		
KG		ii) Install	No.	1		
		b) **CCTV Switch:** Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
KH		i) Supply	No.			Rate only
KI		ii) Install	No.			Rate only
		c) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
KJ		i) Supply	No.			Rate only
KK		ii) Install	No.			Rate only
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
KL		i) Supply	No.			Rate only
KM		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
KN		i) Supply	No.	1		
KO		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with CCTV switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
KP		i) Supply	No.			Rate only
KQ		ii) Install	No.			Rate only
		g) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
KR		i) Supply	No.	4		
KS		ii) Install	No.	4		
		h) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
KT		i) Supply	No.	5		
KU		ii) Install	No.	5		
		i) **Rack Enclosures: 47**U, 19", wall mounting rack enclosure, with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour Light Grey (G29) Powder Coated**				
KV		i) Supply	No.	1		
KW		ii) Install	No.	1		
		j) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 50m				
KX		i) Supply	No.	25		
KY		ii) Install	No.	25		
		II) LC - LC Single-mode patch lead 25m				
KZ		i) Supply	No.	25		
LA		ii) Install	No.	25		
		III) ST-LC Single-mode patch lead 200m				
LB		i) Supply	No.	5		
LC		ii) Install	No.	5		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Substation B				
		a) **Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/ cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
LD		i) Supply	No.	1		
LE		ii) Install	No.	1		
		b) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
LF		i) Supply	No.			Rate only
LG		ii) Install	No.			Rate only
		c) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
LH		i) Supply	No.			Rate only
LI		ii) Install	No.			Rate only
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
LJ		i) Supply	No.			Rate only
LK		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
LL		i) Supply	No.	1		
LM		ii) Install	No.	1		
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with CCTV switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
LN		i) Supply	No.			Rate only
LO		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		g) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
LP		i) Supply	No.	2		
LQ		ii) Install	No.	2		
		h) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
LR		i) Supply	No.	3		
LS		ii) Install	No.	3		
		i) **Rack Enclosures: 47**U, 19", wall mounting rack enclosure, with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour Light Grey (G29) Powder Coated**				
LT		i) Supply	No.	1		
LU		ii) Install	No.	1		
		j) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 50m				
LV		i) Supply	No.	25		
LW		ii) Install	No.	25		
		II) LC - LC Single-mode patch lead 25m				
LX		i) Supply	No.	25		
LY		ii) Install	No.	25		
		III) ST-LC Single-mode patch lead 200m				
LZ		i) Supply	No.			Rate only
MA		ii) Install	No.			Rate only
		<u>Tippler 3 Building Server Room</u>				
		a) **Main ICT and Plant Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/ cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
MB		i) Supply	No.	1		
MC		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
MD		i) Supply	No.	1		
ME		ii) Install	No.	1		
		c) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
MF		i) Supply	No.			Rate only
MG		ii) Install	No.			Rate only
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
MH		i) Supply	No.			Rate only
MI		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
MJ		i) Supply	No.	1		
MK		ii) Install	No.	1		
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
ML		i) Supply	No.	1		
MM		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		g) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
MN		i) Supply	No.	2		
MO		ii) Install	No.	2		
		h) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
MP		i) Supply	No.	4		
MQ		ii) Install	No.	4		
		i) **Rack Enclosures:** 47U, 19", floor standing rack enclosure (Maximum height = 2m), with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. **Note: IP54, colour Light Grey (G29) Powder Coated**				
MR		i) Supply	No.	1		
MS		ii) Install	No.	1		
		j) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 2.5m				
MT		i) Supply	No.	25		
MU		ii) Install	No.	25		
		II) LC - LC Single-mode patch lead 200m				
MV		i) Supply	No.	10		
MW		ii) Install	No.	10		
		III) Shielded twisted pair CAT 6A RJ45 patch lead 2.5m				
MX		i) Supply	No.	20		
MY		ii) Install	No.	20		
		<u>Substation H</u>				
		a) **Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
MZ		i) Supply	No.	1		
NA		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
NB		i) Supply	No.			Rate only
NC		ii) Install	No.			Rate only
		c) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
ND		i) Supply	No.			Rate only
NE		ii) Install	No.			Rate only
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
NF		i) Supply	No.			Rate only
NG		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
NH		i) Supply	No.	1		
NI		ii) Install	No.	1		
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with CCTV switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
NJ		i) Supply	No.			Rate only
NK		ii) Install	No.			Rate only
		g) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
NL		i) Supply	No.	3		
NM		ii) Install	No.	3		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		h) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
NN		i) Supply	No.	4		
NO		ii) Install	No.	4		
		i) Rack Enclosures: 47U, 19", wall mounting rack enclosure, with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. Note: IP54, colour Light Grey (G29) Powder Coated				
NP		i) Supply	No.	1		
NQ		ii) Install	No.	1		
		j) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 2.5m				
NR		i) Supply	No.	35		
NS		ii) Install	No.	35		
		II) LC - LC Single-mode patch lead 25m				
NT		i) Supply	No.	35		
NU		ii) Install	No.	35		
		III) ST-LC Single-mode patch lead 200m				
NV		i) Supply	No.	5		
NW		ii) Install	No.	5		
		Substation J				
		a) **Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/ cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
NX		i) Supply	No.	1		
NY		ii) Install	No.	1		
		b) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
NZ		i) Supply	No.			Rate only
OA		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
OB		i) Supply	No.			Rate only
OC		ii) Install	No.			Rate only
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
OD		i) Supply	No.			Rate only
OE		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
OF		i) Supply	No.	1		
OG		ii) Install	No.	1		
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with CCTV switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
OH		i) Supply	No.			Rate only
OI		ii) Install	No.			Rate only
		g) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
OJ		i) Supply	No.	4		
OK		ii) Install	No.	4		
		h) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
OL		i) Supply	No.	5		
OM		ii) Install	No.	5		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		i) Rack Enclosures: 47U, 19", wall mounting rack enclosure, with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. Note: IP54, colour Light Grey (G29) Powder Coated				
ON		i) Supply	No.	2		
OO		ii) Install	No.	2		
		j) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 2.5m				
OP		i) Supply	No.	50		
OQ		ii) Install	No.	50		
		II) LC - LC Single-mode patch lead 25m				
OR		i) Supply	No.	50		
OS		ii) Install	No.	50		
		III) ST-LC Single-mode patch lead 200m				
OT		i) Supply	No.	5		
OU		ii) Install	No.	5		
		Substation K				
		a) **Switch:** Hirschmann, or equal approved, MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/ cabinet mounted type with 16 dual combo, 8 x RJ45 ports, 8 x Singlemode M-SFP-LX/LC ports. Complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
OV		i) Supply	No.	1		
OW		ii) Install	No.	1		
		b) CCTV Switch: Cisco, or equal approved, layer 2 full gigabit Ethernet switch 2960X-24PS-L rack/cabinet mounted type with 24 gigabit POE/POE+ 30W RJ45 ports, 4 SFP fibre ports, complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
OX		i) Supply	No.			Rate only
OY		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **Power Supply Unit:** For Hirschmann, or equal approved MAR1040-4C4C4C4C9999SM9HR switch, and/or associated equipment. Complete with all other associated wiring, fixing materials and any additional equipment and accessories as required etc.				
OZ		i) Supply	No.			Rate only
PA		ii) Install	No.			Rate only
		d) Power Supply Unit: For Cisco, or equal approved 2960X-24PS-L switch, AC/DC environment complete with all associated wiring, fixing materials and any additional equipment and accessories as required etc.				
PB		i) Supply	No.			Rate only
PC		ii) Install	No.			Rate only
		e) **Converters:** For any Hirschmann, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
PD		i) Supply	No.	1		
PE		ii) Install	No.	1		
		f) **Converters:** For any Cisco, or equal approved, equipment to be connected to the switch, not connecting to 110V DC, 24 V DC, 230 V AC. Mounted in cabinet with CCTV switches, complete with all associated wiring, DIN rail and plates, fixing materials and any additional equipment and accessories as required etc.				
PF		i) Supply	No.			Rate only
PG		ii) Install	No.			Rate only
		g) **Patch Panel:** 48 Port front panel changeable fibre optic 19" rack mountable patch panel, complete with all fixing materials, accessories etc.				
PH		i) Supply	No.	3		
PI		ii) Install	No.	3		
		h) **Brush Tray:** 1U 19" rack mountable brush tray for mounting above and below switches and patch panels etc., complete with all fixing materials, accessories etc.				
PJ		i) Supply	No.	4		
PK		ii) Install	No.	4		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		i) Rack Enclosures: 47U, 19", wall mounting rack enclosure, with glass door, side and back panels, adjustable vertical mounting rails, switchgear, integrated electrical bonding, accessory channels, all the integrated cabling and management systems including allowance for top or bottom cable entry facilities, any other associated wiring, station earthing, fixing materials and all other equipment and accessories etc. complete. Note: IP54, colour Light Grey (G29) Powder Coated				
PL		i) Supply	No.	1		
PM		ii) Install	No.	1		
		j) **Patch Leads:** To be of the ruggedised type complete with terminations etc., as follows:				
		I) LC - LC Single-mode patch lead 2.5m				
PN		i) Supply	No.	35		
PO		ii) Install	No.	35		
		II) LC - LC Single-mode patch lead 25m				
PP		i) Supply	No.	35		
PQ		ii) Install	No.	35		
		III) ST-LC Single-mode patch lead 200m				
PR		i) Supply	No.	5		
PS		ii) Install	No.	5		
		INTRUDER ALARM SYSTEMS INSTALLATIONS				
		<u>Control Panels</u>				
		a) **Substation M:** Complete new 230Vac input (including power supply if required), programmable intruder alarm control panel with software, all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
PT		i) Supply	No.	1		
PU		ii) Install	No.	1		
		b) **Substation N:** Complete new 230Vac input (including power supply if required), programmable intruder alarm control panel with software, all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
PV		i) Supply	No.	1		
PW		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **New Main Intake Substation:** Complete new 230Vac input (including power supply if required), programmable intruder alarm control panel with software, all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
PX		i) Supply	No.	1		
PY		ii) Install	No.	1		
		Intruder Alarm Visual Indication (Amber Colour)				
		a) Harsh environment and dust proof, IP65, outdoor, LED visual alarm indicator, for indication of intruder alarm activation, complete with all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
PZ		i) Supply	No.	6		
QA		ii) Install	No.	6		
		Intruder Alarm Audible Indication				
		a) Harsh environment and dust proof, IP65, outdoor, audible alarm indicator, for indication of intruder alarm activation, complete with all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
QB		i) Supply	No.	6		
QC		ii) Install	No.	6		
		Keypad				
		a) Complete wall mounted, IP65, system keypad with LED backlight, keypad cover (if needed), with all wiring, flush /or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
QD		i) Supply	No.	5		
QE		ii) Install	No.	5		
		b) Complete IP65, 316L stainless steel purpose made enclosure for keypad, powder coated to **SANS 1091 'B26' electric orange** colour, open/closable door and handle, fixing materials and all other accessories etc.				
QF		i) Supply	No.	5		
QG		ii) Install	No.	5		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PIR Intruder Detector a) Complete wall mounted, high quality, false alarm immune passive infrared intruder detector, system compatible, including all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
QH		i) Supply	No.	27		
QI		ii) Install	No.	27		
		Door (Open/Close) Sensor a) Complete door (open or closed) sensor installed onto normal access door or roller shutter door, with all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
QJ		i) Supply	No.	64		
QK		ii) Install	No.	64		
		CLOSED CIRCUIT TELEVISION (CCTV) **Local Monitoring/Setup (Workstation) Station** a) **CCTV PC:** 19" Rack mountable industrial substation PC, completely configured. Solid state drives 250GB min., 110V DC, i3 Processor min., 8GB RAM min., 2 x serial ports, 4 USB 2.0 ports, 2 x 1GB Ethernet LAN ports. All communication software for remote interrogation of IEDs installed and communication interfaces configured for automated download and storage of events, all wiring, fixing materials and any other equipment and accessories as required complete				
QL		i) Supply	No.	3		
QM		ii) Install	No.	3		
		b) **Peripherals Combo Tray:** 19" Rack mountable 1U screen, mouse, keyboard combo tray, mounted in rack/ cabinet with PC, complete with wiring, fixing materials and all other accessories etc.				
QN		i) Supply	No.	3		
QO		ii) Install	No.	3		
		c) **CCTV Server:** 19" Rack mountable CCTV server, complete with wiring, fixing materials and all other equipment and accessories etc. **Note: Bosch DL380 Gen9 Management Server or equal approved**				
QP		i) Supply	No.			Rate only
QQ		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) **CCTV Recorder:** 19" Rack mountable 128 channel, 32TB CCTV recorder, complete with all wiring, fixing materials and all other equipment and accessories etc. **Note: Bosch DIVAR IP 6000 or equal approved**				
QR		i) Supply	No.			Rate only
QS		ii) Install	No.			Rate only
		e) **CCTV Matrix/Control System:** 19" Rack mountable 32 video inputs, 6 video outputs, RS-232 ports, complete with all wiring, fixing materials and all other equipment and accessories etc. **Note: Bosch LTC 8300/90 Allegiant Matrix/Control Systems or equal approved**				
QT		i) Supply	No.			Rate only
QU		ii) Install	No.			Rate only
		Indoor Camera a) Indoor/outdoor, ceiling/wall mounted, IP54, IP, fixed HD dome type, 1080p30, 160 x zoom, built in motion detection, POE CCTV camera, including shielded CAT 6A wiring, RJ45 terminations, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories. **Note: Bosch AutoDome Junior Fixed Camera or equal approved**				
QV		i) Supply	No.	52		
QW		ii) Install	No.	52		
		Outdoor Camera a) Outdoor, wall/pole mounted, IP66, 1080p30, POE, HD, IP, auto zoom/focus CCTV camera, including shielded CAT 6A wiring, RJ45 terminations, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories. **Bosch DINION IP Imager 9000 HD or equal approved**				
QX		i) Supply	No.	4		
QY		ii) Install	No.	4		
		b) Outdoor, wall/pole mounted, IP66, PTZ, IP, HD dome type, 1080p, 30 x zoom, POE CCTV camera, including shielded CAT 6A wiring, RJ45 terminations, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories. **Note: Bosch AutoDome IP Dynamic 7000HD or equal approved**				
QZ		i) Supply	No.			Rate only
RA		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ATMOSPHERIC PRESSURE DETECTOR a) Atmospheric (Barometric) pressure, settable, wall mounted type, minimum IP20, with 24V DC supply, 5V DC output, RS232 serial link, all wiring, fixing materials and any other equipment and accessories as required				
RB		i) Supply	No.	16		
RC		ii) Install	No.	16		
		Pressure Loss Visual Indication (White) a) Harsh environment and dust proof, IP65, outdoor, LED visual alarm indicator, for indication of pressure loss within the substation, complete with all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
RD		i) Supply	No.	6		
RE		ii) Install	No.	6		
		Pressure Loss Audible Indication a) Harsh environment and dust proof, IP65, outdoor, audible alarm indicator, for indication of pressure loss within the substation, complete with all wiring, flush/or surface mounted 25mm dia. plastic conduit and round inspection boxes, fixing materials and all other equipment and accessories etc.				
RF		i) Supply	No.	6		
RG		ii) Install	No.	6		
		LABELLING				
RH		a) Labelling of **Substation M's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
RI		b) Labelling of **Substation N's** installation as specified and /or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
RJ		c) Labelling of **New Main Intake Substation's** installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		
		TESTING AND COMMISSIONING				
RK		a) Complete testing and commissioning of **Substation M's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
RL		b) Complete testing and commissioning of **Substation N's** installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment/installations**	Sum	1		
RM		c) Complete testing and commissioning of the **New Main Intake Substation's** installation as required. **Note: Only suitably qualified and experienced personnel to test and commission the relevant equipment/installations**	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUNDRY ITEMS				
RN		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
RO		b) Inspection of all **Type Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
RP		c) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
RQ		d) Inspection of all **Routine Tests** at the premises of the manufacturer, of any of the equipment as may be required by	Sum	1		
RR		e) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
RS		f) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
RT		g) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		
RU		h) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
RV		i) Provision of all manufacturer(s) prescribed critical and recommended spares	Sum	1		
RW		j) All manufacturer(s) prescribed operating equipment, tools etc. for all the *Employer's* equipment etc.	Sum	1		
RX		k) Software and licenses where applicable for all relevant equipment, including programming and copies to the *Employer*	Sum	1		
RY		l) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
RZ		m) Accredited/certified operational and maintenance training on monitoring and control systems/infrastructure, including intruder alarm, CCTV etc.	Sum	1		
SA		n) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS a) b) c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
11		**SECTION 10 : MEDIUM VOLTAGE EQUIPMENT** **NOTE** This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc. **11kV MEDIUM VOLTAGE SWITCHGEAR** **New Main Intake Substation** a) **Incomer Panel:** ABB ZX2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC 62271-200, 100kA peak withstand current, 2500A double busbar SF6 gas insulated switchgear with 2500A vacuum circuit breaker (VCB) and 2 x 2500A three position switches. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
A		i) Supply	No.	2		
B		ii) Install	No.	3		
		b) **Bus Coupler (Section) Panel:** ABB ZX2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC 62271-200, 100kA peak withstand current, 2500A double busbar SF6 gas insulated switchgear with 2500A vacuum circuit breaker (VCB), 1 x 2500A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
C		i) Supply	No.	1		
D		ii) Install	No.	4		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **Riser Panel:** ABB ZX2 type or equal approved, 12kV rated voltage, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC62271-200, 100kA peak withstand current, 2500A double busbar SF6 gas insulated switchgear with 2500A three position switch and three phase busbar VT, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
E		i) Supply	No.	1		
F		ii) Install	No.	4		
		d) **Feeder Panel:** ABB ZX2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC 62271-200, 100kA peak withstand current, 2500A double busbar SF6 gas insulated switchgear with 2000A vacuum circuit breaker (VCB) and 2 x 2000A three position switches. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
G		i) Supply	No.	6		
H		ii) Install	No.	6		
		e) Complete arc ducting, with T-off's, bends, all fixing materials, accessories etc.				
I		i) Supply	m	100		
J		ii) Install	m	100		
		<u>Substation M</u>				
		a) **Incomer Panel:** ABB ZX1.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 31.5kA 3s rated short-time withstand current, IAC: 31.5kA 1s AFLR according to IEC 62271-200, 80kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB) and 1250A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
K		i) Supply	No.	0		Rate Only
L		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **Bus Coupler (Section) Panel:** ABB ZX1.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 31.5kA 3s rated short-time withstand current, IAC: 31.5kA 1s AFLR according to IEC62271-200, 80kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB), 1250A three position switch and three phase busbar VT. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
M		i) Supply	No.	0		Rate Only
N		ii) Install	No.	1		
		c) **Riser Panel:** ABB ZX1.2 type or equal approved, 12kV rated voltage, 28kV power frequency withstand voltage, 75kV BIL, 31.5kA 3s rated short-time withstand current, IAC: 31.5kA 1s AFLR according to IEC62271-200, 80kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A three position switch and three phase busbar VT, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
O		i) Supply	No.	0		Rate Only
P		ii) Install	No.	1		
		d) **Feeder Panel:** ABB ZX1.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 31.5kA 3s rated short-time withstand current, IAC: 31.5kA 1s AFLR according to IEC62271-200, 80kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 630A vacuum circuit breaker (VCB) and 630A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, additional panel riser section (if applicable) plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
Q		i) Supply	No.	0		Rate Only
R		ii) Install	No.	5		
		e) Complete arc ducting, with T-off's, bends, all fixing materials, accessories etc.				
S		i) Supply	m	60		
T		ii) Install	m	60		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Substation N				
		a) **Incomer Panel:** ABB ZX2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC 62271-200, 100kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB) and 1250A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
U		i) Supply	No.	0		Rate Only
V		ii) Install	No.	2		
		b) **Bus Coupler (Section) Panel:** ABB ZX2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC62271-200, 100kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB), 1250A three position switch and three phase busbar VT. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
W		i) Supply	No.	0		Rate Only
X		ii) Install	No.	1		
		c) **Riser Panel:** ABB ZX2 type or equal approved, 12kV rated voltage, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC62271-200, 100kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A three position switch and three phase busbar VT, including current transformers, all internal panel wiring, cable clamps/ cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
Y		i) Supply	No.	0		Rate Only
Z		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) **Feeder Panel:** ABB ZX2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 40kA 3s rated short-time withstand current, IAC: 40kA 1s AFLR according to IEC62271-200, 100kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 630A vacuum circuit breaker (VCB) and 630A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 7035 (Light Grey)**				
AA		i) Supply	No.	0		Rate Only
AB		ii) Install	No.	3		
		e) Complete arc ducting, with T-off's, bends, all fixing materials, accessories etc.				
AC		i) Supply	m	60		
AD		ii) Install	m	60		
		3.3kV MEDIUM VOLTAGE SWITCHGEAR				
		<u>Substation M</u>				
		a) **Incomer Panel:** ABB ZX0.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC 62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB) and 1250A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire Blue)**				
AE		i) Supply	No.	0		Rate Only
AF		ii) Install	No.	1		
		b) **Bus Coupler (Section) Panel:** ABB ZX0.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB), 1250A three position switch and three phase busbar VT. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire Blue)**				
AG		i) Supply	No.	0		Rate Only
AH		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		c) **Riser Panel:** ABB ZX0.2 type or equal approved, 12kV rated voltage, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A three position switch, including current transformers, all internal panel wiring, cable clamps/ cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire Blue)**				
AI		i) Supply	No.	0		Rate Only
AJ		ii) Install	No.	1		
		d) **Feeder Panel:** ABB ZX0.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 630A vacuum circuit breaker (VCB) and 630A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire Blue)**				
AK		i) Supply	No.	0		Rate Only
AL		ii) Install	No.	3		
		e) Complete arc ducting, with T-off's, bends, all fixing materials, accessories etc.				
AM		i) Supply	m	60		
AN		ii) Install	m	60		
		<u>Substation N</u>				
		a) **Incomer Panel:** ABB ZX0.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC 62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB) and 1250A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire Blue)**				
AO		i) Supply	No.	0		Rate Only
AP		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		b) **Bus Coupler (Section) Panel:** ABB ZX0.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A vacuum circuit breaker (VCB), 1250A three position switch and three phase busbar VT. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire**				
AQ		i) Supply	No	0		Rate Only
AR		ii) Install	No	1		
		c) **Riser Panel:** ABB ZX0.2 type or equal approved, 12kV rated voltage, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 1250A three position switch, including current transformers, all internal panel wiring, cable clamps/ cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire Blue)**				
AS		i) Supply	No.	0		Rate Only
AT		ii) Install	No.	1		
		d) **Feeder Panel:** ABB ZX0.2 type or equal approved, 12kV, 28kV power frequency withstand voltage, 75kV BIL, 25kA 3s rated short-time withstand current, IAC: 25kA 1s AFLR according to IEC62271-200, 63kA peak withstand current, 1250A single busbar SF6 gas insulated switchgear with 630A vacuum circuit breaker (VCB) and 630A three position switch. VCB rated C2, M2, E2 in accordance with IEC 62271-100, including current transformers, all internal panel wiring, cable clamps/cleats, plus fixing materials and all other accessories as required complete. **Note: Colour to be RAL 5003 (Saphire**				
AU		i) Supply	No.	0		Rate Only
AV		ii) Install	No.	5		
		e) Complete arc ducting, with T-off's, bends, all fixing materials, accessories etc.				
AW		i) Supply	m	80		
AX		ii) Install	m	80		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		POWER TRANSFORMERS				
		<u>New Main Intake Substation</u>				
		a) 132-66/11kV 40MVA YNd1 oil-filled, dual primary winding outdoor transformer with vacuum OLTC in accordance with SANS 60076. OLTC range 132/11kV: +2.5% -7.5% with 0.625% voltage per tap, 66/11kV: +5% -15% with 1.25% voltage per tap, 16% impedance, painted RAL 7035 (Light Grey) and the conservator tank painted RAL1013 (Oyster White), with the unit complete including 31mm/kV creepage distance bushings, 66kV and 11kV surge arresters, oil, fixing material, any internal wiring plus all other accessories etc. **Note: Powertech or equal approved**				
AY		i) Supply	No.	1		
AZ		ii) Install	No.	2		
		<u>Substation M</u>				
		a) ABB type or equal approved 11/3.3kV 3.5MVA Dyn11 C2, E2, F1 rated AN dry-type vacuum cast coil transformer, with IP54 3CR12 enclosure with bi-directional wheels and off-circuit tap switch in accordance with SANS 60076. OCTS range of +5% - 5% with 2.5% voltage per tap, 7% impedance. Complete unit also with temperature monitor, fans and fans controller, antivibration pads, MV top entry plug-in bushings, LV cable side box, voltage detectors, any internal wiring, fixing materials and all other accessories. **Note: Enclosure colour to be RAL 7035 (Light Grey)**				
BA		i) Supply	No.	1		
BB		ii) Install	No.	1		
		b) ABB type or equal approved 11/0.4kV 1MVA Dyn11 C2, E2, F1 rated AN dry-type vacuum cast coil transformer, with IP54 3CR12 enclosure with bi-directional wheels and off-circuit tap switch in accordance with SANS 60076. OCTS range of +5% - 5% with 2.5% voltage per tap, 5% impedance. Complete unit also with temperature monitor, fans and fans controller, antivibration pads, MV top entry plug-in bushings, LV cable side box, voltage detectors, any internal wiring, fixing materials and all other accessories. **Note: Enclosure colour to be RAL 7035 (Light Grey)**				
BC		i) Supply	No.	1		
BD		ii) Install	No.	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Substation N				
		a) ABB type or equal approved 11/3.3kV 4.5MVA Dyn11 C2, E2, F1 rated AN dry-type vacuum cast coil transformer, with IP54 3CR12 enclosure with bi-directional wheels and off-circuit tap switch in accordance with SANS 60076. OCTS range of +5% - 5% with 2.5% voltage per tap, 7% impedance. Complete unit also with temperature monitor, fans and fans controller, antivibration pads, MV top entry plug-in bushings, LV cable side box, voltage detectors, any internal wiring, fixing materials and all other accessories. **Note: Enclosure colour to be RAL 7035 (Light Grey)**				
BE		i) Supply	No.	1		
BF		ii) Install	No.	1		
		b) ABB type or equal approved 11/0.4kV 1MVA Dyn11 C2, E2, F1 rated AN dry-type vacuum cast coil transformer, with IP54 3CR12 enclosure with bi-directional wheels and off-circuit tap switch in accordance with SANS 60076. OCTS range of +5% - 5% with 2.5% voltage per tap, 5% impedance. Complete unit also with temperature monitor, fans and fans controller, antivibration pads, MV top entry plug-in bushings, LV cable side box, voltage detectors, any internal wiring, fixing materials and all other accessories. **Note: Enclosure colour to be RAL 7035 (Light Grey)**				
BG		i) Supply	No.	1		
BH		ii) Install	No.	1		
		Tippler 3 Building				
		a) ABB type or equal approved 11/0.4kV 3.15 MVA Dyn11 C2, E2, F1 rated AN dry-type vacuum cast coil transformer, with IP54 3CR12 enclosure with bi-directional wheels and off-circuit tap switch in accordance with SANS 60076. OCTS range of +5% - 5% with 2.5% voltage per tap, 7% impedance. Complete unit also with temperature monitor, fans and fans controller, antivibration pads, MV top entry plug-in bushings, LV cable side box, protection enclosure complete with all protection and other equipment as specified elsewhere, voltage detectors, any internal wiring, fixing materials and all other accessories. **Note: Enclosure colour to be RAL 7035 (Light Grey)**				
BI		i) Supply	No.	1		
BJ		ii) Install	No.	1		
		NECRT				
		a) Actom type or equal approved 11kV, 360A, 10s, 95kV BIL, combined three phase electro-magneticcoupler with neutral earthing resistor as well as 11/0.4kV 315kVA Dyn11 auxiliary transformer complete, including 31mm/kV creepage distance bushings, oil, internal wiring, MCCBs, CTs, fixing materials as well as all accessories as required etc. **Note: Unit colour to be RAL 7035 (Light Grey)**				
BK		i) Supply	No.	2		
BL		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		11kV SERIES REACTOR a) 11kV, 40MVA, 8% impedance, air-core dry type series current limiting reactor in accordance with SANS 60076 including 11kV outdoor type busings with 31mm/kV creepage distance, complete including steel supports, fixing materials and all other accessories etc. **Note: (1) Unit Trench Group or equal approved type. (2) Unit colour to be RAL 7035 (Light Grev)**				
BM		i) Supply	No.			Rate only
BN		ii) Install	No.			Rate only
		132kV CIRCUIT BREAKER **Eskom (Ystervark) Substation** a) ABB type 132kV, 3150A, 40kA, 650kV BIL, 3-pole circuit breaker, insulator creepage of 31mm/kV, with operating mechanism rated for 110V DC, including the operating mechanism/control boxes, complete as per Eskom requirements - drawing **D-DT-6250** with **Eskom SAP number: 0218735**				
BO		i) Supply	No.			Rate Only
BP		ii) Install	No.	3		
		New Main Intake Substation a) ABB type, or equal approved, 132kV, 3150A, 40kA, 650kV BIL, 3-pole circuit breaker **including one additional trip coil**, insulator creepage of 31mm/kV, with operating mechanism rated for 110V DC, including the operating mechanism/control boxes, complete as per Eskom requirements - drawing **D-DT-6250** with **Eskom SAP number: 0218735**				
BQ		i) Supply	No.	2		
BR		ii) Install	No.	2		
		66kV CIRCUIT BREAKER **Eskom Iscor Substation** a) ABB type 66kV, 2500A, 25kA, 375kV BIL, 3-pole circuit breaker, insulator creepage of 31mm/kV, with operating mechanism rated for 110V DC, including steel supports and operating mechanism/control boxes, complete as per Eskom requirements - drawing **D-DT-6251** with **Eskom SAP number: 0017543**				
BS		i) Supply	No.			Rate Only
BT		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		132kV ISOLATOR				
		Eskom (Ystervark) Substation				
		a) ACTOM type, hand operated, 3-pole "Centre Rotate Double Break", 132kV, 2500A, 650kV BIL, 40kA isolator, with 31mm/kV insulator creepage, including **16 Pole** auxiliary switch, complete as per Eskom requirements - drawing **D-DT-6302** and **Eskom SAP Number: 0527586**				
BU		i) Supply	No.			Rate Only
BV		ii) Install	No.	9		
		b) ACTOM type, motorised, 3-pole "Centre Rotate Double Break", 132kV, 2500A, 650kV BIL, 40kA isolator, with 31mm /kV insulator creepage, including **16 Pole** auxiliary switch, complete as per Eskom requirements - drawing **D-DT-6302** with **Eskom SAP number 0527587**				
BW		i) Supply	No.			Rate Only
BX		ii) Install	No.	3		
		c) ACTOM type, hand operated, 3-pole in-line "Centre Rotate Double Break", 132kV, 2500A, 650kV, 40kA isolator, with 31mm/kV insulator creepage, including **16 Pole** auxiliary switch, complete as per drawing **D-DT-6302** with **Eskom SAP number 0527588**				
BY		i) Supply	No.			Rate Only
BZ		ii) Install	No.	5		
		New Main Intake Substation				
		a) ACTOM type, or equivelant approved, hand operated, 3-pole "Centre Rotate Double Break", 132kV, 2500A, 650kV BIL, 40kA isolator, with 31mm/kV insulator creepage, including **16 Pole** auxiliary switch, complete as per Eskom requirements - drawing **D-DT-6302** and **Eskom SAP Number: 0527586**				
CA		i) Supply	No.			Rate Only
CB		ii) Install	No.	2		
		66kV VOLTAGE TRANSFORMER				
		Eskom (Ystervark) Substation				
		a) ABB type 66kV/110V, 100/50VA, 350kV BIL, Class 3P/0.2, single phase electromagnetic voltage transformer with 31mm/kV insulator creepage, complete as per Eskom requirements - drawing **D-DT-6176** and **Eskom SAP number: 0180091**				
CC		i) Supply	No.			Rate Only
CD		ii) Install	No.	6		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		66kV POWER VOLTAGE TRANSFORMER **<u>Eskom (Ystervark) Substation</u>** a) ABB type 66kV/400 V, 2500VA, 350kV BIL, single phase electromagnetic power voltage transformer with 31mm/kV insulator creepage, complete as per Eskom requirements - drawing **D-DT-6315** with **Eskom SAP number: 0237662**				
CE		i) Supply	No.			Rate Only
CF		ii) Install	No.	6		
		132kV CURRENT TRANSFORMER **<u>Eskom (Ystervark) Substation</u>** a) ACTOM type IMB 132kV, 2500A, 40kA oil insulated tank CT, with 6 cores (2 x Protection: 2400/1A MR, 2 x Buszone: 1600/1 MR, 2 x Meter: 2400/1A MR), including insulated to 145kV, 31mm/kV insulator creepage distance, 650kV BIL, complete as per Eskom requirements - drawing **D-DT- 6190** with **Eskom SAP number: 0180034**				
CG		i) Supply	No.			Rate Only
CH		ii) Install	No.	18		
		<u>New Main Intake Substation</u> a) ACTOM type IMB, or equivelant approved, 132kV, 2500A, 40kA oil insulated tank CT, with 6 cores (2 x Protection: 2400/1A MR, 2 x Buszone: 1600/1 MR, 2 x Meter: 2400/1A MR), including insulated to 145kV, 31mm/kV insulator creepage distance, 650kV BIL, complete as per Eskom requirements - drawing **D-DT- 6190** with **Eskom SAP number: 0180034**				
CI		i) Supply	No.	6		
CJ		ii) Install	No.	6		
		66kV SURGE ARRESTER **<u>Eskom (Ystervark) Substation</u>** a) ABB type 66kV surge arrester, with 31mm/kV insulator creepage distance, minimum MCOV 48kV, maximum residual voltage 165kV, discharge current 10kA, IEC line discharge class 2 as per drawing **D-DT-6212** with **Eskom SAP number: 0004562**				
CK		i) Supply	No.			Rate Only
CL		ii) Install	No.	6		
		<u>Eskom Iscor Substation</u> a) ABB type 66kV surge arrester, with 31mm/kV insulator creepage distance, minimum MCOV 48kV, maximum residual voltage 165kV, discharge current 10kA, IEC line discharge class 2 as per drawing **D-DT-6212** with **Eskom SAP number: 0004562**				
CM		i) Supply	No.			Rate Only
CN		ii) Install	No.			Rate Only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		132kV POST INSULATOR **<u>Eskom (Ystervark) Substation</u>** a) 132kV, 4kN, 550kV BIL, station class post insulator, with 31mm/kV insulator creepage distance, complete as per Eskom requirements - drawing **D-DT-6230** with **Eskom SAP number 0017528**				
CO		i) Supply	No.	54		
CP		ii) Install 37 b) 132kV, 10kN, 550kV BIL, station class post insulator, with 31mm/kV insulator creepage distance, complete	No.	87		
CQ		i) Supply	No.			Rate only
CR		ii) Install	No.			Rate only
		c) 132kV, 4kN, 650kV BIL, station class post insulator, with 31mm/kV insulator creepage distance, complete				
CS		i) Supply	No.			Rate only
CT		ii) Install	No.			Rate only
		d) 132kV, 10kN, 650kV BIL, station class post insulator, with 31mm/kV insulator creepage distance, complete				
CU		i) Supply	No.			Rate only
CV		ii) Install	No.			Rate only
		66kV POST INSULATOR **<u>New Main Intake Substation</u>** a) 66kV, 4kN, 350kV BIL station class insulator, with 31mm/kV insulator creepage distance, fixing materials and other material as required as per drawing **D-DT-6232** with **Eskom SAP number: 0017527 or equivelant approved**				
CW		i) Supply	No.			Rate Only
CX		ii) Install	No.	12		
		TUBULAR BUSBARS a) 120mm (OD) x 112mm (ID) x 4mm wall thickness, 12,2m long aluminium tube busbar, with current rating of 2300A, in accordance with Eskom requirements - drawing **D-DT-6000** with **Eskom SAP number: 0206318**				
CY		i) Supply	No.	44		
CZ		ii) Install	No.	44		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		CLAMPS **<u>Eskom (Ystervark) Substation</u>** a) Bolted clamp 26.5mm to bolted clamp 26.5mm for stranded conductor, type **EX-B** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6002 with Eskom SAP number: 0401584**				
DA		i) Supply	No.	12		
DB		ii) Install	No.	12		
		b) Bolted/palm clamp for 26.5mm stranded conductor to palm, type **EPT-A** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6004 with Eskom SAP number: 0401766**				
DC		i) Supply	No.	15		
DD		ii) Install	No.	15		
		c) Bolted/compression clamp for 38mm stud to 26.5mm stranded conductor, type **EXC-B** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6006 with Eskom SAP number: 0401766**				
DE		i) Supply	No.	30		
DF		ii) Install	No.	30		
		d) Bolted/compression tee clamps for 23.5mm stranded conductor to 26.5mm stranded conductor, type **ETC-A** clamps including for the termination at each conductor end, complete to Eskom requirements - drawing **D-DT-6010 with Eskom SAP number: 0401758**				
DG		i) Supply	No.	6		
DH		ii) Install	No.	6		
		e) Bolted/compression tee clamps for 26.5mm stranded conductor to 26.5mm stranded conductor, type **ETC-C** clamps including for the termination at each conductor end, complete to Eskom requirements - drawing **D-DT- 6010 with Eskom SAP number: 0401754**				
DI		i) Supply	No.	6		
DJ		ii) Install	No.	6		
		f) Bolted/compression tee clamps for 38.3mm stranded conductor to 26.5mm stranded conductor, type **ETC-J** clamps including for the termination at each conductor end, complete to Eskom requirements - drawing **D-DT- 6010 with Eskom SAP number: 0401768**				
DK		i) Supply	No.	6		
DL		ii) Install	No.	6		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		g) Bolted/compression clamp for 38mm stud to 2 x 38.3mm stranded conductor, type **EYC-B** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6013 with Eskom SAP number: 0005663**				
DM		i) Supply	No.	12		
DN		ii) Install	No.	12		
		h) Palm-stranded 8 hole 26.5mm conductor clamp, 0 degrees, type **EPC-A** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6018 with Eskom SAP number: 0401580**				
DO		i) Supply	No.	50		
DP		ii) Install	No.	50		
		i) Palm-to-stranded 8 hole 26.5mm conductor clamp, 45 degrees, type **EPC-B** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6018 with Eskom SAP number: 0400420**				
DQ		i) Supply	No.	27		
DR		ii) Install	No.	27		
		j) Palm-to-stranded 8 hole 26.5mm conductor clamp, 90 degrees, type **EPC-C** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6018 with Eskom SAP number: 0560891**				
DS		i) Supply	No.	10		
DT		ii) Install	No.	10		
		k) Bolted 26mm stud to 2 x 38.3mm stranded conductor clamp, type **EY-H** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6022 with Eskom SAP number: 0206355**				
DU		i) Supply	No.	6		
DV		ii) Install	No.	6		
		l) Pad with PCD 127mm to bolted stranded 2 x 38.3mm conductor clamp, type **F-SUPt 38.1 P38/127/150** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6025 with Eskom SAP number: 0401669**				
DW		i) Supply	No.	2		
DX		ii) Install	No.	2		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		m) Pad with PCD 127mm to bolted stranded 26.5mm conductor clamp, type **KCP 26/127** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6029 with Eskom SAP number: 0005213**				
DY		i) Supply	No.	31		
DZ		ii) Install	No.	31		
		n) Pad with PCD 127mm to fixed bolted 120mm tube clamp, type **ESC-PI-F-F** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6039 with Eskom SAP number: 0213925**				
EA		i) Supply	No.	12		
EB		ii) Install	No.	12		
		o) End cap for tube 120 x 4mm plain, type **EEC-PL-C** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6040 with Eskom SAP number: 0206319**				
EC		i) Supply	No.	42		
ED		ii) Install	No.	42		
		p) End cap for tube 120 x 4mm with 26.5mm stranded conductor clamp, type **EEC-DC-C** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6040 with Eskom SAP number: 0206320**				
EE		i) Supply	No.	42		
EF		ii) Install	No.	42		
		q) Conductor spacer 150mm for 2 x 38.3mm stranded conductor clamp, type **ES-B** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6087 with Eskom SAP number: 0402559**				
EG		i) Supply	No.	42		
EH		ii) Install	No.	42		
		r) Bolted 120mm tube to 2 x compressed 38.3mm stranded coductor clamp, 0 degrees, type **ETP-TE-IL2-F0** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6090 with Eskom SAP number: 0206328**				
EI		i) Supply	No.	12		
EJ		ii) Install	No.	12		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		s) Pad with PCD 127mm to fixed/sliding bolted 120mm tube clamp, type **EEC-PI-FS-F** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6093 with Eskom SAP number: 0206329**				
EK		i) Supply	No.	36		
EL		ii) Install	No.	36		
		t) Palm to 2 x stranded 8 hole 38.3mm conductor clamp, 0 degrees, type **EYC-R** clamp including for the termination at the equipment and conductor ends, complete to all Eskom requirements - drawing **D-DT-6109 with Eskom SAP number: 0400426**				
EM		i) Supply	No.	3		
EN		ii) Install	No.	3		
		u) Palm to 2 x stranded 8 hole 38.3mm conductor clamp, 45 degrees, type **EYC-S** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6109 with Eskom SAP number: 0401802**				
EO		i) Supply	No.	15		
EP		ii) Install	No.	15		
		v) Bolted to peg clamp 26.5mm, type **EPC-26** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6115 with Eskom SAP number: 0005175**				
EQ		i) Supply	No.	90		
ER		ii) Install	No.	90		
		w) Bolted to peg clamp 38.3mm, type **EPC-38** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6115 with Eskom SAP number: 0005176**				
ES		i) Supply	No.	12		
ET		ii) Install	No.	12		
		x) Bolted 120 mm tube to compressed 26.5mm stranded coductor clamp, tap-off, type **ETP-IL1-H** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6119 with Eskom SAP number: 0216098**				
EU		i) Supply	No.	30		
EV		ii) Install	No.	30		
		y) Bolted 120 mm tube to 2 x compressed 38.3mm stranded coductor clamp, tap-off, type **ETP-IL2-T** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6119 with Eskom SAP number: 0216099**				
EW		i) Supply	No.	6		
EX		ii) Install	No.	6		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		z) Pad with PCD 127mm to sliding bolted 120mm tube clamp, type **ESC-PI-S-F** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6316 with Eskom SAP number: 0242920**				
EY		i) Supply	No.	6		
EZ		ii) Install	No.	6		
		New Main Intake Substation				
		a) Bolted clamp 26.5mm to bolted clamp 26.5mm for stranded conductor, type **EX-B** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6002 with Eskom SAP number: 0401584**				
FA		i) Supply	No.	6		
FB		ii) Install	No.	6		
		b) Bolted/compression clamp for 26mm stud to 26.5mm stranded conductor, type **EXC-A** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6006 with Eskom SAP number: 0401752**				
FC		i) Supply	No.	6		
FD		ii) Install	No.	6		
		c) Bolted/compression clamp for 38mm stud to 26.5mm stranded conductor, type **EXC-B** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6006 with Eskom SAP number: 0401766**				
FE		i) Supply	No.	12		
FF		ii) Install	No.	12		
		d) Bolted/compression clamp for 38mm stud to 2 x 38.3mm stranded conductor, 90 degrees, type **EYC-F** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6013 with Eskom SAP number: 0401772**				
FG		i) Supply	No.	6		
FH		ii) Install	No.	6		
		e) Palm-to-stranded 8 hole 26.5mm conductor clamp, 0 degrees, type **EPC-A** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6018 with Eskom SAP number: 0401580**				
FI		i) Supply	No.	18		
FJ		ii) Install	No.	18		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) Palm-to-stranded 8 hole 26.5mm conductor clamp, 45 degrees, type **EPC-B** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6018 with Eskom SAP number: 0400420**				
FK		i) Supply	No.	6		
FL		ii) Install	No.	6		
		g) Bolted clamp 38mm to 2 x Bolted 38.3mm for stranded conductor clamp, type **EY-B** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6022 with Eskom SAP number: 0005631**				
FM		i) Supply	No.	6		
FN		ii) Install	No.	6		
		h) Pad with PCD 127mm to bolted stranded 2 x 38.3mm conductor clamp, type **F-SUPt 38.1 P38/127/150** clamps including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6025 with Eskom SAP number: 0401669**				
FO		i) Supply	No.	12		
FP		ii) Install	No.	12		
		i) Pad with PCD 127mm to fixed bolted 120mm tube clamp, type **ESC-PI-F-F** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6039 with Eskom SAP number: 0213925**				
FQ		i) Supply	No.	6		
FR		ii) Install	No.	6		
		j) Plain end cap for tube 120 x 4mm, type **EEC-PL-C** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6040 with Eskom SAP number: 0206319**				
FS		i) Supply	No.	12		
FT		ii) Install	No.	12		
		k) Bolted 120 mm tube to 2 x compressed 38.3mm stranded coductor clamp, 0 degrees, type **ETP-TE-IL2-F0** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6090 with Eskom SAP number: 0206328**				
FU		i) Supply	No.	6		
FV		ii) Install	No.	6		
		l) Bolted 120 mm tube to 1 hole palm, type **ETP-PL-1H-C** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6092 with Eskom SAP number: 0528678**				
FW		i) Supply	No.	12		
FX		ii) Install	No.	12		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		m) Bolted 26.5mm to peg clamp, type **EPC-26** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6115 with Eskom SAP number: 0005175**				
FY		i) Supply	No.	6		
FZ		ii) Install	No.	6		
		n) Pad with PCD 127mm to sliding bolted 120mm tube clamp, type **ESC-PI-S-F** clamp including for the termination at the equipment and conductor ends, complete to Eskom requirements - drawing **D-DT-6316 with Eskom SAP number: 0242920**				
GA		i) Supply	No.	6		
GB		ii) Install	No.	6		
		WILDLIFE AND ASSET PROTECTION				
		Equipment Raysulate or equal approved, unless otherwise specified/stated				
		Medium Voltage Fusion Tape (15kV)				
		a) Fusion tape with catalogue number: MVFT-G-2-12 (B4)				
GC		i) Supply	m			Rate only
GD		ii) Install	m			Rate only
		Medium Voltage Conductor Cover for Outage Prevention (25kV)				
		a) Cover with catalogue number: MVCC-10/.40 (B100)				
GE		i) Supply	m			Rate only
GF		ii) Install	m			Rate only
		b) Cover with catalogue number: MVCC-G-10/.40 (B100)				
GG		i) Supply	m			Rate only
GH		ii) Install	m			Rate only
		c) Cover with catalogue number: MVCC-19/.75 (B50)				
GI		i) Supply	m			Rate only
GJ		ii) Install	m			Rate only
		d) Cover with catalogue number: MVCC-G-19/.75 (B50)				
GK		i) Supply	m			Rate only
GL		ii) Install	m			Rate only
		e) Cover with catalogue number: MVCC-25/1.0 (B25)				
GM		i) Supply	m			Rate only
GN		ii) Install	m			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		f) Cover with catalogue number: MVCC-G-25/1.0 (B25)				
GO		i) Supply	m			Rate only
GP		ii) Install	m			Rate only
		g) Cover with catalogue number: MVCC-45/1.75x4 (B24)				
GQ		i) Supply	m			Rate only
GR		ii) Install	m			Rate only
		h) Cover with catalogue number: MVCC-G-45/1.75x4 (B24)				
GS		i) Supply	m			Rate only
GT		ii) Install	m			Rate only
		i) LDPE type 1 class 3 black colour, UV stabilized (non-metallic) pipe, with 13.2 up to 68mm nominal out diameter. **Note: The pipes to be equal to Eskom standard type shown in D-DT-3127**				
GU		i) Supply	m	50		
GV		ii) Install	m	50		
		Bird Diverters **Units and their installation accordingly complete to Eskom requirements or as specified otherwise. Final locations of installation to be confirmed on- site** a) Complete bird flapper 'red, blue or white colours' disc, with helical conductor attachment. **Note: Spaced every 10m, unless differently required**				
GW		i) Supply	No.	20		
GX		ii) Install	No.	20		
		b) Complete bird flapper live line, with flapper disc, poly-carbonate UV stabilized plastic and attachment clamp. **Note: Spaced every 10m, unless differently required - drawing D-DT-3053 with SAP No. 0212724**				
GY		i) Supply	No.			Rate only
GZ		ii) Install	No.			Rate only
		c) Complete double loop PVC spiral type bird flight diverters as per Eskom requirements - drawing **D-DT- 3107 with SAP No. 0239366**				
HA		i) Supply	No.			Rate only
HB		ii) Install	No.			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		d) 'Eagle Eye' optical device bird diverter, UV stabilised, any colour, complete with vertical mounting and all other accessories as required				
HC		i) Supply	No.	20		
HD		ii) Install	No.	20		
		e) Complete 15kV, minimum 1,9m long special purpose rotor moulded alkathene or LDPE raptor/bird cap protector, cold applied, UV stabilised, any colour, for conductor dia. up to 120mm and 11kV bushings, with fixing materials and any other accessories etc.				
HE		i) Supply	No.			Rate only
HF		ii) Install	No.			Rate only
		f) Complete polycarbonate/plastic type UV stabilized strap on bird spikes, flexible, any colour, with fixing materials etc. **Note: (1) Supplied in 7m long batches. (2) Any steel fixing materials to be of 316L stainless steel type**				
HG		i) Supply	No.	50		
HH		ii) Install	No.	50		
		CLEANING OF EXISTING SWITCHGEAR				
HI		a) Cleaning of Substation A 11kV ALSTOM existing 2 x incomer switchboards cable compartments and other sections as applicable, by specialised subcontractor/OEM etc., and certification thereof	Sum	1		
HJ		b) Cleaning of Substation H 11kV ALSTOM existing 2 x incomer switchboards cable compartments and other sections as applicable, by specialised subcontractor/OEM etc., and certification thereof	Sum	1		
HK		c) Cleaning of Substation J 11kV ALSTOM existing 2 x incomer switchboards cable compartments and other sections as applicable, by specialised subcontractor/OEM etc., and certification thereof	Sum	1		
HL		d) Cleaning of Substation K 11kV ALSTOM existing 2 x incomer switchboards cable compartments and other sections as applicable, by specialised subcontractor/OEM etc., and certification thereof	Sum	1		
		DISMANTLING/REMOVAL OF EXISTING EQUIPMENT				
HM		a) Complete dismantling and removal of existing 11kV incomer power cables at Substation A	Sum	1		
HN		b) Complete dismantling and removal of existing 11kV incomer power cables at Substation H	Sum	1		
HO		c) Complete dismantling and removal of existing 11kV incomer power cables at Substation J	Sum	1		
HP		d) Complete dismantling and removal of existing 11kV incomer power cable at Substation K	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		LABELLING				
HQ		a) Labelling of this section of the installation as specified and/ or required by any applicable SANS standard(s), the supply authority requirements etc., including all necessary and correct fixing materials etc. complete	Sum	1		
		TESTING AND COMMISSIONING				
HR		a) Complete testing and commissioning of this section of the installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment / installations**	Sum	1		
		SUNDRY ITEMS				
HS		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
HT		b) Inspection of all **Type Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
HU		c) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		
HV		d) Inspection of all **Routine Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer*. Note: All costs to be included.	Sum	1		
HW		e) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		
HX		f) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		
HY		g) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	1		
HZ		h) Cold galv, aluminium spray, paint and all other associated material for repair to any steel structures etc.	Sum	1		
IA		i) High melting point, non-oxidant electrical contact grease. **Note: Eskom requirements to be included**	Sum	1		
IB		j) Provision of all manufacturer(s) prescribed critical and recommended spares	Sum	1		
IC		k) All manufacturer(s) prescribed operating equipment, tools etc. for all the *Employer's* equipment etc. **Note: Excludes Eskom portions**	Sum	1		
ID		l) Provision for internal arc simulations within the MV switchgear room for the New Main Intake Substation, by a specialist contractor/OEM and the provision of a comprehensive report to the *Employer* detailing the results etc.	Sum	1		
IE		m) Provision for internal arc simulations within the VSD and Transformer rooms for the new Substations M and N respectively, by a specialist contractor/OEM and the provision of a comprehensive report to the *Employer* detailing the results etc.	Sum	1		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
IF		n) Provision for internal arc simulations within the transformer room for the new Tippler 3 building, by a specialist contractor/OEM and the provision of a comprehensive report to the *Employer* detailing the results etc.	Sum	1		
IG		o) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
IH		p) Complete loading, offloading, rigging, transport, labour etc. to Eskom Brackenfell depot of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
II		q) Accredited/certified operational and maintenance training of *Employer's* staff on all MV and associated equipment etc. **Note: Excludes Eskom portions**	Sum	1		
IJ		r) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
12		**SECTION 11 : ARCHITECTURE**				
		SUBSTATION M				
		MASONRY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		SUBSTRUCTURE				
A		220mm One brick wall in staircases	m²	10.00		
B		230mm One brick wall	m²	14.00		
C		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties	m²	14.00		
		SUPERSTRUCTURE				
		Brickwork in NFP clay stock bricks in class I cement mortar				
D		220mm One brick wall in staircases	m²	5.00		
E		230mm One brick wall	m²	90.04		
F		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties	m²	121.16		
		FACE BRICKWORK				
		Face bricks pointed with flush horizontal and vertical joints				
G		Extra Over in NFP brickwork for face brickwork Corobrik 'Satin Red' or equal approved and flush pointed joints including sealing	m²	62.36		
H		Face brick on edge lintol	m	35.64		
I		Face brick on edge sill	m	12.84		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		BRICKWORK SUNDRIES				
J		Splayed mortar fillet one course high in 50mm cavity	m	6.70		
K		Closing 50mm cavity of hollow wall vertically with brickwork half brick wide	m	2.40		
L		Closing 50mm cavity of hollow wall horizontally with one course of brickwork	m	-		Rate only
		Construction joints of "Sondor Jointex" in vertical and horizontal concrete surfaces				
M		10mm thick "Jointex" to sealed keyed construction joints (CJ1)	m	75.48		
N		10mm thick "Jointex" to sealed doweled construction joints (CJ2)	m	1.20		
O		10mm thick "Jointex" between vertical concrete surfaces and horizontal brickwall surfaces (CBJ)	m	3.60		
		3mm Wide Saw Cut Joints				
P		Sealed saw cut joint (SJ1)	m	148.51		
		Isolation Joints of "Sondor Jointex" between vertical brickwork surfaces and horizontal concrete surfaces				
Q		10mm Thick Jointex in isolation joints (IJ1)	m	245.59		
R		20mm Thick Jointex in isolation joints (IJ2)	m	2.40		
		Expansion Joints of "Sondor Jointex" between horizontal or vertical brick surfaces and adjoining brickwork surfaces				
S		10mm Thick Jointex in expansion joints (EJ1)	m	3.60		
		Movement joints with bituminous impregnated softboard between horizontal or vertical concrete and brick surfaces				
T		12mm Joint not exceeding 300mm wide	m	-		Rate only
		Movement joints with "Sondor Jointex" between horizontal or vertical steel and brick surfaces				
U		10mm Joint not exceeding 300mm wide	m	20.40		
		Brickwork reinforcement				
V		75mm Wide reinforcement built in horizontally	m	4 365.12		
W		150mm Wide reinforcement built in horizontally	m	289.44		
		Stresso pre-stressed fabricated lintels				
X		90 x 75mm Lintel in lengths not exceeding 3m	m	-		Rate only
Y		140 x 75mm Lintel in lengths not exceeding 3m	m	15.00		
Z		140 x 75mm Lintel in lengths exceeding 4.5m and not exceeding 6m	m	6.00		
		COPING				
AA		Profile precast concrete coping, dowel fixed (380mm wide)	m	27.60		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Galvanized hoop iron cramps, ties, etc.		-		
AB		40 x 1.6mm Wall tie strip shot pinned to concrete and with tie bent out and built into brickwork	No	97.20		
				-		
AC		40 x 1.6mm Wall tie strip shot pinned to steel IPE and with tie bent out and built into brickwork	No	-		Rate only
				-		
		WATERPROOFING		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		SUPPLEMENTARY PREAMBLES				
		Waterproofing				
		Waterproofing of roofs, basements, etc. shall be laid under a ten year guarantee. Waterproofing to roofs shall be laid to even falls to outlets, etc. with necessary ridges, hips and valleys. Descriptions of sheet or membrane waterproofing shall be deemed to include additional labour to turn-ups and turn-downs				
		DAMPPROOFING OF WALLS AND FLOORS				
		One layer of 375 micron "Consol Plastics Brikgrip DPC" embossed damp proof course		-		
AD		In walls	m²	-		Rate only
		Two coats A.B.E 'brixeal'		-		
AE		On walls	m²	13.16		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		JOINT SEALANTS, ETC.				
		Approved silicone pointing, 10mm wide bead		-		
AF		Between door & window frame and wall	m	221.82		
		10x10 Sikaflex 11FC, Pro-2HP or equally approved sealant with Polyethylene Bond		-		
AG		10 x 10mm Horizontal Joint between brickwork and concrete	m	73.00		
AH		20 x 10mm Horizontal Joint between brickwork and concrete	m	2.40		
AI		10 x 10mm Horizontal Joint to concrete	m	321.60		
AJ		10 x 10mm Horizontal Joint to brickwork	m	51.48		
AK		12 x 12mm Vertical Joint between brickwork and concrete	m	-		Rate only
AL		10 x 10mm Vertical Joint between brickwork and concrete	m	75.60		
AM		10 x 10mm Joint between brickwork and steel	m	44.40		
		CARPENTRY & JOINERY		-		
		NOTE Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works To be read in conjunction with but not limited to the following Project Technical Specification(s) : 1924701-2-510-A-DE-0061-01-OC-AE 1924701-2-510-A-GA-0016-01-OC-AE 1924701-2-510-A-GA-0016-02-OC-AE 1924701-2-510-A-SC-0034-01-OC-AE 1924701-2-510-A-SC-0035-01-OC-AE 1924701-2-510-A-SC-0041-01-OC-AE 1924701-2-510-A-SE-0010-01-OC-AE 1924701-2-510-A-SE-0010-02-OC-AE				
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		DOORS, ETC.				
		Bitcon Industries or similar approved 1 hour rated fire doors with 1.2mm powder coated 316L stainless steel cladding to both sides hung to companion double rebated 1.6mm powder coated 316L stainless steel frames, complete as per drawing 1924701-2-510-A-SC-0034-01-OC-AE		-		
AN		Door type D03, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No	1.20		
AO		Door type D05, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No	- 2.40		
		Bitcon Industries or similar approved doors with 1.2mm powder coated 316L stainless steel cladding to both sides hung to companion double rebated 1.6mm powder coated 316L stainless steel frames, complete as per drawing 1924701-2-510-A-SC-0034-01-OC-AE		- -		
AP		Door type D03, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No	- 7.20		
AQ		Door type D04, 2000 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No	- 1.20		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		CEILINGS, PARTITIONS AND ACCESS FLOORING				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		SUPPLEMENTARY PREAMBLES				
		Descriptions				
		Items described as "nailed" shall be deemed to be fixed with hardened steel nails or pins or shot pinned to brickwork or concrete				
		Items described as "plugged" shall be deemed to include screwing to fibre, plastic or metal plugs at not exceeding 600mm centres, and where described as "bolted" the bolts have been given elsewhere				
		CEILINGS, ETC.				
		SUSPENDED CEILINGS				
		Gyproc Gyprex 'Frost White' 1200 x 600mm exposed ceiling Grid System. Donn QRC T38 Main Tees at 1200mm centres, Donn QRC T38 (1200) Cross Tee at 600mm centres. Every second perimeter main tee to be suitably fixed to the wall using "angle cleats". Donn 316L stainless steel hanger wire 2.5mm (as main tee suspension). The wire should be wound 3 times at the main tee. Donn 316L stainless steel hanger wire 2.5mm to be suitably suspended from a structural member. Hold down clips in area susceptible to draught. Wall angle: Donn SM25 wall angle				
AR		Ceilings suspended not exceeding 1m below steel purlins	m²	375.40		
AS		Ceilings suspended exceeding 2m and not exceeding 3m below steel purlins	m²	66.28		
		PARTITITIONS				
		12mm Gyproc Rhinowall "Rhinoboard fixed to donn ultrasteel studs using 25mm & 41mm streaker screws at 220mm centres. All fixing/installation to comply with "BPB Gypsum" specifications.				

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
AT		1hr Fire rated Drywall above brickwork	m	40.54 -		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		IRONMONGERY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		1924701-2-510-A-SC-0043-01-OC				
		SUPPLEMENTARY PREAMBLES				
		Protection				
		Notwithstanding anything to the contrary contained in the Model Preambles, all ironmongery items are to be brought to site suitably protected and to the satisfaction of the Employer's representative(s)				
		Works to include all hinges and sundry fixings unless detailed below as per manufacturers specification and satisfaction of the Employer's representative(s)				
		IRONMONGERY				
		Handles				
AU		Geze Daytona 19mm / 160 X 160 X 1.5/PL.C ylinder (Code: EDE/101C)	Pairs	- - -		Rate only
AV		Geze B/TH Pull handle 111 x 19 on 160 x 160 BP (Code: 075/160CL)	No	1.00 -		
AW		Geze B/TH Pull handle 111 x 19 on 160 x 160 BP (Code: 075/160CR)	No	1.00 -		
		Push plates and kick plates		- -		
AX		Geze 1.6mm Stainless steel push plate 160 X 160mm cylinder/RH (Code: 079/160CR)	No	1.00 -		
AY		Geze 1.6mm Stainless steel push plate 160 X 160mm cylinder/LH (Code: 079/160CL)	No	1.00 -		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
AZ		Geze 1.2mm Stainless Steel push plate 100 x 400mm (079/100/xx400x1.2)	No	2.00		
				-		
		Door closers		-		
				-		
BA		Geze TS2000G Door closer with guide rail & ARM SR (Code: AZ2003SR)	Sets	6.00		
				-		
BB		Geze TS500NV Double action floor spring NSO SS	Each	2.00		
				-		
		Locks		-		
				-		
BC		Geze 50mm Brass padlock master key (Code: IG95800507MK)	No	3.00		
				-		
BD		Geze N/PL Knob cylinder 60mm Master key (Code: IG955930308M)	No	4.00		
				-		
BE		Geze N/PL DBL Cylinder 60mm master key (Code: IG950930308M)	No	-		Rate Only
				-		
BF		Geze 76mm Profile arch sash lock stainless steel (Code: 730/68)	No	2.00		
				-		
BG		Geze 76mm Profile cylinder deadlock stainless steel (Code: 742/68)	No	2.00		
				-		
		Door stops		-		
				-		
BH		Geze Stainless steel F/Mnt doorstop (Code: 140/69)	No	5.00		
				-		
		Sundries		-		
				-		
BI		Geze 5.4mm PAT F/Screw NP 40-55mm (Code: 963/03)	No	16.00		
				-		
BJ		Geze M5 Patent fixing screws (Code: ND0501)	No	21.00		
				-		
BK		Geze Rebate for 700 series lock (Code: 131/69)	Sets	1.00		
				-		
BL		Geze S/Chrome flush bolt 150 x 20mm (Code: 120/150)	No	2.00		
				-		
		Signage		-		
				-		
BM		Geze Stainless steel P/PL 160 x160 x 0.9mm E/Run/M (Code: 079/160E/RM)	No	2.00		
				-		
BN		Geze Stainless steel P/PL 160 x 160 x 0.9mm E/Arrow (Code: 079/160E/A)	No	2.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		METALWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		ALUMINIUM LOUVRES				
		Trox AWR external weather louvres with 50mm flange and 316L stainless steel mesh, complete as per drawing 1924701-2-510-A-SC-0035-01-OC-AE				
BO		Louvre type LV01, 600 x 2000mm overall	No	4.00		
BP		Louvre type LV02, 2075 x 1575mm overall	No	4.00		
		STEEL ROLLER SHUTTERS ETC.				
		Serranda or equal approved powder coated galvanised steel push-up 75 x 1,0mm thick end locked slatted curtain roller shutter with overhead box 360mm high including canopy cover with standard bottom rail, windlock guides, ancillary components including 4,5mm thick end plates, guide rails, fusible link and release mechanism and canopy cover, fixed to structural steel jambs and concrete lintel, complete as per drawing 1924701-2-510-A-SC-0034-01-OC-AE				
BQ		Door type D01, 4700 x 4500mm overall	No	1.00		
BR		Door type D02, 2000 x 2812mm overall	No	2.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PLASTER				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		INTERNAL PLASTER				
		One coat cement plaster on brickwork		-		
BS		On walls	m²	875.47		
BT		On narrow widths	m²	16.64		
		One coat cement plaster on concrete		-		
BU		On columns	m²	22.65		
BV		On beams	m²	47.24		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PAINTWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		PAINTWORK ETC. TO NEW WORK				
		ON EPOXY SURFACES				
		One coat "Mastertop Primer 1200 Plus" resin with Solvent No.2 to entire surface and two coats "Light Grey Mastertop 1210 Plus" topcoat & -75 x 6mm(thick) galvanised steel plate bonded with Sikaflex 11 FC		-		
BW		On concrete floors	m²	433.23		
				-		
BX		On concrete walls	m²	337.42		
				-		
BY		On brick walls to form 100mm skirtings	m	420.00		
				-		
		ON PLASTER		-		
				-		
		Bag and apply one coat Plascon Professional Primer (PP700) with an overcoating time of 18 hours and finish with two coats Plascon Professional Superior Low Sheen (PEM100)		-		
				-		
BZ		On walls	m²	762.15		
				-		
CA		On beams	m²	47.24		
				-		
		ON CONCRETE		-		
				-		
		Bag and apply one coat Plascon Plaster Primer (UC56) and two coats Plascon Super Acrylic Polven (EPL30). Apply as per manufactures guidelines		-		
				-		
CB		On soffits and landings	m²	-		Rate only
				-		
CC		On sloping soffits of stairs	m²	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Bag and apply one coat Plascon Professional Primer (PP700) with an overcoating time of 18 hours and finish with two coats Plascon Professional Superior Low Sheen (PEM100)		-		
CD		On columns	m²	108.88		
				-		
CE		On walls	m²	337.42		
				-		
		Sikalastic 841-ST spray applied pure polyurea waterproof membrane. Light Grey (RAL 7005).		-		
				-		
CF		On concrete landings	m²	68.00		
				-		
CG		On stairs risers and treads	m²	73.00		
				-		
CH		On concrete floor	m²	60.00		
				-		
CI		On brick walls to form 100mm skirtings	m	33.00		
				-		
		FIRE STOPPING		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0061-01-OC-AE				
		1924701-2-510-A-GA-0016-01-OC-AE				
		1924701-2-510-A-GA-0016-02-OC-AE				
		1924701-2-510-A-SC-0034-01-OC-AE				
		1924701-2-510-A-SC-0035-01-OC-AE				
		1924701-2-510-A-SC-0041-01-OC-AE				
		1924701-2-510-A-SE-0010-01-OC-AE				
		1924701-2-510-A-SE-0010-02-OC-AE				
		FIRE STOPPING				
		Fire stopping vertically rated at 60 minutes. Any fire stopping shall be carried out in accordance with SANS 10400 clause 4.39 & 4.40. The Contractor shall issue a certificate of compliance once the fire stopping installation is complete		-		
				-		
CJ		Voids exceeding 0.5m2	m²	51.00		
				-		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Fire stopping horizontally to sleeves exceeding 100mm and not exceeding 200mm diameter through concrete rated at 120 minutes. Any fire stopping shall be carried out in accordance with SANS 10400 clause 4.39 & 4.40. The Contractor shall issue a certificate of compliance once the fire stopping installation is complete		-		
CK		270mm Thick reinforced concrete slab, beam, wall, etc.	No	24.00		
CL		420mm Thick reinforced concrete slab, beam, wall, etc.	No	52.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUBSTATION N				
		MASONRY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		SUBSTRUCTURE		-		
CM		220mm One brick wall in staircases	m²	-		Rate Only
CN		230mm One brick wall	m²	44.98		
CO		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties	m²	58.43		
		SUPERSTRUCTURE		-		
		Brickwork in NFP clay stock bricks in class I cement mortar		-		
CP		220mm One brick wall in staircases	m²	-		Rate Only
CQ		230mm One brick wall	m²	275.03		
CR		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties	m²	610.96		
		FACE BRICKWORK		-		
		Face bricks pointed with flush horizontal and vertical joints		-		
CS		Extra Over in NFP brickwork for face brickwork Corobrik 'Satin Red' or equal approved and flush pointed joints including sealing	m²	748.40		
CT		Face brick on edge lintol	m	29.70		
CU		Face brick on edge sill	m	10.70		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		BRICKWORK SUNDRIES				
CV		Splayed mortar fillet one course high in 50mm cavity	m	135.58		
CW		Closing 50mm cavity of hollow wall vertically with brickwork half brick wide	m	78.00		
CX		Closing 50mm cavity of hollow wall horizontally with one course of brickwork	m	23.00		
		Construction joints of "Sondor Jointex" in vertical and horizontal concrete surfaces				
CY		10mm thick "Jointex" to sealed keyed construction joints (CJ1)	m	117.90		
CZ		10mm thick "Jointex" to sealed doweled construction joints (CJ2)	m	-		Rate Only
DA		10mm thick "Jointex" between vertical concrete surfaces and horizontal brickwall surfaces (CBJ)	m	367.00		
		3mm Wide Saw Cut Joints				
DB		Sealed saw cut joint (SJ1)	m	163.76		
		Isolation Joints of "Sondor Jointex" between vertical brickwork surfaces and horizontal concrete surfaces				
DC		10mm Thick Jointex in isolation joints (IJ1)	m	424.66		
DD		20mm Thick Jointex in isolation joints (IJ2)	m	246.00		
		Expansion Joints of "Sondor Jointex" between horizontal or vertical brick surfaces and adjoining brickwork surfaces				
DE		10mm Thick Jointex in expansion joints (EJ1)	m	23.00		
		Movement joints with bituminous impregnated softboard between horizontal or vertical concrete and brick surfaces				
DF		12mm Joint not exceeding 300mm wide	m	-		Rate only
		Movement joints with "Sondor Jointex" between horizontal or vertical steel and brick surfaces				
DG		10mm Joint not exceeding 300mm wide	m	353.00		
		Brickwork reinforcement				
DH		75mm Wide reinforcement built in horizontally	m	3 937.60		
DI		150mm Wide reinforcement built in horizontally	m	941.20		
		Stresso pre-stressed fabricated lintels				
DJ		90 x 75mm Lintel in lengths not exceeding 3m	m	3.00		
DK		140 x 75mm Lintel in lengths not exceeding 3m	m	35.50		
DL		140 x 75mm Lintel in lengths exceeding 4.5m and not exceeding 6m	m	5.00		
		COPING		-		
DM		Profile precast concrete coping, dowel fixed (380mm wide)	m	23.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Galvanized hoop iron cramps, ties, etc.				
				-		
DN		40 x 1.6mm Wall tie strip shot pinned to concrete and with tie bent out and built into brickwork	No	2 281.00		
				-		
DO		40 x 1.6mm Wall tie strip shot pinned to steel IPE and with tie bent out and built into brickwork	No	537.00		
				-		
		WATERPROOFING				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		SUPPLEMENTARY PREAMBLES				
		Waterproofing				
		Waterproofing of roofs, basements, etc. shall be laid under a ten year guarantee. Waterproofing to roofs shall be laid to even falls to outlets, etc. with necessary ridges, hips and valleys. Descriptions of sheet or membrane waterproofing shall be deemed to include additional labour to turn-ups and turn-downs				
		DAMPPROOFING OF WALLS AND FLOORS				
		One layer of 375 micron "Consol Plastics Brikgrip DPC" embossed damp proof course		-		
DP		In walls	m²	96.56		
		Two coats A.B.E 'brixeal'		-		
DQ		On walls	m²	610.96		
		JOINT SEALANTS, ETC.		-		
		Approved silicone pointing, 10mm wide bead		-		
DR		Between door & window frame and wall	m	248.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		10x10 Sikaflex 11FC, Pro-2HP or equally approved sealant with Polyethylene Bond		-		
				-		
DS		10x10mm Horizontal Joint between brickwork and concrete	m	43.00		
				248.00		
DT		20x10mm Horizontal Joint between brickwork and concrete	m	123.00		
				-		
DU		10x10mm Horizontal Joint to concrete	m	52.00		
				-		
DV		10x10mm Horizontal Joint to brickwork	m	10.00		
				-		
DW		12 x 12mm Vertical Joint between brickwork and concrete	m	159.61		Rate only
				-		
DX		10 x 10mm Vertical Joint between brickwork and concrete	m	246.00		
				-		
DY		10 x 10mm Joint between brickwork and steel	m	348.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		CARPENTRY & JOINERY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		DOORS, ETC.				
		Bitcon Industries or similar approved 1 hour rated fire doors with 1.2mm powder coated 316L stainless steel cladding to both sides hung to companion double rebated 1.6mm powder coated 316L stainless steel frames, complete as per drawing 1924701-2-510-A-SC-0036-01-OC-AE				
DZ		Door type D03, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No			
EA		Door type D05, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No			
		Bitcon Industries or similar approved doors with 1.2mm powder coated 316L stainless steel cladding to both sides hung to companion double rebated 1.6mm powder coated 316L stainless steel frames, complete as per drawing 1924701-2-510-A-SC-0036-01-OC-AE				
EB		Door type D03, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No			
EC		Door type D04, 2000 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No			
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		CEILINGS, PARTITIONS AND ACCESS FLOORING				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		SUPPLEMENTARY PREAMBLES				
		Descriptions				
		Items described as "nailed" shall be deemed to be fixed with hardened steel nails or pins or shot pinned to brickwork or concrete				
		Items described as "plugged" shall be deemed to include screwing to fibre, plastic or metal plugs at not exceeding 600mm centres, and where described as "bolted" the bolts have been given elsewhere				
		CEILINGS, ETC.				
		SUSPENDED CEILINGS				
		Gyproc Gyprex 'Frost White' 1200 x 600mm exposed ceiling Grid System. Donn QRC T38 Main Tees at 1200mm centres, Donn QRC T38 (1200) Cross Tee at 600mm centres. Every second perimeter main tee to be suitably fixed to the wall using "angle cleats". Donn 316L stainless steel hanger wire 2.5mm (as main tee suspension). The wire should be wound 3 times at the main tee. Donn 316L stainless steel hanger wire 2.5mm to be suitably suspended from a structural member. Hold down clips in area susceptible to draught. Wall angle: Donn SM25 wall angle				
ED		Ceilings suspended not exceeding 1m below steel purlins	m²	367.00	-	-
EE		Ceilings suspended exceeding 2m and not exceeding 3m below steel purlins	m²	65.00	-	-
		PARTITITIONS				
		12mm Gyproc Rhinowall "Rhinoboard fixed to donn ultrasteel studs using 25mm & 41mm streaker screws at 220mm centres. All fixing/installation to comply with "BPB Gypsum" specifications.				
EF		1hr Fire rated Drywall above brickwork	m	33.78		

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		IRONMONGERY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		1924701-2-510-A-SC-0045-01-OC				
		SUPPLEMENTARY PREAMBLES				
		Protection				
		Notwithstanding anything to the contrary contained in the Model Preambles, all ironmongery items are to be brought to site suitably protected and to the satisfaction of the Employer's representative(s)				
		Works to include all hinges and sundry fixings unless detailed below as per manufacturers specification and satisfaction of the Employer's representative(s)				
		IRONMONGERY				
		Handles				
EG		Geze Daytona 19mm / 160 X 160 X 1.5/PL.C ylinder (Code: EDE/101C)	Pairs	- 2.00 -		Rate only
EH		Geze B/TH Pull handle 111 x 19 on 160 x 160 BP (Code: 075/160CL)	No	- -		
EI		Geze B/TH Pull handle 111 x 19 on 160 x 160 BP (Code: 075/160CR)	No	1.00 -		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Push plates and kick plates				
EJ		Geze 1.6mm Stainless steel push plate 160 X 160mm cylinder/RH (Code: 079/160CR)	No	1.00		
EK		Geze 1.6mm Stainless steel push plate 160 X 160mm cylinder/LH (Code: 079/160CL)	No	2.00		
EL		Geze 1.2mm Stainless Steel push plate 100 x 400mm (079/100/xx400x1.2)	No	2.00		
		Door closers		-		
EM		Geze TS2000G Door closer with guide rail & ARM SR (Code: AZ2003SR)	Sets	7.00		
EN		Geze TS500NV Double action floor spring NSO SS	Each	2.00		
		Locks		-		
EO		Geze 50mm Brass padlock master key (Code: IG95800507MK)	No	3.00		
EP		Geze N/PL Knob cylinder 60mm Master key (Code: IG955930308M)	No	4.00		
EQ		Geze N/PL DBL Cylinder 60mm master key (Code: IG950930308M)	No	-		Rate only
ER		Geze 76mm Profile arch sash lock stainless steel (Code: 730/68)	No	2.00		
ES		Geze 76mm Profile cylinder deadlock stainless steel (Code: 742/68)	No	2.00		
		Door stops		-		
ET		Geze Stainless steel F/Mnt doorstop (Code: 140/69)	No	5.00		
		Sundries		-		
EU		Geze 5.4mm PAT F/Screw NP 40-55mm (Code: 963/03)	No	16.00		
EV		Geze M5 Patent fixing screws (Code: ND0501)	No	21.00		
EW		Geze Rebate for 700 series lock (Code: 131/69)	Sets	2.00		
EX		Geze S/Chrome flush bolt 150 x 20mm (Code: 120/150)	No	2.00		
		Signage		-		
EY		Geze Stainless steel P/PL 160 x160 x 0.9mm E/Run/M (Code: 079/160E/RM)	No	2.00		
EZ		Geze Stainless steel P/PL 160 x 160 x 0.9mm E/Arrow (Code: 079/160E/A)	No	2.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		METALWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		ALUMINIUM LOUVRES				
		Trox AWR external weather louvres with 50mm flange and 316L stainless steel mesh, complete as per drawing 1924701-2-510-A-SC-0037-01-OC-AE				
				-		
FA		Louvre type LV01, 600 x 2000mm overall	No	4.00		
				-		
FB		Louvre type LV02, 5015 x 1575mm overall	No	4.00		
				-		
		STEEL ROLLER SHUTTERS ETC.		-		
				-		
		Serranda or equal approved powder coated galvanised steel push-up 75 x 1,0mm thick end locked slatted curtain roller shutter with overhead box 360mm high including canopy cover with standard bottom rail, windlock guides, ancillary components including 4,5mm thick end plates, guide rails, fusible link and release mechanism and canopy cover, fixed to structural steel jambs and concrete lintel, complete as per drawing 1924701-2-510-A-SC-0036-01-OC-AE		-		
				-		
FC		Door type D01, 4700 x 4500mm overall	No	1.00		
				-		
FD		Door type D02, 2000 x 2812mm overall	No	2.00		
				-		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PLASTER				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		INTERNAL PLASTER				
		One coat cement plaster on brickwork		-		
FE		On walls	m²	1 161.03		
FF		On narrow widths	m²	- 16.64		
		One coat cement plaster on concrete		-		
FG		On columns	m²	108.88		
FH		On beams	m²	- 47.24		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PAINTWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		PAINTWORK ETC. TO NEW WORK				
		ON EPOXY SURFACES				
		One coat "Mastertop Primer 1200 Plus" resin with Solvent No.2 to entire surface and two coats "Light Grey Mastertop 1210 Plus" topcoat & -75 x 6mm(thick) galvanised steel plate bonded with Sikaflex 11 FC		-		
FI		On concrete floors	m²	433.23		
				-		
FJ		On concrete walls	m²	337.42		
				-		
FK		On brick walls to form 100mm skirtings	m	420.00		
				-		
		ON PLASTER		-		
				-		
		Bag and apply one coat Plascon Professional Primer (PP700) with an overcoating time of 18 hours and finish with two coats Plascon Professional Superior Low Sheen (PEM100)		-		
				-		
FL		On walls	m²	974.48		
				-		
FM		On beams	m²	47.24		
				-		
		ON CONCRETE		-		
				-		
		Bag and apply one coat Plascon Plaster Primer (UC56) and two coats Plascon Super Acrylic Polven (EPL30). Apply as per manufactures guidelines		-		
				-		
FN		On soffits and landings	m²	-		Rate only
				-		
FO		On sloping soffits of stairs	m²	-		Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Bag and apply one coat Plascon Professional Primer (PP700) with an overcoating time of 18 hours and finish with two coats Plascon Professional Superior Low Sheen (PEM100)		-		
FP		On columns	m²	108.88		
				-		
FQ		On walls	m²	337.42		
				-		
		Sikalastic 841-ST spray applied pure polyurea waterproof membrane. Light Grey (RAL 7005).		-		
				-		
FR		On concrete landings	m²	15.00		
				-		
FS		On stairs risers and treads	m²	80.00		
				-		
FT		On concrete floor	m²	22.00		
				-		
FU		On brick walls to form 100mm skirtings	m	32.00		
				-		
		FIRE STOPPING		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0062-01-OC				
		1924701-2-510-A-GA-0017-01-OC				
		1924701-2-510-A-GA-0017-02-OC				
		1924701-2-510-A-SC-0036-01-OC				
		1924701-2-510-A-SC-0037-01-OC				
		1924701-2-510-A-SC-0040-01-OC				
		1924701-2-510-A-SE-0011-01-OC				
		1924701-2-510-A-SE-0011-02-OC				
		FIRE STOPPING				
		Fire stopping vertically rated at 60 minutes. Any fire stopping shall be carried out in accordance with SANS 10400 clause 4.39 & 4.40. The Contractor shall issue a certificate of compliance once the fire stopping installation is complete		-		
FV		Voids exceeding 0.5m2	m²	51.00		
				-		
				-		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Fire stopping horizontally to sleeves exceeding 100mm and not exceeding 200mm diameter through concrete rated at 120 minutes. Any fire stopping shall be carried out in accordance with SANS 10400 clause 4.39 & 4.40. The Contractor shall issue a certificate of compliance once the fire stopping installation is complete		-		
FW		420mm Thick reinforced concrete slab, beam, wall, etc.	No	- 78.00 -		
		SUBSTATION MAIN INTAKE				
		MASONRY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		MASONRY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0063-01-OC				
		1924701-2-510-A-GA-0018-01-OC				
		1924701-2-510-A-GA-0018-02-OC				
		1924701-2-510-A-SC-0038-01-OC				
		1924701-2-510-A-SC-0039-01-OC				
		1924701-2-510-A-SC-0042-01-OC				
		1924701-2-510-A-SC-0046-01-OB				
		1924701-2-510-A-SE-0012-01-OC				
		1924701-2-510-A-SE-0012-02-OC				
		SUPERSTRUCTURE				
		Brickwork in NFP clay stock bricks in class I cement mortar				
FX		230mm One brick wall	m²	- 1 108.20		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
FY		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties	m²	46.51		
				-		
FZ		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties circular on plan	m²	1.20		
				-		
		FACE BRICKWORK		-		
				-		
		Face bricks pointed with flush horizontal and vertical joints		-		
				-		
GA		Extra over brickwork in NFP bricks for face brickwork Corobrik 'Firelight Satin' or equal approved and flush pointed joints including sealing	m²	26.11		
				-		
		BRICKWORK SUNDRIES		-		
				-		
GB		Splayed mortar fillet one course high in 50mm cavity	m	7.20		
				-		
GC		Closing 50mm cavity of hollow wall vertically with brickwork half brick wide	m	2.40		
				-		
GD		Closing 50mm cavity of hollow wall horizontally with one course of brickwork	m	1.20		
				-		
		Movement joints with bituminous impregnated softboard between horizontal or vertical concrete and brick surfaces		-		
				-		
GE		12mm Joint not exceeding 300mm wide	m	48.00		
				-		
		Movement joints with "Sondor Jointex" between horizontal or vertical steel and brick surfaces		-		
				-		
GF		10mm Joint not exceeding 300mm wide	m	12.00		
				-		
		Brickwork reinforcement		-		
				-		
GG		75mm Wide reinforcement built in horizontally	m	1 742.45		
				-		
GH		150mm Wide reinforcement built in horizontally	m	1 736.00		
				-		
		Stresso pre-stressed fabricated lintels		-		
				-		
GI		90 x 75mm Lintel in lengths not exceeding 3m	m	12.00		
				-		
GJ		140 x 75mm Lintel in lengths not exceeding 3m	m	72.73		
				-		
		Galvanized hoop iron cramps, ties, etc.		-		
				-		
GK		40 x 1.6mm Wall tie strip shot pinned to concrete and with tie bent out and built into brickwork	No	121.20		
				-		
GL		40 x 1.6mm Wall tie strip shot pinned to steel IPE and with tie bent out and built into brickwork	No	44.40		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		WATERPROOFING				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0063-01-OC				
		1924701-2-510-A-GA-0018-01-OC				
		1924701-2-510-A-GA-0018-02-OC				
		1924701-2-510-A-SC-0038-01-OC				
		1924701-2-510-A-SC-0039-01-OC				
		1924701-2-510-A-SC-0042-01-OC				
		1924701-2-510-A-SC-0046-01-OB				
		1924701-2-510-A-SE-0012-01-OC				
		1924701-2-510-A-SE-0012-02-OC				
		SUPPLEMENTARY PREAMBLES				
		Waterproofing				
		Waterproofing of roofs, basements, etc. shall be laid under a ten year guarantee. Waterproofing to roofs shall be laid to even falls to outlets, etc. with necessary ridges, hips and valleys. Descriptions of sheet or membrane waterproofing shall be deemed to include additional labour to turn-ups and turn-downs				
		DAMPPROOFING OF WALLS AND FLOORS				
		One layer of 375 micron "Consol Plastics Brikgrip DPC" embossed damp proof course				
GM		In walls	m²	- 11.80 -		
		Sikaflex PRO-3 or equally approved waterproofing		- -		
GN		Between aluminium shopfronts and walls	m	93.00 -		
		Apply 2 coats 'A.B.E Brixeal' waterproofing or similar approved to cement plaster surface. All surfaces to be clean, dry, sound and free of oils and laitance. No special primer required. Stir well before use. Apply 2 coats and allow to dry. Brushed coat on: 1st coat 2 m2/L. Average unbagged: 2nd coat 4 m2/L brickwork, complete as per manufacturer's specifications		-		
GO		On walls	m²	- 59.71 -		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		WATERPROOFING TO ROOFS, BASEMENTS, ETC.				
		Sikalastic 841 ST Grey (RAL 7005) spray applied pure polyurea waterproof membrane installed as per manufacturer's specifications		-		
GP		On floors in Chiller Plant Room	m²	70.00		
		JOINT SEALANTS, ETC.		-		
		Approved silicone pointing, 10mm wide bead		-		
GQ		Between aluminium door & window frame and wall	m	590.00		
		Polysulphide sealant approved by the *Employer's* representative(s)		-		
GR		12 x 12mm In horizontal joint between brickwork and concrete	m	390.00		
GS		12 x 12mm Vertical Joint between brickwork and concrete	m	795.00		
GT		10 x 10mm Joint between brickwork and steel	m	170.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		CARPENTRY & JOINERY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0063-01-OC				
		1924701-2-510-A-GA-0018-01-OC				
		1924701-2-510-A-GA-0018-02-OC				
		1924701-2-510-A-SC-0038-01-OC				
		1924701-2-510-A-SC-0039-01-OC				
		1924701-2-510-A-SC-0042-01-OC				
		1924701-2-510-A-SC-0046-01-OB				
		1924701-2-510-A-SE-0012-01-OC				
		1924701-2-510-A-SE-0012-02-OC				
		DOORS, ETC.				
		Bitcon Industries or similar approved 2 hour rated fire doors with 1.2mm powder coated 316L stainless steel cladding to both sides hung to companion double rebated 1.6mm powder coated 316L stainless steel frames, complete as per drawing 1924701-2-510-A-SC-0027-01				
				-		
GU		Door type D01, 2000 x 2032mm overall, including powder coated 316L stainless steel frame for 230mm brick wall and preparing frame for door closers	No	5.00		
				-		
GV		Door type D01, 2000 x 2032mm overall, including powder coated 316L stainless steel frame for 230mm concrete wall and preparing frame for door closers	No	1.00		
				-		
GW		Door type D01, 2000 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No	1.00		
				-		
GX		Door type D02, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 230mm brick wall and preparing frame for door closers	No	11.00		
				-		
GY		Door type D02, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 230mm concrete wall and preparing frame for door closers	No	2.00		
				-		
GZ		Door type D02, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 250mm concrete wall and preparing frame for door closers	No	2.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
HA		Door type D02, 813 x 2032mm overall, including powder coated 316L stainless steel frame for 280mm brick wall and preparing frame for door closers	No	1.00		
		FITTINGS AND FURNITURE		- - -		
HB		Allow the Provisional Amount of TBA for Fittings and Furniture to Control Room to be executed by a specialist subcontractor as instructed by the *Employer*	PS	1.00		TBA
		CEILINGS, PARTITIONS AND ACCESS FLOORING		-		
		NOTE Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works To be read in conjunction with but not limited to the following Project Technical Specification(s) : 1924701-2-510-A-DE-0063-01-OC 1924701-2-510-A-GA-0018-01-OC 1924701-2-510-A-GA-0018-02-OC 1924701-2-510-A-SC-0038-01-OC 1924701-2-510-A-SC-0039-01-OC 1924701-2-510-A-SC-0042-01-OC 1924701-2-510-A-SC-0046-01-OB 1924701-2-510-A-SE-0012-01-OC 1924701-2-510-A-SE-0012-02-OC **SUPPLEMENTARY PREAMBLES** Descriptions Items described as "nailed" shall be deemed to be fixed with hardened steel nails or pins or shot pinned to brickwork or concrete Items described as "plugged" shall be deemed to include screwing to fibre, plastic or metal plugs at not exceeding 600mm centres, and where described as "bolted" the bolts have been given elsewhere				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		CEILINGS, ETC.				
		SUSPENDED CEILINGS				
		Gyproc Gyprex 'Frost White' 1200 x 600mm exposed ceiling Grid System. Donn QRC T38 Main Tees at 1200mm centres, Donn QRC T38 (1200) Cross Tee at 600mm centres. Every second perimeter main tee to be suitably fixed to the wall using "angle cleats". Donn Galvanised Hanger Wire 2.5mm (as main tee suspension). The wire should be wound 3 times at the main tee. Donn Galvanised Hanger Wire 2.5mm to be suitably suspended from a structural member. Hold down clips in area susceptible to draught. Wall angle: Donn SM25 wall angle				
HC		Ceilings suspended exceeding 1m and not exceeding 2m below steel purlins	m²	365.00		
				-		
HD		Ceilings suspended exceeding 2m and not exceeding 3m below steel purlins	m²	140.00		
				-		
HE		Ceilings suspended exceeding 3m and not exceeding 4m below steel purlins	m²	212.00		
				-		
		ACCESS FLOORING		-		
				-		
		Pentafloor access flooring with 1.5mm high pressure laminate "Grey Starlight" formica Smart Edge 600 x 600 x 35mm panels on a Snap Lock Stringer substructure system		-		
				-		
HF		Access flooring to control room floor	m²	132.80		
				-		
		IRONMONGERY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0063-01-OC				
		1924701-2-510-A-GA-0018-01-OC				
		1924701-2-510-A-GA-0018-02-OC				
		1924701-2-510-A-SC-0038-01-OC				
		1924701-2-510-A-SC-0039-01-OC				
		1924701-2-510-A-SC-0042-01-OC				
		1924701-2-510-A-SC-0046-01-OB				
		1924701-2-510-A-SE-0012-01-OC				
		1924701-2-510-A-SE-0012-02-OC				
		1924701-2-510-A-SC-0044-01-OC				
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUPPLEMENTARY PREAMBLES				
		Protection				
		Notwithstanding anything to the contrary contained in the Model Preambles, all ironmongery items are to be brought to site suitably protected and to the satisfaction of the *Employer*'s representative(s)				
		Drawings				
		The attached schedule form part of the tender documents and tenderers are referred to the schedule for tender purposes				
		IRONMONGERY				
		Handles				
HG		Geze Daytona 19mm 160 x 160 x 1.5mm PL cylinder (Code: EDE/101C)	Pairs	19.00		
HH		Geze 160 x 160mm Stainless steel handle (Code: 075/160)	No	3.00		
HI		Geze B/TH Pull handle 111 x 19 on 160 x 160 BP (Code: 075/160CL)	No	54.00		
HJ		Geze B/TH Pull handle 111 x 19 on 160 x 160 BP (Code: 075/160CR)	No	-		Rate only
		Push plates and kick plates		-		
HK		Geze 1.6mm Stainless steel push plates 160 x 160mm 304GR (Code: 079/160)	No	57.00		
HL		Geze 1.6mm Stainless steel push plate 160 X 160mm cylinder/LH (Code: 079/160CL)	No	-		Rate only
HM		Geze 1.6mm Stainless steel push plate 160 X 160mm cylinder/RH (Code: 079/160CR)	No	-		Rate only
		Door closers		-		
HN		Geze TS3000 door closer C/W ISM guide rail (Code: AZ3034SR)	Sets	30.00		
HO		Geze TS2000G door closer with guide rail & a rm SR (Code: AZ2003SR)	Sets	-		Rate only
		Locks		-		
HP		Assa Abloy 'Adams Rite' armlock 281 500kg mag lock (Code: 281-005) including 'Adams Rite' bracket (Code: 281-800)	No	-		Rate only
HQ		Geze 50mm Brass padlock master key (Code: IG95800507MK)	No	9.00		
HR		Geze N/PL DBL Cylinder 60mm Master Key (Code: IG950930308M)	No	19.00		
HS		Geze 76mm Profile Arch Sash Lock Stainless Steel (Code: 730/68)	No	19.00		
		Door stops		-		
HT		Geze Stainless steel floor mount doorstop (Code: 140/69)	No	82.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Sundries		-		
HU		Geze 5.4mm PAT F/screw NP 40-55mm (Code: 963/03)	No	304.00		
				-		
HV		Geze M5 Patent fixing screws (Code: ND0501)	No	171.00		
				-		
HW		Geze Rebate for 700 series lock (Code: 131/69)	Sets	6.00		
				-		
HX		Geze S/chrome flush bolt 150 x 20mm (Code: 120/150)	No	12.00		
				-		
		Signage		-		
				-		
HY		Geze Stainless steel P/PL 160 x160 x0.9mm E/Run/M (Code: 079/160E/RM)	No	30.00		
				-		
HZ		Geze Stainless steel P/PL 160 x 160 x 0.9mm E/arrow (Code: 079/160E/A)	No	30.00		
				-		
		METALWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0063-01-OC				
		1924701-2-510-A-GA-0018-01-OC				
		1924701-2-510-A-GA-0018-02-OC				
		1924701-2-510-A-SC-0038-01-OC				
		1924701-2-510-A-SC-0039-01-OC				
		1924701-2-510-A-SC-0042-01-OC				
		1924701-2-510-A-SC-0046-01-OB				
		1924701-2-510-A-SE-0012-01-OC				
		1924701-2-510-A-SE-0012-02-OC				
		ALUMINIUM LOUVRES				
		Trox AWR external weather louvres with 50mm flange and 316L stainless steel mesh, complete as per drawing 1924701-2-510-A-SC-0039-01-OC-AE				
				-		
IA		Louvre type LV01, 1320 x 3612mm overall	No	1.00		
				-		
IB		Louvre type LV02, 2000 x 3428mm overall	No	1.00		
				-		
IC		Louvre type LV03, 1455 x 3014mm overall	No	1.00		
				-		
ID		Louvre type LV04, curved 232 x 2613mm overall	No	1.00		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Trox ARK 2 Pressure relief damper louvres with 50mm flange, complete as per drawing 1924701-2-510-A-SC-0039-01-OC-AE				
IE		Louvre type LV05, 600 x 1000mm overall	No	2.00		
		ALUMINIUM SHOPFRONTS		-		
		Aluminium powder coated shopfronts with 6.38mm Solarvue Serene Green HL laminated coated safety glass fixed with neoprene gaskets and aluminium clip-on glazing beads, complete as per drawing 1924701-2-510-A-SC-0043-01-OB-AE		-		
IF		Shopfront type SF01, 5581 x 2687mm overall	No	1.00		
IG		Shopfront type SF02, 5581 x 3300mm overall	No	1.00		
IH		Shopfront type SF03, 3060 x 2687mm overall	No	1.00		
II		Shopfront type SF04, 5848 x 2500mm overall	No	1.00		
IJ		Shopfront type SF05, 5835 x 3300mm overall	No	1.00		
IK		Shopfront type SF06, 2640 x 3300mm overall	No	1.00		
		STEEL ROLLER SHUTTERS ETC.		-		
		"Serranda" Powder coated galvanised steel push-up 75 x 1.0mm thick end locked slatted curtain roller shutter with overhead box 360mm high including canopy cover with standard bottom rail, windlock guides, ancillary components including 4.5mm thick end plates, guide rails, fusible link and release mechanism and canopy cover, fixed to structural steel jambs and concrete lintel, complete as per drawing 1924701-2-510-A-SC-0038-01-OC-AE		-		
IL		Door type D03, 2800 x 2700mm overall	No	9.00		
		PLASTER		-		
		NOTE Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works To be read in conjunction with but not limited to the following Project Technical Specification(s) : 1924701-2-510-A-DE-0063-01-OC 1924701-2-510-A-GA-0018-01-OC 1924701-2-510-A-GA-0018-02-OC 1924701-2-510-A-SC-0038-01-OC 1924701-2-510-A-SC-0039-01-OC 1924701-2-510-A-SC-0042-01-OC				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		1924701-2-510-A-SC-0046-01-OB				
		1924701-2-510-A-SE-0012-01-OC				
		1924701-2-510-A-SE-0012-02-OC				
		INTERNAL PLASTER				
		One coat cement plaster on brickwork		-		
IM		On walls	m²	2 841.67		
				-		
IN		On narrow widths	m²	4.00		
				-		
		PAINTWORK		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-A-DE-0063-01-OC				
		1924701-2-510-A-GA-0018-01-OC				
		1924701-2-510-A-GA-0018-02-OC				
		1924701-2-510-A-SC-0038-01-OC				
		1924701-2-510-A-SC-0039-01-OC				
		1924701-2-510-A-SC-0042-01-OC				
		1924701-2-510-A-SC-0046-01-OB				
		1924701-2-510-A-SE-0012-01-OC				
		1924701-2-510-A-SE-0012-02-OC				
		PAINTWORK ETC. TO NEW WORK				
		ON EPOXY SURFACES				
		One coat "Mastertop Primer 1200" with Solvent No.2 to entire surface and two coats "Mastertop 1210 light grey"		-		
IO		On concrete floors	m²	1 551.50		
				-		
		ON PLASTER		-		
				-		
		Bag and apply one coat Plascon Professional Primer (PP700) with an overcoating time of 18 hours and finish with two coats Plascon Professional Superior Low Sheen (PEM100)		-		
IP		On walls	m²	2 874.61		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ON CONCRETE				
		Bag and apply one coat Plascon Plaster Primer (UC56) and two coats Plascon Super Acrylic Polven (EPL30). Apply as per manufacture's guidelines		-		
IQ		On ceilings and landings	m²	1 402.36		
IR		On sloping soffits of stairs	m²	11.55		
		Bag and apply one coat Plascon Professional Primer (PP700) with an overcoating time of 18 hours and finish with two coats Plascon Professional Superior Low Sheen (PEM100)		-		
IS		On columns	m²	228.79		
IT		On walls	m²	1 344.30		
		ON METAL		-		
		Prepare, clean and apply intumescent paint to create 2 hour fire protection rating		-		
IU		On columns and beams	m²	8.00		
		FIRE STOPPING				
		NOTE Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works To be read in conjunction with but not limited to the following Project Technical Specification(s) : 1924701-2-510-A-DE-0063-01-OC 1924701-2-510-A-GA-0018-01-OC 1924701-2-510-A-GA-0018-02-OC 1924701-2-510-A-SC-0038-01-OC 1924701-2-510-A-SC-0039-01-OC 1924701-2-510-A-SC-0042-01-OC 1924701-2-510-A-SC-0046-01-OB 1924701-2-510-A-SE-0012-01-OC 1924701-2-510-A-SE-0012-02-OC				
		FIRE STOPPING				
		Fire stopping horizontally rated at 120 minutes. Any fire stopping shall be carried out in accordance with SANS 10400 clause 4.39 & 4.40. The *Contractor* shall issue a certificate of compliance once the fire stopping installation is complete		-		
IV		Voids exceeding 0.1m2 not exceeding 0.5m2	m²	1.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
IW		Voids exceeding 0.5m2	m²	155.00		
				-		
		Fire stopping horizontally to sleeves exceeding 100mm and not exceeding 200mm diameter through concrete rated at 120 minutes. Any fire stopping shall be carried out in accordance with SANS 10400 clause 4.39 & 4.40. The *Contractor* shall issue a certificate of compliance once the fire stopping installation is complete		-		
				-		
IX		250mm Thick reinforced concrete slab, beam, wall, etc.	No	203.00		
				-		
IY		300mm Thick reinforced concrete slab, beam, wall, etc.	No	64.00		
				-		
		Fire stopping vertically to sleeves exceeding 100mm and not exceeding 200mm diameter through concrete rated at 120 minutes. Any fire stopping shall be carried out in accordance with SANS 10400 clause 4.39 & 4.40. The *Contractor* shall issue a certificate of compliance once the fire stopping installation is complete		-		
				-		
IZ		300mm Thick reinforced concrete slab, beam, wall, etc.	No	105.00		
				-		
		MAIN INTAKE (P) (YARD EQUIPMENT)				
		MASONRY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0027-01-OC-AE				
		FOUNDATIONS				
		Brickwork in NFX clay stock bricks in class I cement mortar		-		
				-		
JA		230mm One brick wall	m²	12.00		
				-		
		SUPERSTRUCTURE		-		
		Brickwork in NFP clay stock bricks in class I cement mortar		-		
				-		
JB		230mm One brick wall	m²	5.00		
				-		
JC		230mm Knockout one brick wall	m²	2.00		
				-		
JD		Mass brickwork to steps	m³	1.00		
				-		
		FACE BRICKWORK		-		
				-		
		Face bricks pointed with flush horizontal and vertical joints		-		
				-		
JE		Extra over brickwork in NFP bricks for face brickwork Corobrik 'Golden Wheat' or equal approved and flush pointed joints including sealing	m²	5.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		BRICKWORK SUNDRIES				
		Brickwork reinforcement		-		
JF		150mm Wide reinforcement built in horizontally	m	13.20		
		PLASTER		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0027-01-OC-AE				
		SCREEDS				
		Screeds wood floated, on concrete		-		
JG		15mm Thick on treads and risers of stairs including reedings	m²	6.00		
JH		15mm Thick on sides of steps	m²	- 2.40		
				-		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		YSTERVARK (BUILDING)				
		MASONRY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		FOUNDATIONS				
		Brickwork in NFX clay stock bricks in class I cement mortar		-		
JI		230mm One brick wall	m²	-		Rate only
JJ		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties	m²	-		Rate only
		SUPERSTRUCTURE		-		
		Brickwork in NFP clay stock bricks in class I cement mortar		-		
JK		Half brick walls in beamfilling	m²	7.00		
JL		230mm One brick wall	m²	10.00		
JM		280mm Cavity wall of two half brick skins including galvanised wire butterfly ties	m²	8.00		
		FACE BRICKWORK		-		
		Face bricks pointed with flush horizontal and vertical joints		-		
JN		Extra over brickwork in NFP bricks for face brickwork Corobrik 'Golden Wheat' or equal approved and flush pointed joints including sealing	m²	22.00		
JO		Face brick on edge lintol	m	10.80		
JP		Face brick on edge sill	m	1.00		
		BRICKWORK SUNDRIES		-		
JQ		Splayed mortar fillet one course high in 50mm cavity	m	6.00		
JR		Closing 50mm cavity of hollow wall vertically with brickwork half brick wide	m	6.00		
JS		Closing 50mm cavity of hollow wall horizontally with one course of brickwork	m	2.00		
		Movement joints with "Sondor Jointex" between horizontal or vertical brick surfaces		-		
JT		10mm Joint not exceeding 300mm wide	m²	9.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Brickwork reinforcement		-		
JU		75mm Wide reinforcement built in horizontally	m	250.00		
				-		
JV		150mm Wide reinforcement built in horizontally	m	75.00		
				-		
		Stresso pre-stressed fabricated lintels		-		
				-		
JW		90 x 75mm Lintel in lengths not exceeding 3m	m	3.22		
				-		
		Galvanized hoop iron cramps, ties, etc.		-		
				-		
JX		30 x 1,6mm Roof tie 1,5m long with one end fixed to timber and other end built into brickwork	No	-		Rate only
				-		
		Air bricks etc.		-		
				-		
JY		220 x 160mm Cement air brick	No	8.00		
				-		
		WATERPROOFING		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		SUPPLEMENTARY PREAMBLES				
		Waterproofing				
		Waterproofing of roofs, basements, etc. shall be laid under a ten year guarantee. Waterproofing to roofs shall be laid to even falls to outlets, etc. with necessary ridges, hips and valleys. Descriptions of sheet or membrane waterproofing shall be deemed to include additional labour to turn-ups and turn-downs				
		DAMPPROOFING OF WALLS AND FLOORS				
		One layer of 375 micron "Consol Plastics Brikgrip DPC" embossed damp proof course		-		
JZ		In walls	m²	2.00		
				-		
		One layer of 500 micron "Gundle Plastics Gunplas USB Orange" waterproof sheeting sealed at laps with "Gunplas Pressure Sensitive Tape"		-		
				-		
KA		Under surface bed	m²	-		Rate only
				-		
		JOINT SEALANTS, ETC.		-		
				-		
		Approved silicone pointing, 10mm wide bead		-		
				-		
KB		Between door & window frame and wall	m	43.00		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Polyurethane sealant approved by the *Employer's* representative(s)		-		
				-		
KC		10 x 10mm In expansion joint not exceeding 300mm high through wall	m	17.00		
		ROOF COVERINGS ETC.				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		PROFILED METAL SHEETING AND ACCESSORIES				
		0.8mm Thick galvanised "Chromodek" IBR sheeting on green sheeting fixed to timber purlins		-		
KD		Roof covering with pitch not exceeding 25 degrees	m²	69.14		
				-		
KE		Ridge capping 740mm girth	m	12.00		
				-		
		CARPENTRY & JOINERY		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		ROOFS ETC.				
		Plate nailed timber roof truss construction				
		The following is applicable in respect of roof trusses				
		Trusses are at maximum 600mm centres				
		Roof covering is "Chromadek" IBR sheeting on purlins. Ceilings are 4mm suspended fibre cement panel ceilings. The references given in the descriptions are to the respective types of trusses detailed on the drawings. The dimensions in the descriptions of the trusses are nominal and actual measurements are to be obtained from the *Employer's* representative(s) and/or the site before design or fabrication commences				
				-		
		Sawn softwood		-		
				-		
KF		114 x 38mm Wall plates	m	23.00		
				-		
KG		76 x 50mm Purlins	m	95.00		
				-		
				-		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
KH		Queen truss 4200 x 845mm high overall at maximum 600mm centres with 520mm eaves overhang projection on both sides	No	19.00		
		Nutec pressed fibre-cement		-		
KI		Eaves soffit covering 1225mm wide of 4mm thick sheets including 38 x 38mm sawn softwood brandering along edges, along centre and at 450 x 900mm centres across sheets	m²	23.00		
		Nutec Fascias and bargeboards		-		
KJ		225 x 10mm Fascias including galvanised steel H-profile jointing strips	m	24.00		
KK		275 x 80mm Barge boards including galvanised steel H-profile jointing strips	m	13.00		
		EAVES, VERGES, ETC.		-		
		Sawn softwood		-		
KL		15mm Quadrant beads	m	47.00		
KM		18mm Half round cover strips	m	19.00		
		DOORS, ETC.		-		
		Transformer room door		-		
KN		Door type D01, 1600 x 2100mm overall (Code: Type M)	No	1.00		
		Meranti FLBB door		-		
KO		Door type D04, 1160 x 1080mm overall	No	1.00		
		WINDOWS		-		
		Swartland Wrought meranti windows		-		
KP		Window type W1, 545 x 600mm overall (Code: Swartland SD1)	No	1.00		
		FRAMED FRAMES ETC.		-		
		Wrought meranti		-		
KQ		108 x 70mm Frame suitable for door type D4, 1160 x 1080mm overall	No	1.00		
		DUCT COVERS		-		
		Wrought meranti		-		
KR		3374 x 700mm Framed frames fixed to brickwork with M8 x 100mm CSK expansion bolts at 800mm centres	m	15.00		
		Nutec pressed fibre-cement		-		
KS		690 x 1100 x 15mm Flat sheets fixed to meranti frame with stainless steel screws at 265mm centres along vertical edges	No	6.00		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		CEILINGS, PARTITIONS AND ACCESS FLOORING				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		SUPPLEMENTARY PREAMBLES				
		Descriptions				
		Items described as "nailed" shall be deemed to be fixed with hardened steel nails or pins or shot pinned to brickwork or concrete				
		Items described as "plugged" shall be deemed to include screwing to fibre, plastic or metal plugs at not exceeding 600mm centres, and where described as "bolted" the bolts have been given elsewhere				
		CEILINGS, ETC.				
		SUSPENDED CEILINGS				
		4mm Thick fibre cement panel as suspended ceiling panel set in white pre-painted aluminium T-hanger system		-		
KT		Ceilings suspended not exceeding 1m below timber trusses	m²	41.00		
		SUSPENDED CEILING SUNDRIES		-		
KU		Extra over ceiling for opening for light fitting	No	7.00		
KV		Extra over ceiling for 550 x 550mm trap door	No	2.00		
		CEILING INSULATION		-		
		50mm "Isotherm" or similar approved		-		
KW		On suspended ceilings	m²	41.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		IRONMONGERY				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		SUPPLEMENTARY PREAMBLES				
		Protection				
		Notwithstanding anything to the contrary contained in the Model Preambles, all ironmongery items are to be brought to site suitably protected and to the satisfaction of the *Employer*'s representative(s)				
		Drawings				
		The attached schedule form part of the tender documents and tenderers are referred to the schedule for tender purposes				
		IRONMONGERY				
		Hinges		-		
KX		100 x 4.2mm Thick heavy duty flanged brass hinge	No	6.00		
KY		100mm Brass butt hinge	Pairs	3.00		
KZ		Howick 125 x 150mm Brass parliament hinge (Code: H085R)	Pairs	4.00		
		Handles		-		
LA		Pull handle on 152 x 76mm modular backplate	No	1.00		
LB		Pad latch	No	1.00		
		Locks		-		
LC		Union cast zinc bathroom indicator bolt	No	2.00		
LD		120 x 40mm Wide tongue and groove assembly lockset	No	1.00		
		Sundries		-		
LE		Howick 178 x 50mm brass double knuckle hasp & staple (Code: H055)	No	2.00		
LF		Howick 200 x 32mm brass necked bolts (Code: H108)	No	1.00		
LG		Howick 100 x 32mm brass barrel bolts (Code: H100)	No	4.00		
LH		150mm long cabin hook and eye fixed to wall with meranti blocks	No	3.00		
LI		Union aluminium hat & coat hook (Code: AL8722AS)	No	2.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		BATHROOM ACCESSORIES				
		Bidvest Steiner' or equal approved		-		
LJ		360 x 125 x 130mm Toilet roll holder 3 sateen (colour: silver)	No	1.00		
		METALWORK		-		
		NOTE		-		
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works		-		
		DOORS, ETC.		-		
		Steel door		-		
LK		Door type D02 & D03, 900 x 2100mm overall	No	2.00		
		Steel Frames		-		
		1.6mm Pressed galvanised steel frames		-		
LL		270 x 44mm Steel frame suitable for door type D01, 1600 x 2100mm overall	No	1.00		
LM		155 x 44mm Steel frame suitable for door type D02 & D03, 900 x 2100mm overall	No	2.00		
		Shelving		-		
LN		600mm Cable rack complete with brackets fixed to brickwork	m	18.00		
LO		100mm Fibre optic cable rack complete with brackets fixed to brickwork	m	21.00		
		SUNDRIES		-		
LP		50 x 3mm Flat copper bar fastened to purlins, complete	kg	47.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PLASTER				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		SCREEDS				
		Sikafloor 381 Epoxy screeds on concrete		-		
LQ		5mm Thick on floors and landings	m²	28.00		
		INTERNAL PLASTER		-		
		One coat cement plaster on brickwork		-		
LR		On walls	m²	175.00		
LS		On narrow widths	m²	5.00		
		TILING		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		SUPPLEMENTARY PREAMBLES				
		Fixing				
		Unless described as "fixed with adhesive to plaster (plaster elsewhere)" descriptions of tiling on brick or concrete walls, columns, etc. shall be deemed to include 1:4 cement plaster backing and descriptions of tiling on concrete floors etc. shall be deemed to include 1:3 plaster bedding				
		Tiling described as "fixed with adhesive on power floated concrete" shall be deemed to include for approved tiling key-coat				
		Tiling to floors and landings includes surface beds, landings and suspended slabs, with cement screed surface (cement screed measured elsewhere)				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Samples				
		Contractor to allow for and provide a minimum of four grouting samples of each tile type complete with at least four tiles fixed to a freestanding board, all for the *Employer's* representative(s) approval				
		Descriptions				
		Prime Cost Amounts (PC) are the net selling price per m² as per the suppliers				
		The *Contractor* is to allow for in his rate for wastage and transport				
		Prices to included for supply, transport, wastage, storage, protection, cutting and laying of tiles complete including approved adhesive and grout, all in accordance with manufacturer's specifications and to the satisfaction of the *Employer's* representative(s)				
				-		
		Tiling to have aluminium edging to all exposed tile edges and corners		-		
				-		
		WALL TILING		-		
				-		
		150 x 150mm Glazed white tiles fixed to plastered walls including grouting, etc.		-		
				-		
LT		On walls (PC amount of R290/m²)	m²	1.00		
				-		
LU		Take delivery of, sort and install 150 x 150mm porcelain tiles on walls	m²	1.00		
				-		
		PLUMBING AND DRAINAGE				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		RAINWATER DISPOSAL				
		Iso Box Longspan gutters		-		
LV		280 x 198mm Eaves gutters	m	24.00		
				-		
LW		Extra over eaves gutter for stopped end	No	4.00		
				-		
LX		Extra over eaves gutter for outlet for 75mm pipe	No	2.00		
				-		
		PVC downpipes		-		
				-		
LY		75mm Diameter rainwater downpipe	m	33.00		
				-		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Sundries		-		
LZ		Extra over rainwater pipe for shoe	No	3.00		
				-		
MA		Extra over rainwater pipe for bend	No	6.00		
				-		
		SANITARY WARE		-		
				-		
		Vaal or similar approved		-		
				-		
MB		Klip vitreous china washdown pan with enlarged pedestal (Code: 751200) and matching 9 litre cistern (Code: 7116LL) complete with lid and fitments	No	1.00		
				-		
MC		Bantam 455 x 290mm vitreous china basin with one taphole, integrated overflow, chainstay hole, wall brackets and fixings	No	1.00		
				-		
		WASTE UNIONS ETC.		-		
				-		
		Cobra or similar approved		-		
				-		
MD		Chrome plated basin waste slotted with 62mm diameter flange and 80mm long shank	No	1.00		
				-		
		TRAPS ETC.		-		
				-		
		Cobra or similar approved		-		
				-		
ME		32mm 360 CP lagged bottle trap with 40mm PVC adaptor	No	1.00		
				-		
		TAPS, VALVES, ETC.		-		
				-		
		Cobra or similar approved		-		
				-		
MF		Star pillar tap (Code: 211-15)	No	1.00		
				-		
MG		Angle regulating valves (Code: 832-10)	No	2.00		
				-		
		GLAZING				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		TOPS, SHELVES, DOORS, MIRRORS, ETC.				
		6mm Silvered float glass mirrors with polished edges fixed above basin with spacers and stainless steel round head fixing screws centred above basin with rubber washers as per manufacturer's specifications				
				-		
MH		Mirror 600 x 450mm high	No	1.00		
				-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		GLAZING TO WOOD WITH PINNED ON BEADS (BEADS ELSEWHERE)				
		6.38mm Frosted safety glass		-		
MI		Panes exceeding 0,1m2 and not exceeding 0,5m2	m²	1.00		
		PAINTWORK		-		
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		PAINTWORK ETC. TO NEW WORK				
		EXTERIOR				
		ON METAL				
		Clean with degreaser, one coat epoxy primer and two coats enamel		-		
MJ		On steel doors	m²	14.00		
MK		On steel door frames	m²	- 5.00		
		ON FIBRE-CEMENT		-		
		One universal under coat and two coats white acrylic PVA paint		-		
ML		On eaves soffits	m²	- 12.00		
MM		On fascias and barge boards	m²	- 20.00		
MN		On duct covers	m²	- 10.00		
		INTERIOR		-		
		ON PLASTER		-		
		One filler coat and two coats "Dulux Wash n Wear" PVA paint		-		
MO		On walls	m²	- 237.00		
		ON FIBRE-CEMENT		-		
		One filler coat and two coats "Dulux Wash n Wear" PVA paint		-		
MP		On ceilings and cornices	m²	- 41.00		
				-		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	TENDER AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ON WOOD				
		One coat clear sealer and two coats of approved polyurethane finish				
MQ		On timber windows	m²	1.00		
MR		On timber doors	m²	13.00		
MS		On timber door frames	m²	1.00		
		ON FLOORS				
		Epoxy paint				
MT		On floors	m²	17.00		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
13		**SECTION 12 : STRUCTURES AND FOUNDATIONS**				
		SUBSTATION M				
		CONCRETE, FORMWORK AND REINFORCEMENT				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0015-01-OC-AE				
		1924701-2-510-B-LA-0033-01-OC-AE				
		1924701-2-510-B-LA-0034-01-OC-AE				
		1924701-2-510-B-LA-0035-01-OC-AE				
		1924701-2-510-B-LA-0042-01-OC-AE				
		1924701-2-510-B-SE-0011-01-OC-AE				
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	8.2	**SCHEDULED FORMWORK ITEMS**				
	8.2.1	**Rough formwork**				
		Vertical surfaces				
A		Raft foundation	m²	-		N/A
B		Strip footings	m²	-		Rate only
C		Mass concrete to stairs	m²	12.00		
	8.2.2	**Smooth formwork**				
		Vertical surfaces				
D		Sides of beams	m²	7.00		
E		Sides of upstand beams	m²			
F		Walls not exceeding 3.5m in height	m²	-		Rate only
G		Rectangular column not exceeding 3.5m in height	m²	-		Rate only
H		Ditto, but Square column	m²	56.16		
I		Rectangular columns exceeding 6.5m and not exceeding 8m in height	m²	-		Rate only
J		Ditto, but Rectangular columns	m²	121.50		
K		Rectangular columns exceeding 8m and not exceeding 9.5m in height	m²	-		Rate only
L		Outer edge of slab not exceeding 300mm high	m	71.10		
M		Edge, riser, end and reveal not exceeding 300mm high or wide	m	54.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
N		Edge, riser, end and reveal exceeding 300mm high or wide	m²	23.00		
		Horizontal surfaces				
O		Soffits of beams	m²	-		Rate only
P		Soffits of landings propped up not exceeding 1.5m high	m²	-		Rate only
		Sloping surfaces				
Q		Sloping outer edge of ramp 1200mm high extreme	m	-		Rate only
	8.3	**SCHEDULED REINFORCEMENT ITEMS**				
	8.3.2	**High Tensile Welded Mesh**				
R		Type reference 395	m²	38.00		
	8.3.1	**Steel bars of various diameters**				
S		Mild steel	t	-		Rate only
T		High tensile steel	t	-		Rate only
	8.4	**SCHEDULED CONCRETE ITEMS**				
	8.4.3	**Strength concrete**				
U		Grade 15MPa/19mm concrete to blinding	m³	-		Rate only
V		Grade 15MPa/19mm concrete to cavity walls	m³	-		Rate only
W		Grade 40MPa/19mm concrete to strip footings	m³	-		Rate only
X		Grade 30MPa/19mm concrete to mass concrete infill	m³	-		Rate only
Y		Grade 40MPa/19mm concrete to raft	m³	-		N/A
Z		Grade 40MPa/19mm concrete to columns	m³	8.00		
AA		Grade 40MPa/19mm concrete to surface beds including beams and inverted beams	m³	2.00		
AB		Grade 40MPa/19mm concrete to stairs including landings, beams and inverted beams	m³	2.22		
AC		Grade 40MPa/19mm concrete to walls	m³	-		Rate only
	8.4.4	**Unformed Surface Finishes**				
		Power floated finish				
AD		Slabs	m²	-		Rate only
		Wood floated finish				
AE		Slabs	m²	12.00		
	8.7	**GROUTING**				
		Non-shrink grout				
AF		20mm Thick under base plates	dm3	-		Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SLEEVES, HOLES, ETC.				
		Sleeves exceeding 100mm and not exceeding 200mm diameter through				
AG		270mm Thick reinforced concrete slab, beam, wall, etc.	No	-		Rate only
AH		420mm Thick reinforced concrete slab, beam, wall, etc.	No	-		Rate only
		STRUCTURAL STEELWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0015-01-OC-AE				
		1924701-2-510-B-LA-0033-01-OC-AE				
		1924701-2-510-B-LA-0034-01-OC-AE				
		1924701-2-510-B-LA-0035-01-OC-AE				
		1924701-2-510-B-LA-0042-01-OC-AE				
		1924701-2-510-B-SE-0011-01-OC-AE				
	SANS 1200 H	**STRUCTURAL STEELWORK**				
	8.3.1	**SUPPLY AND FABRICATION**				
	8.3.1.1	**Preparation of shop detail drawings**				
AI		Prepare and submit detailed shop drawings as described in the Project Specification and to the approval of the Employer's representative	t	3.58		
		Allowance for trial assembly				
AJ		Trial assembly	t	-		Rate only
	8.3.1.2	**Supply and fabrication of steelwork**				
		Supply and fabricate in S355JR steel to SANS 50025 all steelwork complete with all the necessary cleats, shop bolts, brackets, gussets, packs, base plates, etc., delivered ex works ready for dispatch to site. For all hollow sections supply and fabricate in S355JRH steel to SANS 657 and /or SANS 50219. All steelwork to be hot dip galvanized to SABS ISO 1461. This includes purlins, purlin bracing, sheeting rails and anti-sag angles and anti-sag bars. All bolts and nuts shall be hot dip galvanized to SABS ISO 1461				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Light Steelwork 0-25kg/m				
AK		70 x 70 x 8 L (8.36kg/m)	t	0.73		
AL		15 x 90 x 10 L (10kg/m)	t	0.01		
AM		CFLC 125 x 65 x 20 x 2.5 (5.47kg/m)	t	0.47		
AN		CHS 63.5 x 5.0 (7.16kg/m)	t	0.03		
AO		CHS 101.6 x 3.0 (7.32kg/m)	t	0.32		
AP		PFC 180 x 70 (21.1kg/m)	t	0.10		
		Wall Stiffeners				
AQ		PLT 10 (Wall stiffeners)	t	-		Rate only
AR		PLT 8 (Base plates)	t	0.01		
AS		PFC 300 x 100 (24.5 kg/m)	t	0.18		
AT		75 x 50 x 6 L (5.65 kg/m)	t	0.01		
AU		R12 rebar welded to base plates & cast into concrete cavity infill (0.89kg/m)	No	-		Rate only
		Extra over for end load bearing plates and intermediate stiffeners				
AV		PLT 8 (Stiffeners)	t	-		Rate only
AW		PLT 10 (Stiffeners)	t	-		Rate only
AX		PLT 10 (Base plates)	t	-		Rate only
AY		PLT 10 (Cleats)	t	-		Rate only
AZ		PLT 16 (End plates)	t	-		Rate only
BA		PLT 20 (Stiffeners)	t	-		Rate only
BB		PLT 20 (End plates)	t	-		Rate only
BC		PLT 30 (Base plates)	t	-		Rate only
	8.3.4	**ERECTION BOLTS**				
		Class 5.8 high tensile bolts, Class 8 nuts and washers to new structural steelwork and platework				
BD		M8 Bolts	kg	-		Rate only
BE		M10 Bolts	kg			Rate only
		Class 8.8 high tensile bolts, Class 8 nuts and washers to new structural steelwork and platework				
BF		M8 Bolts	kg	12.57		
BG		M10 Bolts	kg	18.93		
BH		M12 Bolts	kg			Rate only
BI		M16 Bolts	kg	31.49		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
BJ		M18 Bolts	kg			Rate only
BK		M20 Bolts	kg			Rate only
		Hilti bolts				
BL		HD-M24-300 Holding down bolt with anchor plate	No	21.00		
BM		HSFG-M24 high strength friction grip bolt CLASS 10.9	No	23.00		
BN		JBL-M20-300 J-Bolt	No	6.00		
BO		M8 Hilti HSA studs with Hilti HIT-HY200 injection mortar (80mm embedment deep)	No	60.00		
BP		M8 Hilti HSA stud anchor bolts with Hilti HIT-HY200 injection mortar (80mm embedment deep)	No	28.00		
BQ		M16 Hilti V-R threaded rods with Hilti HIT-HY200 injection mortar (80mm embedment deep)	No	4.00		
BR		M20 Hilti V-R threaded rods with Hilti HIT-HY200 injection mortar (90mm embedment deep)	No	10.00		
		BALUSTRADE, FLOORING, TREADS ETC.				
	8.3.7	**HANDRAILS**				
	8.3.7.b	**a) Handrail assembly complete**				
	8.3.7.b.1	1) Horizontal				
BS		Macklock heavy duty 34.1mm x 2.0mm 316L stainless steel tubular and forged handrail fixed to wall with 10mm thick stainless steel rods at 900mm centres complete	m	69.00		
BT		Macklock heavy duty 316L stainless steel balustrade comprising of 60mm diameter x 3mm thick tubular stanchion 1040mm high at 900mm centres including 150 x 80 x 10mm thick base plate fixed to steel with 2No. bolts including 43mm diameter x 2.5mm thick tubular intermediate rail and 43mm diameter x 2.5mm thick tubular handrail both fixed to balustrade complete	m	52.00		
	8.3.7.b.2	2) Raking/ sloping				
BU		Macklock heavy duty 34.1mm x 2.0mm 316 Lstainless steel tubular and forged handrail fixed to wall with 10mm thick stainless steel rods at 900mm centres complete	m	-		Rate only
BV		Macklock heavy duty 316L stainless steel balustrade comprising of 60mm diameter x 3mm thick tubular stanchion 1040mm high at 900mm centres including 150 x 80 x 10mm thick base plate fixed to steel with 2No. bolts including 43mm diameter x 2.5mm thick tubular intermediate rail and 43mm diameter x 2.5mm thick tubular handrail both fixed to balustrade complete	m	-		Rate only
	8.3.7.b.3	3) Shaped ends				
BW		Macklock heavy duty 316L stainless steel balustrade shaped end comprising of 60mm diameter x 3mm thick tubular 316L stainless steel including fixing to balustrade	No	18.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Extra over balustrades/handrails				
BX		Extra over balustrades for 45 degree bends	No	10.00		
BY		Extra over balustrades for 90 degree bends	No			Rate only
BZ		Extra over handrails for 45 degree bends	No	6.00		
CA		Extra over handrails for 90 degree bends	No			Rate only
	8.3.9	**FLOORING, COMPLETE AND INSTALLED WITH FRAMES**				
		Flooring, complete and installed with frames:				
CB	8.3.9.3	6mm Vastrap or equal approved floor plate floor fixed to 50 x 50 x 8mm angles cast into concrete with Y10 lugs at 300mm centres, including countersunk bolts, complete	m²	80.00		
	8.3.2	**DELIVERY**				
	8.3.2.1	Normal delivery				
CC		Normal delivery to site of new structural steelwork and platework (as listed)	t	8.94		
CD		Abnormal delivery to site of new structural steelwork	t			Rate only
	8.3.3	**ERECTION ON SITE**				
CE		Erection on site of all new structural steelwork and platework (as listed)	t	17.88		
	SANS 1200 HC	**CORROSION PROTECTION OF STRUCTURAL**				
	8.2.3	**Surface preparation and coating application**				
		Supply, prepare and apply corrosion protection in accordance with Employer's Specification on new steel, in the shop and on site (shown above)				
CF	8.2.3.a	a) In shop (new structural steelwork shown above)	t	16.77		
CG	8.2.3.b	b) On site (new structural steelwork shown above)	t	16.77		
	SANS 1200 HC	**CLADDING & SHEETING**				
	8.2.2	Aluminium IBR roof and side cladding with mill finish, including all ribs, fixings, flashings, ridging, cranked or bullnosed sheets etc. installation in accordance with manufacturers specifications				
CH		0.9mm Thick curved sheeting on roofs	m²	523.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		METAL SAFETY HOOKS				
		316L Stainless steel "Ringanka Kee i-bolt®" safety eyebolts shall be fixed into steel purlin using 102mm M12 Female threaded curled inserts supplied by "Fall Protection Engineering Works" or approved equivalent, spaced equally at a maximum spacing of 1.5 m centres				
CI		Safety bolts fixed to steel purlin including drilling, waterproofing, etc. complete	No	22.00		
		INSULATION				
		50mm thick, non-combustible, lightweight 'Factorylite' building insulation with reinforced aluminium foil facing on one side (facing down), with thermal resistance of 1.28m2K/W, installed over purlins and using 2.5mm thick 316L stainless steel straining wires spaced at 300mm centres and hoop irons and clamps as per manufacturer's installation guidelines				
CJ		Roof insulation	m²	523.00		
		RAINWATER GOODS				
		Aluminium gutter (shop drawing to be preapproved by Employer's representative(s)). Colour to match roof sheeting				
CK		300mm x 200mm Gutters	m	68.00		
CL		Extra over gutter for stopped end	No	4.00		
CM		Extra over gutter for outlet for 110mm pipe	No	8.00		
		Aluminium rainwater pipes				
CN		110mm downpipes	m	44.00		
CO		Extra over 110mm rainwater pipe for bend	No	8.00		
CP		Extra over 110mm rainwater pipe for shoe	No	8.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUBSTATION N				
		CONCRETE, FORMWORK AND REINFORCEMENT				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-DE-0016-01-OC-AE				
		1924701-2-510-LA-0036-01-OC-AE				
		1924701-2-510-LA-0037-01-OC-AE				
		1924701-2-510-LA-0038-01-OC-AE				
		1924701-2-510-LA-0043-01-OC-AE				
		1924701-2-510-SE-0012-01-OC-AE				
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	8.2	**SCHEDULED FORMWORK ITEMS**				
	8.2.1	**Rough formwork**				
		Vertical surfaces				
CQ		Raft foundation	m²			
CR		Strip footings	m²	-		Rate only
CS		Mass cocnrete stairs	m²	12.00		
	8.2.2	**Smooth formwork**				
		Vertical surfaces				
CT		Sides of beams	m²	100.00		
CU		Walls not exceeding 3.5m in height	m²	587.00		
CV		Rectangular column not exceeding 3.5m in height	m²	7.20		
CW		Ditto, but Square column	m²	56.16		
CX		Rectangular columns exceeding 6.5m and not exceeding 8m in height	m²	37.50		
CY		Ditto, but square columns	m²	292.50		
CZ		Outer edge of slab not exceeding 300mm high	m	71.10		
DA		Edge, riser, end and reveal not exceeding 300mm high or wide	m	279.00		
DB		Edge, riser, end and reveal exceeding 300mm high or wide	m²	21.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Sloping surfaces				
DC		Sloping outer edge of ramp 1200mm high extreme	m	37.54		
	8.3	**SCHEDULED REINFORCEMENT ITEMS**		-		
		High Tensile Welded Mesh				
DD		Type reference 395	m²	395.00		
	8.3.1	**Steel bars of various diameters**				
DE		Mild steel	t	0.59		
DF		High tensile steel	t	16.84		
	8.4	**SCHEDULED CONCRETE ITEMS**				
	8.4.3	**Strength concrete**		-		
DG		Grade 15MPa/19mm concrete to blinding	m³	-		Rate only
DH		Grade 15MPa/19mm concrete to cavity walls	m³	3.60		
DI		Grade 40MPa/19mm concrete to strip footings	m³	7.00		
DJ		Grade 30MPa/19mm concrete to mass concrete infill	m³	3.60		
DK		Grade 40MPa/19mm concrete to raft	m³	-		Rate only
DL		Grade 40MPa/19mm concrete to columns	m³	18.00		
DM		Grade 40MPa/19mm concrete to beams	m³	22.00		
DN		Grade 40MPa/19mm concrete to surface beds including beams and inverted beams	m³	76.52		
DO		Grade 40MPa/19mm concrete to stairs including landings, beams and inverted beams	m³	-		Rate only
DP		Grade 40MPa/19mm concrete to walls	m³	87.00		
	8.4.4	**Unformed Surface Finishes**		-		
		Power floated finish		-		
DQ		Slabs	m²	- 460.00		
		Wood floated finish		- -		
DR		Slabs	m²	91.66		
	8.7	**GROUTING**				
		Non-shrink grout		-		
DS		20mm Thick under base plates	dm3	- 11.00		
		SLEEVES, HOLES, ETC.		- -		
		Sleeves exceeding 100mm and not exceeding 200mm diameter through		-		
DT		420mm Thick reinforced concrete slab, beam, wall, etc.	No	48.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		STRUCTURAL STEELWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-DE-0016-01-OC-AE				
		1924701-2-510-LA-0036-01-OC-AE				
		1924701-2-510-LA-0037-01-OC-AE				
		1924701-2-510-LA-0038-01-OC-AE				
		1924701-2-510-LA-0043-01-OC-AE				
		1924701-2-510-SE-0012-01-OC-AE				
	SANS 1200 H	**STRUCTURAL STEELWORK**				
	8.3.1	**SUPPLY AND FABRICATION**				
	8.3.1.1	**Preparation of shop detail drawings**				
DU		Prepare and submit detailed shop drawings as described in the Project Specification and to the approval of the Employer's representative	t	3.47		
		Allowance for trial assembly				
DV		Trial assembly	t	3.47		
	8.3.1.2	**Supply and fabrication of steelwork**				
		Supply and fabricate in S355JR steel to SANS 50025 all steelwork complete with all the necessary cleats, shop bolts, brackets, gussets, packs, base plates, etc., delivered ex works ready for dispatch to site. For all hollow sections supply and fabricate in S355JRH steel to SANS 657 and /or SANS 50219. All steelwork to be hot dip galvanized to SABS ISO 1461. This includes purlins, purlin bracing, sheeting rails and anti-sag angles and anti-sag bars. All bolts and nuts shall be hot dip galvanized to SABS ISO 1461				
		Light Steelwork 0-25kg/m				
DW		70 x 70 x 8 L (8.36kg/m)	t	3.66		
DX		150 x 90 x 10 L (10kg/m)	t	0.05		
DY		CFLC 125 x 65 x 20 x 2.5 (5.47kg/m)	t	2.01		
DZ		CHS 101.6 x 3.0 (7.32kg/m)	t	2.13		
EA		PFC 180 x 70 (21.1kg/m)	t	3.17		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Wall Stiffeners				
EB		PLT 10 (Wall stiffeners)	t	1.06		
EC		PLT 8 (Base plates)	t	0.02		
ED		PFC 300 x 100 (24.5 kg/m)	t	0.84		
EE		75 x 50 x 6 L (5.65 kg/m)	t	0.02		
EF		R12 rebar welded to base plates & cast into concrete cavity infill (0.89kg/m)	No	3.00		
		Extra over for end load bearing plates and intermediate stiffeners				
EG		PLT 8 (Stiffeners)	t	0.11		
EH		PLT 10 (Stiffeners)	t	0.11		
EI		PLT 10 (Base plates)	t	0.18		
EJ		PLT 10 (Cleats)	t	0.01		
EK		PLT 16 (End plates)	t	0.01		
EL		PLT 20 (Stiffeners)	t	0.02		
EM		PLT 20 (End plates)	t	0.11		
EN		PLT 30 (Base plates)	t	0.13		
	8.3.4	**ERECTION BOLTS**				
		Class 5.8 high tensile bolts, Class 8 nuts and washers to new structural steelwork and platework				
EO		M8 Bolts	kg	1.00		
EP		M10 Bolts	kg			Rate only
		Class 8.8 high tensile bolts, Class 8 nuts and washers to new structural steelwork and platework				
EQ		M8 Bolts	kg	12.00		
ER		M10 Bolts	kg	18.00		
ES		M12 Bolts	kg			Rate only
ET		M16 Bolts	kg	30.00		
EU		M18 Bolts	kg			Rate only
EV		M20 Bolts	kg			Rate only
		Hilti bolts				
EW		HD-M24-300 Holding down bolt with anchor plate	No	19.00		
EX		HSFG-M24 high strength friction grip bolt CLASS 10.9	No	22.00		
EY		JBL-M20-300 J-Bolt	No	6.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
EZ		M8 Hilti HSA studs with Hilti HIT-HY200 injection mortar (80mm embedment deep)	No	60.00		
FA		M8 Hilti HSA stud anchor bolts with Hilti HIT-HY200 injection mortar (80mm embedment deep)	No	24.00		
FB		M16 Hilti V-R threaded rods with Hilti HIT-HY200 injection mortar (80mm embedment deep)	No	4.00		
FC		M20 Hilti V-R threaded rods with Hilti HIT-HY200 injection mortar (90mm embedment deep)	No	10.00		
		BALUSTRADE, FLOORING, TREADS ETC.				
	8.3.7	**HANDRAILS**				
	8.3.7.b	**a) Handrail assembly complete**				
	8.3.7.b.1	1) Horizontal				
FD		Macklock heavy duty 34.1mm x 2.0mm 316L stainless steel tubular and forged handrail fixed to wall with 10mm thick stainless steel rods at 900mm centres complete	m	23.00		
FE		Macklock heavy duty 316L stainless steel balustrade comprising of 60mm diameter x 3mm thick tubular stanchion 1040mm high at 900mm centres including 150 x 80 x 10mm thick base plate fixed to steel with 2No. bolts including 43mm diameter x 2.5mm thick tubular intermediate rail and 43mm diameter x 2.5mm thick tubular handrail both fixed to balustrade complete	m	23.00		
	8.3.7.b.2	2) Raking/ sloping				
FF		Macklock heavy duty 34.1mm x 2.0mm 316 Lstainless steel tubular and forged handrail fixed to wall with 10mm thick stainless steel rods at 900mm centres complete	m	-		Rate only
FG		Macklock heavy duty 316L stainless steel balustrade comprising of 60mm diameter x 3mm thick tubular stanchion 1040mm high at 900mm centres including 150 x 80 x 10mm thick base plate fixed to steel with 2No. bolts including 43mm diameter x 2.5mm thick tubular intermediate rail and 43mm diameter x 2.5mm thick tubular handrail both fixed to balustrade complete	m	-		Rate only
	8.3.7.b.3	3) Shaped ends				
FH		Macklock heavy duty 316L stainless steel balustrade shaped end comprising of 60mm diameter x 3mm thick tubular 316L stainless steel including fixing to balustrade	No	20.00		
		Extra over balustrades/handrails				
FI		Extra over balustrades for 45 degree bends	No	6.00		
FJ		Extra over balustrades for 90 degree bends	No	6.00		
FK		Extra over handrails for 45 degree bends	No			Rate only
FL		Extra over handrails for 90 degree bends	No			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		FLOORING, COMPLETE AND INSTALLED WITH FRAMES				
	8.3.9	Flooring, complete and installed with frames:				
FM	8.3.9.3	6mm Vastrap or equal approved floor plate floor fixed to 50 x 50 x 8mm angles cast into concrete with Y10 lugs at 300mm centres, including countersunk bolts, complete	m²	84.00		
	8.3.2	**DELIVERY**				
	8.3.2.1	Normal delivery				
FN		Normal delivery to site of new structural steelwork and platework (as listed)	t	17.33		
FO		Abnormal delivery to site of new structural steelwork	t			Rate only
	8.3.3	**ERECTION ON SITE**				
FP		Erection on site of all new structural steelwork and platework (as listed)	t	17.33		
	SANS 1200 HC	**CORROSION PROTECTION OF STRUCTURAL**				
	8.2.3	**Surface preparation and coating application**				
		Supply, prepare and apply corrosion protection in accordance with Employer's Specification on new steel, in the shop and on site (shown above)				
FQ	8.2.3.a	a) In shop (new structural steelwork shown above)	t	16.63		
FR	8.2.3.b	b) On site (new structural steelwork shown above)	t	16.63		
	SANS 1200 HB	**CLADDING & SHEETING**				
	8.2.2	Aluminium IBR roof and side cladding with mill finish, including all ribs, fixings, flashings, ridging, cranked or bullnosed sheets etc. installation in accordance with manufacturers specifications				
FS		0.9mm Thick curved sheeting on roofs	m²	601.00		
		METAL SAFETY HOOKS				
		316L Stainless steel "Ringanka Kee i-bolt®" safety eyebolts shall be fixed into steel purlin using 102mm M12 Female threaded curled inserts supplied by "Fall Protection Engineering Works" or approved equivalent, spaced equally at a maximum spacing of 1.5 m centres				
FT		Safety bolts fixed to steel purlin including drilling, waterproofing, etc. complete	No	26.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		INSULATION				
		50mm thick, non-combustible, lightweight 'Factorylite' building insulation with reinforced aluminium foil facing on one side (facing down), with thermal resistance of 1.28m2K/W, installed over purlins and using 2.5mm thick 316L stainless steel straining wires spaced at 300mm centres and hoop irons and clamps as per manufacturer's installation guidelines				
FU		Roof insulation	m²	601.00		
		RAINWATER GOODS				
		Aluminium gutter (shop drawing to be preapproved by Employer's representative(s)). Colour to match roof sheeting				
FV		300mm x 200mm Gutters	m	78.00		
FW		Extra over gutter for stopped end	No	4.00		
FX		Extra over gutter for outlet for 110mm pipe	No	8.00		
		Aluminium rainwater pipes				
FY		110mm downpipes	m	43.20		
FZ		Extra over 110mm rainwater pipe for bend	No	8.00		
GA		Extra over 110mm rainwater pipe for shoe	No	8.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		SUBSTATION MAIN INTAKE				
		CONCRETE, FORMWORK AND REINFORCEMENT				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0028-01-OA-AE				
		1924701-2-510-B-DE-0029-01-OA-AE				
		1924701-2-510-B-DE-0030-01-OA-AE				
		1924701-2-510-B-LA-0046-01-OA-AE				
		1924701-2-510-B-LA-0047-01-OA-AE				
		1924701-2-510-B-LA-0048-01-OA-AE				
		1924701-2-510-B-LA-0049-01-OA-AE				
		1924701-2-510-B-LA-0050-01-OA-AE				
		1924701-2-510-B-LA-0051-01-OA-AE				
		1924701-2-510-B-LA-0052-01-OA-AE				
		1924701-2-510-B-LA-0053-01-OA-AE				
		1924701-2-510-B-SE-0014-01-OA-AE				
		1924701-5-510-B-SE-0014-02-OA-AE				
		1924701-5-510-B-SE-0015-01-OA-AE				
		1924701-5-510-B-SE-0016-01-OA-AE				
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	8.2	**SCHEDULED FORMWORK ITEMS**				
	8.2.1	**Rough formwork**				
		Vertical surfaces				
GB		Raft foundation	m²	-		Rate only
	8.2.2	**Smooth formwork *(Measured items inconsistent with the technical specifications)***				
		Vertical surfaces				
GC		Sides of beams	m²	11.00		
GD		Sides of upstand beams	m²	1.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
GE		Wall not exceeding 3.5m in height	m²	104.00		
GF		Wall exceeding 3.5m not exceeding 5m in height	m²	3.00		
GG		Wall exceeding 5m not exceeding 6.5m in height	m²	7.00		
GH		Wall exceeding 6.5m not exceeding 8m in height	m²	-		Rate only
GI		Splayed irregular shaped column not exceeding 3.5m in height	m²	21.00		
GJ		Rectangular column not exceeding 3.5m in height	m²	12.00		
GK		Ditto but square columns	m²	20.00		
GL		Outer edge of slab not exceeding 300mm high	m	6.00		
GM		Outer edge of landings not exceeding 300mm high	m	4.00		
GN		Edge, riser, end and reveal not exceeding 300mm high or wide	m	77.00		
		Horizontal surfaces				
GO		Soffits of beams	m²	-		Rate only
GP		Slab exceeding 250mm thick and not exceeding 500mm thick propped up exceeding 1.5m and not exceeding 3.5m high	m²	-		Rate only
GQ		Soffits of landings propped up exceeding 1.5m and not exceeding 3.5m high	m²	-		Rate only
		Sloping surfaces				
GR		Sloping and stepped outer edge of stair 440mm high extreme	m	-		Rate only
GS		Sloping soffits of stairs propped up exceeding 1.5m and not exceeding 3.5m high	m²	-		Rate only
	8.2.6	**Box out Holes/ Form Voids**				
		Small other than circular, of area up to and including 0,1 m², and in the following depth ranges				
GT		Over 0,0m and up to and including 0,5m deep	No	-		Rate only
	8.3	**SCHEDULED REINFORCEMENT ITEMS**				
	8.3.1	**Steel bars of various diameters**				
GU		Mild steel	t	0.90		
GV		High tensile steel	t	16.70		
	8.4	**SCHEDULED CONCRETE ITEMS**				
	8.4.3	Strength concrete				
GW		Grade 40MPa/19mm concrete to raft	m³	-		Rate only
GX		Grade 40MPa/19mm concrete to columns	m³	4.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
GY		Grade 40MPa/19mm concrete to slabs including beams and inverted beams	m³	-		Rate only
GZ		Grade 40MPa/19mm concrete to stairs including landings, beams and inverted beams	m³	-		Rate only
HA		Grade 40MPa/19mm concrete to walls	m³	36.00		
	8.4.4	**Unformed Surface Finishes**				
		Power floated finish				
HB		Raft	m²	-		Rate only
HC		Slabs	m²	-		Rate only
		Construction joints				
		30mm thick "Sondor Jointex" with 30 x 30mm tear off strip between any surfaces with and including 30 x 30mm approved sealant with polyethylene bond-breaker backing tape				
HD		30mm Joint not exceeding 300mm wide between concrete walls	m	6.00		
HE		30mm Joint not exceeding 300mm wide between concrete columns	m	3.00		
HF		30mm Joint exceeding 300mm wide between concrete columns	m	6.00		
		Recessed heavy duty "Migua" compression expansion joints				
HG		Supply and installation of "Migua" series FS 220 recessed heavy duty expansion joint in floors	m	-		Rate only
	8.7	**GROUTING**				
		Non-shrink grout				
HH		20mm Thick under base plates	dm³	79.00		
		SLEEVES, HOLES, ETC.				
		Sleeves hole exceeding 100mm and not exceeding 200mm diameter through				
HI		250mm Thick reinforced concrete slab, beam, wall, etc.	No	-		Rate only
HJ		300mm Thick reinforced concrete slab, beam, wall, etc.	No	19.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		STRUCTURAL STEELWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0028-01-OA-AE				
		1924701-2-510-B-DE-0029-01-OA-AE				
		1924701-2-510-B-DE-0030-01-OA-AE				
		1924701-2-510-B-LA-0046-01-OA-AE				
		1924701-2-510-B-LA-0047-01-OA-AE				
		1924701-2-510-B-LA-0048-01-OA-AE				
		1924701-2-510-B-LA-0049-01-OA-AE				
		1924701-2-510-B-LA-0050-01-OA-AE				
		1924701-2-510-B-LA-0051-01-OA-AE				
		1924701-2-510-B-LA-0052-01-OA-AE				
		1924701-2-510-B-LA-0053-01-OA-AE				
		1924701-2-510-B-SE-0014-01-OA-AE				
		1924701-5-510-B-SE-0014-02-OA-AE				
		1924701-5-510-B-SE-0015-01-OA-AE				
		1924701-5-510-B-SE-0016-01-OA-AE				
	SANS 1200 H	**STRUCTURAL STEELWORK**				
	8.3.1	**SUPPLY AND FABRICATION**				
	8.3.1.1	**Preparation of shop detail drawings**				
HK		Prepare and submit detailed shop drawings as described in the Project Specification and to the approval of the *Employer's* representative	t	46.99		
		Allowance for trial assembly				
HL		Trial assembly	t	9.40		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.1.2	**Supply and fabrication of steelwork** Supply and fabricate in S355JR steel to SANS 50025 all steelwork complete with all the necessary cleats, shop bolts, brackets, gussets, packs, base plates, etc., delivered ex works ready for dispatch to site. For all hollow sections supply and fabricate in S355JRH steel to SANS 657 and /or SANS 50219. All steelwork to be hot dip galvanized to SABS ISO 1461. This includes purlins, purlin bracing, sheeting rails and anti-sag angles and anti-sag bars. All bolts and nuts shall be hot dip galvanized to SABS ISO 1461 <u>Light Steelwork 0-25kg/m</u>				
HM		50 x 50 x 3 L (2.34kg/m)	t	0.22		
HN		100 x 100 x 8 L (12.2kg/m)	t	1.19		
HO		150 x 75 x 10 L (17kg/m)	t	0.22		
HP		76 x 153 x 12 T (11.7kg/m)	t	-		
HQ		SHS 100 x 100 x 4 (11.6kg/m)	t	0.11		
HR		CHS 114.3 x 6.0 (16.03kg/m)	t	3.10		
HS		PFC 180 x 70 (21.1kg/m)	t	26.05		
HT		PFC 260 x 90 (34.8g/m)	t	3.79		
		<u>Heavy Steelwork >50kg/m</u>				
HU		UB 406 x 178 x 54 (54.1kg/m) curved to 1.143m radius	t	3.63		
HV		UB 406 x 178 x 54 (54.1kg/m) curved to 29.379m radius	t	3.34		
HW		UB 406 x 178 x 54 (54.1kg/m) curved to 29.385m radius	t	0.17		
HX		UB 356 x 171 x 67 (67.1kg/m)	t	0.22		
HY		UC 254 x 254 x 73 (73.1kg/m)	t	0.40		
		<u>Extra over for end load bearing plates and intermediate stiffeners</u>				
HZ		PLT 10 (Stiffeners)	t	0.16		
IA		PLT 10 (Base plates)	t	0.03		
IB		PLT 10 (Cleats)	t	0.01		
IC		PLT 16 (Base plates)	t	0.01		
ID		PLT 16 (End plates)	t	0.03		
IE		PLT 20 (Stiffeners)	t	0.09		
IF		PLT 20 (End plates)	t	0.55		
IG		PLT 30 (Base plates)	t	0.69		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.4	**ERECTION BOLTS**				
		Class 8.8 high tensile bolts, Class 8 nuts and washers to new structural steelwork and platework				
IH		M8 Bolts	No			Rate only
II		M10 Bolts	No			Rate only
IJ		M12 Bolts	No			Rate only
IK		M16 Bolts	No	1 062.00		
IL		M18 Bolts	No			Rate only
IM		M20 Bolts	No			Rate only
		Hilti bolts				
IN		HD-M24-300 Holding down bolt with anchor plate	No	112.00		
IO		HSFG-M24 high strength friction grip bolt CLASS 10.9	No	120.00		
IP		JBL-M20-300 J-Bolt	No	16.00		
IQ		M16 Hilti V-R threaded rods with Hilti HIT-HY200 injection mortar (80mm embedment deep)	No	150.00		
IR		M20 Hilti V-R threaded rods with Hilti HIT-HY200 injection mortar (90mm embedment deep)	No	8.00		
		BALUSTRADE, FLOORING, TREADS ETC.				
	8.3.7	**HANDRAILS**				
	8.3.7.b	**b Handrail assembly complete**				
	8.3.7.b.1	1) Horizontal				
IS		"Macklock" heavy duty 34.1mm x 2.0mm 316L stainless steel tubular and forged handrail fixed to wall with 10mm thick stainless steel rods at 900mm centres complete	m	12.00		
IT		"Macklock" heavy duty 316L stainless steel balustrade comprising of 60mm diameter x 3mm thick tubular stanchion 1040mm high at 900mm centres including 150 x 80 x 10mm thick base plate fixed to steel with 2No. bolts including 43mm diameter x 2.5mm thick tubular intermediate rail and 43mm diameter x 2.5mm thick tubular handrail both fixed to balustrade complete	m	21.00		
	8.3.7.b.2	2) Raking/ sloping				
IU		"Macklock" heavy duty 34.1mm x 2.0mm 316 Lstainless steel tubular and forged handrail fixed to wall with 10mm thick stainless steel rods at 900mm centres complete	m	9.00		
IV		"Macklock" heavy duty 316L stainless steel balustrade comprising of 60mm diameter x 3mm thick tubular stanchion 1040mm high at 900mm centres including 150 x 80 x 10mm thick base plate fixed to steel with 2No. bolts including 43mm diameter x 2.5mm thick tubular intermediate rail and 43mm diameter x 2.5mm thick tubular handrail both fixed to balustrade complete	m	29.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.7.b.3	3) Shaped ends				
IW		"Macklock" heavy duty 316L stainless steel balustrade shaped end comprising of 60mm diameter x 3mm thick tubular 316L stainless steel including fixing to balustrade	No	4.00		
		Extra over balustrades/handrails				
IX		Extra over balustrades for 45 degree bends	No	12.00		
IY		Extra over balustrades for 90 degree bends	No	8.00		
IZ		Extra over handrails for 45 degree bends	No	12.00		
JA		Extra over handrails for 90 degree bends	No	3.00		
		FLOORING, COMPLETE AND INSTALLED WITH FRAMES				
	8.3.9	Flooring, complete and installed with frames:				
JB	8.3.9.3	6mm Vastrap floor plate floor fixed to 100 x 100 x 10mm angles cast into concrete with Y10 lugs at 300mm centres, including countersunk bolts, complete	m²	164.00		
		CAT LADDERS				
	8.3.8	316L Stainless steel cat ladders including all bolts, fixing, etc., complete and installed				
JC		Cat ladder with cage and safety rail to access roof	t	0.79		
	8.3.2	**DELIVERY**				
	8.3.2.1	Normal Delivery				
JD		Normal delivery to site of all new structural steelwork and platework (as listed)	t	46.99		
JE		Abnormal delivery to site of new structural steelwork	t	7.77		
	8.3.3	**ERECTION ON SITE**				
JF		Erection on site of all new structural steelwork and platework (as listed)	t	46.99		
		Provisional Sums				
JG		Allowance for 2 No. structural steel fire escape staircases	PS	1.00		TBA
	SANS 1200 HC	**CORROSION PROTECTION OF STRUCTURAL STEELWORK**				
	8.2.3	**Surface preparation and coating application**				
		Supply, prepare and apply corrosion protection in accordance with *Employer's* Specification on new steel, in the shop and on site (shown above)				
JH	8.2.3.a	a) In shop (new structural steelwork shown above)	t	45.51		
JI	8.2.3.b	b) On site (new structural steelwork shown above)	t	45.51		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	SANS 1200 HB	**CLADDING & SHEETING**				
	8.2.2	Aluminium IBR roof and side cladding with mill finish, including all ribs, fixings, flashings, ridging, cranked or bullnosed sheets etc. installation in accordance with manufacturers specifications				
JJ		0.9mm Thick curved sheeting on roofs	m²	1 977.00		
		316L Powder coated stainless steel woven mesh fixed to steel purlin using 2.0mm x 70mm (w) 316L stainless steel plate & bolts fixed along the length of the purlin using at 500mm centres				
JK		1.6 x 25mm x 25mm Curved woven stainless steel mesh	m²	52.00		
JL		Extra over stainless steel woven mesh for 600 x 600mm access hatch to roof	No	3.00		
		METAL SAFETY HOOKS				
		316L Stainless steel "Ringanka Kee i-bolt®" safety eyebolts shall be fixed into steel purlin using 102mm M12 Female threaded curled inserts supplied by "Fall Protection Engineering Works" or approved equivalent, spaced equally at a maximum spacing of 1.5 m centres				
JM		Safety bolts fixed to steel purlin including drilling, waterproofing, etc. complete	No	41.00		
		INSULATION				
		50mm thick, non-combustible, lightweight 'Factorylite' building insulation with reinforced aluminium foil facing on one side (facing down), with thermal resistance of 1.28m2K/W, installed over purlins and using 2.5mm thick galvanised straining wires spaced at 300mm centres and hoop irons and clamps as per manufacturer's installation guidelines				
JN		Roof insulation	m²	1 977.00		
		RAINWATER GOODS				
		CSM 900 grams (chopped strand mat) 1 x Fibresil mat (fibreglass surface tissue) resin impregnated. Fibre Glass Gutter (shop drawing to be preapproved by Employer's representative(s)). Gelcoat to exposed areas. Colour to match roof sheeting. Fibreglass gutters supported by 5mm (bent to shape) 316L stainless steel brackets and cross bracing spaced at 1000mm centres and fitted to the inside of the gutter. Brackets to be bonded into the gutter as per manufacturer's detail				
JO		350mm x 250mm Gutters	m	118.00		
JP		Extra over gutter for stopped end	No	6.00		
JQ		Extra over gutter for outlet for 110mm pipe	No	8.00		
		HDPE PN6 rainwater pipes				
JR		110mm downpipes	m	28.80		
JS		Extra over 110mm rainwater pipe for bend	No	16.00		
JT		Extra over 110mm rainwater pipe for shoe	No	8.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		MAIN INTAKE (P) (YARD EQUIPMENT)				
		CONCRETE, FORMWORK AND REINFORCEMENT				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0023-01-OC-AE				
		1924701-2-510-B-DE-0024-01-OC-AE				
		1924701-2-510-B-DE-0027-01-OC-AE				
		1924701-2-510-B-LA-0045-01-OC-AE				
		1924701-2-510-B-DE-0019-01-OC-AE				
		1924701-2-510-T-DE-0023-01-OC-AE				
		1924701-2-510-T-DE-0025-01-OC-AE				
		1924701-2-510-T-DE-0027-01-OC-AE				
		1924701-2-510-T-DE-0029-01-OC-AE				
		1924701-2-510-T-DE-0030-01-OC-AE				
		1924701-2-510-T-LA-0004-01-OC-AE				
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	8.2	**SCHEDULED FORMWORK ITEMS**				
	8.2.1	**Rough formwork**				
		Vertical surfaces				
JU		Sides of strip footings	m²	12.80		
JV		Sides of equipment bases	m²	-		Rate only
JW		Sides of surface beds	m²	13.40		
JX		Sides of slip way	m²	-		Rate only
JY		Sides of base to steps	m²	1.00		
	8.2.2	**Smooth formwork**				
		Vertical surfaces				
JZ		Sides of plinths	m²	-		Rate only
KA		Walls not exceeding 3.5m in height	m²			Rate only
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3	**SCHEDULED REINFORCEMENT ITEMS**				
	8.3.1	**Steel bars of various diameters**				
KB		Mild steel	t	-		Rate only
KC		High tensile steel	t	-		Rate only
	8.3.2	**High Tensile Welded Mesh**				
KD		Type reference 245	m²	2.00		
KE		Type reference 617	m²	-		Rate only
	8.4	**SCHEDULED CONCRETE ITEMS**				
	8.4.3	Strength concrete				
KF		Grade 15MPa/19mm concrete to blinding	m³	-		Rate only
KG		Grade 20MPa/19mm concrete to strip footings	m³	71.00		
KH		Grade 25MPa/19mm concrete to equipment bases	m³	-		Rate only
KI		Grade 20MPa/19mm concrete to surface beds to falls	m³	12.00		
KJ		Grade 20MPa/19mm concrete to slipway	m³	1.00		
KK		Grade 20MPa/19mm concrete to plinths	m³	20.00		
KL		Grade 20MPa/19mm concrete to bases to steps	m³	-		Rate only
KM		Grade 40MPa/19mm concrete to walls and lids	m³			Rate only
	8.4.4	**Unformed Surface Finishes**				
		Steel floated finish				
KN		Equipment bases	m²	-		Rate only
		Power floated finish				
KO		Surfacebeds	m²	109.00		
KP		Oil damn lid	m²			Rate only
KQ		Plinths	m²	-		Rate only
KR		Slipway	m²	17.00		
	8.5	**JOINTS**				
		Expansion joints				
		10mm thick "Sondor Jointex" with 10 x 10mm tear off strip between any surfaces with and including 10 x 10mm approved sealant with polyethylene bond-breaker backing tape				
KS		10mm Joint not exceeding 300mm long	m	14.00		
	8.7	**GROUTING**				
		Non-shrink grout				
KT		20mm Thick under base plates	dm3	13.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		BOLTS				
	8.8	**H.D. bolts and miscellaneous metal work**				
		132kV CT				
KU		HD bolts to bases, including washers, nuts, etc.	kg	85.00		
		132kV PI				
KV		HD bolts to bases, including washers, nuts, etc.	kg	85.00		
		132kV Circuit breaker				
KW		HD bolts to bases, including washers, nuts, etc.	kg	37.00		
		132kV Isolator				
KX		HD bolts to bases, including washers, nuts, etc.	kg	28.00		
		NECRT				
KY		HD bolts to bases, including washers, nuts, etc.	kg	12.00		
		Cable End Support				
KZ		HD bolts to bases, including washers, nuts, etc.	kg	32.00		
		21m Lightning mast				
LA		HD bolts to bases, including washers, nuts, etc.	kg	179.00		
		Fire Barrier				
LB		HD bolts to bases, including washers, nuts, etc.	kg	71.00		
		SLEEVES				
		Sleeves encased in concrete				
LC		110mm sleeves	m	6.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		STRUCTURAL STEELWORK **NOTE** Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works To be read in conjunction with but not limited to the following Project Technical Specification(s) : 1924701-2-510-B-DE-0023-01-OC-AE 1924701-2-510-B-DE-0024-01-OC-AE 1924701-2-510-B-DE-0027-01-OC-AE 1924701-2-510-B-LA-0045-01-OC-AE 1924701-2-510-B-DE-0019-01-OC-AE 1924701-2-510-T-DE-0023-01-OC-AE 1924701-2-510-T-DE-0025-01-OC-AE 1924701-2-510-T-DE-0027-01-OC-AE 1924701-2-510-T-DE-0029-01-OC-AE 1924701-2-510-T-DE-0030-01-OC-AE 1924701-2-510-T-LA-0004-01-OC-AE				
	SANS 1200 H	**STRUCTURAL STEELWORK**				
	8.3.1	**SUPPLY AND FABRICATION**				
	8.3.1.1	**Preparation of shop detail drawings**				
LD		Prepare and submit detailed shop drawings as described in the Project Specification and to the approval of the Employer's representative	t	3.67		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Allowance for trial assembly				
LE		Trial assembly	t	-		Rate only
	8.3.1.2	**Supply and fabrication of steelwork**				
		Supply and fabricate in S355JR steel to SANS 50025 all steelwork complete with all the necessary cleats, shop bolts, brackets, gussets, packs, base plates, etc., delivered ex works ready for dispatch to site. For all hollow sections supply and fabricate in S355JRH steel to SANS 657 and /or SANS 50219				
		132kV CT				
LF		Medium equipment support 2.5m, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	0.75		
LG		Extra over medium equipment support 2.5m for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	19.00		
LH		Medium equipment cap, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	0.32		
LI		Extra over medium equipment cap for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	12.00		
LJ		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0018-01-OB-AE	kg	122.00		
		132kV PI				
LK		Medium equipment support 2.5m, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	0.75		
LL		Extra over medium equipment support 2.5m for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	19.00		
LM		Medium equipment cap, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	0.69		
LN		Extra over medium equipment cap for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	12.00		
LO		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0018-01-OB-AE	kg	122.00		
		132kV Circuit breaker				
LP		132kV Circuit breaker support, complete as per drawing 1924701-2-510-T-DE-0021-01-OB-AE	t	0.48		
LQ		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0018-01-OB-AE	kg	41.00		
		132kV Isolator				
LR		132kV Isolator support, complete as per drawing 1924701-2-510-T-DE-0023-01-OC-AE	t	1.55		
LS		Extra over 132kV isolator support for bolts, complete as per drawing 1924701-2-510-T-DE-0023-01-OC-AE	kg	49.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
LT		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0023-01-OC-AE	kg	41.00		
		NECRT				
LU		NECRT support, complete as per drawing 1924701-2-510-T-DE-0028-01	t	0.33		
LV		Extra over NECRT support for bolts, complete as per drawing 1924701-2-510-T-DE-0028-01	kg	13.00		
LW		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0022-02	kg	41.00		
		Cable end support				
LX		11kV Cable end support, complete as per drawing 1924701-2-510-T-DE-0020-01-OB-AE	t	1.16		
LY		Extra over 11kV Cable end support for bolts, complete as per drawing 1924701-2-510-T-DE-0020-01-OB-AE	kg	22.00		
LZ		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0018-01-OB-AE	kg	41.00		
		21m Lightning mast				
MA		21m Lightning mast, complete as per drawing 1924701-2-510-T-DE-0026-01-OB-AE	t	6.79		
MB		Extra over 21m lightning mast for bolts, complete as per drawing 1924701-2-510-T-DE-0026-01-OB-AE	kg	19.00		
MC		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0022-01-OB-AE	kg	182.00		
		Fire barrier				
MD		Fire barrier, complete as per drawing 1924701-2-510-T-DE-0027-01-OC-AE	t	4.24		
ME		Extra over fire barrier for bolts, complete as per drawing 1924701-2-510-T-DE-0027-01-OC-AE	kg	107.00		
MF		Extra over fire barrier IBR sheeting modules in accordance with requirements per module, complete as per drawing 1924701-2-510-T-DE-0027-01-OC-AE	m²	284.00		
MG		Extra over fire barrier IBR sheeting modules for bolts, complete as per drawing 1924701-2-510-T-DE-0027-01-OC-AE	kg	89.00		
MH		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0022-02-OC-AE	kg	203.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		BALUSTRADE, FLOORING, TREADS ETC.				
	8.3.7	**HANDRAILS**				
	8.3.7.b	**b) Handrail assembly complete**				
	8.3.7.b.2	2) Raking/ sloping				
MI		Macklock heavy duty 316L stainless steel balustrade comprising of 60mm diameter x 3mm thick tubular stanchion 1040mm high at 900mm centres including 150 x 80 x 10mm thick base plate fixed to steel with 2No. bolts including 43mm diameter x 2.5mm thick tubular intermediate rail and 43mm diameter x 2.5mm thick tubular handrail both fixed to balustrade complete	m	5		
	8.3.7.b.3	3) Shaped ends				
MJ		Macklock heavy duty 316L stainless steel balustrade shaped end comprising of 60mm diameter x 3mm thick tubular 316L stainless steel including fixing to balustrade	No	24		
	8.3.2	**DELIVERY**				
	8.3.2.1	Normal Delivery				
MK		Normal delivery to site of new structural steelwork and platework (as listed)	t	3.67		
ML		Abnormal delivery to site of new structural steelwork	t	0.37		
	8.3.3	**ERECTION ON SITE**				
MM		Erection on site of all new structural steelwork and platework (as listed)	t	3.67		
	SANS 1200 HC	**CORROSION PROTECTION OF STRUCTURAL STEELWORK**				
	8.2.3	**Surface preparation and coating application**				
		Supply, prepare and apply corrosion protection in accordance with Employer's Specification on new steel, in the shop and on site (shown above)				
MN	8.2.3.a	a) In shop (new structural steelwork shown above)	t	3.64		
MO	8.2.3.b	b) On site (new structural steelwork shown above)	t	3.64		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		YSTERVARK (BUILDING)				
		CONCRETE, FORMWORK AND REINFORCEMENT				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	8.2	**SCHEDULED FORMWORK ITEMS**				
	8.2.1	**Rough formwork**				
		Vertical surfaces				
MP		Strip footings	m²	7.20		
		Vertical surfaces				
MQ		Outer edge of slab not exceeding 300mm high	m	3.50		
MR		Walls not exceeding 3.5m in height	m	18.12		
		Horizontal surfaces				
MS		Slab not exceeding 250mm thick propped up not exceeding 1.5m	m²	8.35		
MT		Outer edge of slab not exceeding 300mm high	m	74.65		
	8.3	**SCHEDULED REINFORCEMENT ITEMS**				
	8.3.1	**Steel bars of various diameters**				
MU		Mild steel	t	-		Rate only
MV		High tensile steel	t	-		Rate only
	8.3.2	**High Tensile Welded Mesh**				
MW		Type reference 193	m²	-		Rate only
MX		Type reference 617	m²	-		Rate only
	8.4	**SCHEDULED CONCRETE ITEMS**				
	8.4.3	Strength concrete				
MY		Grade 15MPa/19mm concrete to blinding	m³	-		Rate only
MZ		Grade 15MPa/19mm concrete to filling of cavities	m³	1.00		
NA		Grade 40MPa/19mm concrete to strip footings	m³	-		Rate only
NB		Grade 40MPa/19mm concrete to surface beds	m³	-		Rate only
NC		Grade 40MPa/19mm concrete to slabs	m³	-		Rate only
ND		Grade 40MPa/19mm concrete to walls	m³	-		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.4.4	**Unformed Surface Finishes**				
		Power floated finish				
NE		Surface beds	m²	7.00		
		Steel floated finish				
NF		Slabs	m²	-		Rate only
	8.5	**JOINTS**				
		Expansion joints				
		10mm thick "Sondor Jointex" with 10 x 10mm tear off strip between any surfaces with and including 10 x 10mm approved sealant with polyethylene bond-breaker backing tape				
NG		10mm Joint not exceeding 300mm long	m	17.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		YSTERVARK (YARD EQUIPMENT) **CONCRETE, FORMWORK AND REINFORCEMENT** **NOTE** Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works To be read in conjunction with but not limited to the following Project Technical Specification(s) : 1924701-2-510-T-LA-0004-01-OB-AE 1924701-2-510-B-DE-0018-01-OB-AE 1924701-2-510-B-DE-0021-01-OB-AE 1924701-2-510-T-DE-0019-01-OB-AE 1924701-2-510-T-DE-0026-01-OB-AE 1924701-2-510-B-LA-0045-01-OB-AE 1924701-2-510-T-DE-0029-01-OB-AE 1924701-2-510-B-DE-0022-01-OB-AE 1924701-2-510-T-DE-0023-01-OB-AE 1924701-2-510-T-DE-0030-01-OB-AE 1924701-2-510-T-DE-0020-01-OB-AE 1924701-2-510-T-DE-0027-01-OB-AE 1924701-2-510-B-DE-0027-01-OB-AE 1924701-2-510-T-DE-0022-01-OB-AE 1924701-2-510-B-DE-0023-01-OB-AE 1924701-2-510-T-DE-0021-01-OB-AE 1924701-2-510-T-DE-0028-01-OB-AE 1924701-2-510-B-DE-0024-01-OB-AE 1924701-2-510-T-DE-0025-01-OB-AE 1924701-2-510-T-DE-0024-01-OB-AE				
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	8.2	**SCHEDULED FORMWORK ITEMS**				
	8.2.1	**Rough formwork**				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		Vertical surfaces				
NH		Equipment bases	m²	513.00		
	8.3	**SCHEDULED REINFORCEMENT ITEMS**				
	8.3.1	**Steel bars of various diameters**				
NI		Mild steel	t	0.20		
NJ		High tensile steel	t	1.79		
	8.3.2	**High Tensile Welded Mesh**				
NK		Type reference 245	m²			
	8.4	**SCHEDULED CONCRETE ITEMS**				
	8.4.3	Strength concrete				
NL		Grade 15MPa/19mm concrete to blinding	m³	3.64		
NM		Grade 40MPa/19mm concrete to equipment bases	m³	208.14		
	8.4.4	**Unformed Surface Finishes**				
		Steel floated finish				
NN		Equipment bases	m²	60.68		
	8.7	**GROUTING**				
		Non-shrink grout				
NO		20mm Thick under base plates	dm3	584.00		
		BOLTS				
	8.8	**H.D. bolts and miscellaneous metal work**				
		132kV CT				
NP		HD bolts to bases, including washers, nuts, etc.	kg	297.00		
		132kV VT				
NQ		HD bolts to bases, including washers, nuts, etc.	kg	170.00		
		132kV PI				
NR		HD bolts to bases, including washers, nuts, etc.	kg	467.00		
		132kV Circuit breaker				
NS		HD bolts to bases, including washers, nuts, etc.	kg	55.00		
		132kV Isolator				
NT		HD bolts to bases, including washers, nuts, etc.	kg	170.00		
		132kV Inline isolator				
NU		HD bolts to bases, including washers, nuts, etc.	kg	71.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		132kV Tubular busbar				
NV		HD bolts to bases, including washers, nuts, etc.	kg	332.00		
		21m Lightning mast				
NW		HD bolts to bases, including washers, nuts, etc.	kg	177.00		
		Earth wire				
NX		HD bolts to bases, including washers, nuts, etc.	kg	291.00		
		JB yard AC DB				
NY		HD bolts to bases, including washers, nuts, etc.	kg	9.00		
		SLEEVES				
		Sleeves encased in concrete				
NZ		110mm sleeves	m	14.00		
	SANS 1200 H	**STRUCTURAL STEELWORK**				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0018-01-OB-AE				
		1924701-2-510-B-DE-0021-01-OB-AE				
		1924701-2-510-B-DE-0022-01-OB-AE				
		1924701-2-510-B-DE-0023-01-OB-AE				
		1924701-2-510-B-DE-0024-01-OB-AE				
		1924701-2-510-B-DE-0027-01-OB-AE				
		1924701-2-510-B-LA-0045-01-OB-AE				
		1924701-2-510-T-DE-0019-01-OB-AE				
		1924701-2-510-T-DE-0020-01-OB-AE				
		1924701-2-510-T-DE-0021-01-OB-AE				
		1924701-2-510-T-DE-0022-01-OB-AE				
		1924701-2-510-T-DE-0023-01-OB-AE				
		1924701-2-510-T-DE-0024-01-OB-AE				
		1924701-2-510-T-DE-0025-01-OB-AE				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		1924701-2-510-T-DE-0026-01-OB-AE				
		1924701-2-510-T-DE-0027-01-OB-AE				
		1924701-2-510-T-DE-0028-01-OB-AE				
		1924701-2-510-T-DE-0029-01-OB-AE				
		1924701-2-510-T-DE-0030-01-OB-AE				
		1924701-2-510-T-LA-0004-01-OB-AE				
	SANS 1200 H	**STRUCTURAL STEELWORK**				
	8.3.1	**SUPPLY AND FABRICATION**				
	8.3.1.1	**Preparation of shop detail drawings**				
OA		Prepare and submit detailed shop drawings as described in the Project Specification and to the approval of the Employer's representative	t	10.49		
		Allowance for trial assembly				
OB		Trial assembly	t	2.10		
	8.3.1.2	**Supply and fabrication of steelwork**				
		Supply and fabricate in S355JR steel to SANS 50025 all steelwork complete with all the necessary cleats, shop bolts, brackets, gussets, packs, base plates, etc., delivered ex works ready for dispatch to site. For all hollow sections supply and fabricate in S355JRH steel to SANS 657 and /or SANS 50219				
		132kV CT				
OC		Medium equipment support 2.5m, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	2.63		
OD		Extra over medium equipment support 2.5m for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	66.00		
OE		Medium equipment cap, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	1.13		
OF		Extra over medium equipment cap for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	41.00		
OG		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0018-01-OB-AE	kg	425.00		
		132kV VT				
OH		Medium equipment support 2.5m, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	1.50		
OI		Extra over medium equipment support 2.5m for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	38.00		
OJ		Medium equipment cap, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	0.77		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
OK		Extra over medium equipment cap for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	23.00		
OL		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0018-01-OB-AE	kg	243.00		
		132kV PI				
OM		Medium equipment support 2.5m, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	4.13		
ON		Extra over medium equipment support 2.5m for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	103.00		
OO		Medium equipment cap, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	t	3.80		
OP		Extra over medium equipment cap for bolts, complete as per drawing 1924701-2-510-T-DE-0019-01-OB-AE	kg	64.00		
OQ		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0018-01-OB-AE	kg	668.00		
		132kV Circuit breaker				
OR		132kV Circuit breaker support, complete as per drawing 1924701-2-510-T-DE-0021-01-OB-AE	t	0.73		
OS		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0018-01-OB-AE	kg	61.00		
		132kV Isolator				
OT		132kV Isolator support, complete as per drawing 1924701-2-510-T-DE-0022-01-OB-AE	t	6.58		
OU		Extra over 132kV isolator support for bolts, complete as per drawing 1924701-2-510-T-DE-0022-01-OB-AE	kg	172.00		
OV		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0018-01-OB-AE	kg	243.00		
		132kV Inline isolator				
OW		132kV Isolator support, complete as per drawing 1924701-2-510-T-DE-0023-01-OB-AE	t	3.88		
OX		Extra over 132kV isolator support for bolts, complete as per drawing 1924701-2-510-T-DE-0023-01-OB-AE	kg	122.00		
OY		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0018-01-OB-AE	kg	101.00		
		SA bracket on isolator				
OZ		SA bracket on isolator, complete as per drawing 1924701-2-510-T-DE-0024-01-OB-AE	t	0.42		
PA		Extra over SA bracket on isolator for bolts, complete as per drawing 1924701-2-510-T-DE-0024-01-OB-AE	kg	8.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		<u>132kV Tubular busbar</u>				
PB		132kV Tubular busbar support, complete as per drawing 1924701-2-510-T-DE-0025-01-OB-AE	t	8.48		
PC		Extra over 132kV tubular busbar support for bolts, complete as per drawing 1924701-2-510-T-DE-0025-01-OB-AE	kg	121.00		
PD		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0021-01-OB-AE	kg	365.00		
		<u>21m Lightning mast</u>				
PE		21m Lightning mast, complete as per drawing 1924701-2-510-T-DE-0026-01-OB-AE	t	7.54		
PF		Extra over 21m lightning mast for bolts, complete as per drawing 1924701-2-510-T-DE-0026-01-OB-AE	kg	21.00		
PG		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0022-01-OB-AE	kg	290.00		
		<u>Earth wire</u>				
PH		Column 33kV C1 & C2, complete as per drawing 1924701-2-510-T-DE-0029-01-OB-AE	t	4.60		
PI		Extra over column 33kV C1 & C2 for bolts, complete as per drawing 1924701-2-510-T-DE-0029-01-OB-AE	kg	168.00		
PJ		Earth wire support and lightning spike, complete as per drawing 1924701-2-510-T-DE-0029-01-OB-AE	t	0.96		
PK		Extra over earth wire support and lightning spike for bolts, complete as per drawing 1924701-2-510-T-DE-0029-01-OB-AE	kg	101.00		
PL		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-T-DE-0024-01-OB-AE	kg	162.00		
		<u>Beam 132 / 40 / 1</u>				
PM		Beam 132 / 40 / 1, complete as per drawing 1924701-2-510-T-DE-0030-01-OB-AE	t	1.61		
PN		Extra over beam 132 / 40 / 1 for bolts, complete as per drawing 1924701-2-510-T-DE-0030-01-OB-AE	kg	79.00		
		<u>JB yard AC DB</u>				
PO		Yard AC DB support, complete as per drawing 1924701-2-510-T-DE-0017-01-OC-AE	t	0.07		
PP		Extra over yard AC DB support for bolts, complete as per drawing 1924701-2-510-T-DE-0017-01-OC-AE	kg	2.00		
PQ		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0021-OB-AE	kg	20.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.2	**DELIVERY**				
	8.3.2.1	Normal Delivery				
PR		Normal delivery to site of new structural steelwork and platework (as listed)	t	10.49		
PS		Abnormal delivery to site of new structural steelwork	t	1.05		
	8.3.3	**ERECTION ON SITE**				
PT		Erection on site of all new structural steelwork and platework (as listed)	t	52.43		
	SANS 1200 HC	**CORROSION PROTECTION OF STRUCTURAL**				
	8.2.3	**Surface preparation and coating application**				
		Supply, prepare and apply corrosion protection in accordance with Employer's Specification on new steel, in the shop and on site (shown above)				
PU	8.2.3.a	a) In shop (new structural steelwork shown above)	t	-		Rate only
PV	8.2.3.b	b) On site (new structural steelwork shown above)	t	10.49		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ISCOR (YARD EQUIPMENT)				
		CONCRETE, FORMWORK AND REINFORCEMENT				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-B-DE-0013-01				
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	8.2	**SCHEDULED FORMWORK ITEMS**				
	8.2.1	**Rough formwork**				
		Vertical surfaces				
PW		Equipment bases	m²	21.00		
	8.3	**SCHEDULED REINFORCEMENT ITEMS**				
	8.3.1	**Steel bars of various diameters**				
PX		Mild steel	t	0.01		
PY		High tensile steel	t	0.12		
	8.4	**SCHEDULED CONCRETE ITEMS**				
	8.4.3	Strength concrete				
PZ		Grade 15MPa/19mm concrete to blinding	m³	-		Rate only
QA		Grade 40MPa/19mm concrete to equipment bases	m³	6.00		
	8.4.4	**Unformed Surface Finishes**				
		Steel floated finish				
QB		Equipment bases	m²	5.50		
	8.7	**GROUTING**				
		Non-shrink grout				
QC		20mm Thick under base plates	dm³	18.50		
		BOLTS				
		132kV PI				
QD		HD bolts to bases, including washers, nuts, etc.	kg	55.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		132kV Circuit breaker				
QE		HD bolts to bases, including washers, nuts, etc.	kg	37.00		
		SLEEVES				
		Sleeves encased in concrete				
QF		110mm sleeves	m	1.00		
		STRUCTURAL STEELWORK				
		NOTE				
		Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		To be read in conjunction with but not limited to the following Project Technical Specification(s) :				
		1924701-2-510-T-DE-0006-01				
		1924701-2-510-T-DE-0008-01				
	SANS 1200 H	**STRUCTURAL STEELWORK**				
	8.3.1	**SUPPLY AND FABRICATION**				
	8.3.1.1	**Preparation of shop detail drawings**				
QG		Prepare and submit detailed shop drawings as described in the Project Specification and to the approval of the *Employer's* representative	t	1.74		
		Allowance for trial assembly				
QH		Trial assembly	t	0.35		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.1.2	**Supply and fabrication of steelwork** Supply and fabricate in S355JR steel to SANS 50025 all steelwork complete with all the necessary cleats, shop bolts, brackets, gussets, packs, base plates, etc., delivered ex works ready for dispatch to site. For all hollow sections supply and fabricate in S355JRH steel to SANS 657 and /or SANS 50219. All steelwork to be hot dip galvanized to SABS ISO 1461. This includes purlins, purlin bracing, sheeting rails and anti-sag angles and anti-sag bars. All bolts and nuts shall be hot dip galvanized to SABS ISO 1461 132kV Medium equipment support				
QI		Medium equipment support 2.5m, complete as per drawing 1924701-2-510-T-DE-0006-01	t	0.75		
QJ		Extra over medium equipment support 2.5m for bolts, complete as per drawing 1924701-2-510-T-DE-0006-01	kg	19.00		
QK		Medium equipment cap, complete as per drawing 1924701-2-510-T-DE-0006-01	t	0.32		
QL		Extra over medium equipment cap for bolts, complete as per drawing 1924701-2-510-T-DE-0006-01	kg	12.00		
QM		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0013-01	kg	122.00		
		132kV Circuit breaker				
QN		132kV Circuit breaker support, complete as per drawing 1924701-2-510-T-DE-0008-01	t	0.48		
QO		50 x 3mm Flat copper, complete as per drawing 1924701-2-510-B-DE-0013-01	kg	41.00		
	8.3.2	**DELIVERY**				
	8.3.2.1	Normal Delivery				
QP		Normal delivery to site of new structural steelwork and platework (as listed)	t	1.74		
QQ		Abnormal delivery to site of new structural steelwork	t	0.17		
	8.3.3	**ERECTION ON SITE**				
QR		Erection on site of all new structural steelwork and platework (as listed)	t	1.74		
	SANS 1200 HC	**CORROSION PROTECTION OF STRUCTURAL STEELWORK**				
	8.2.3	**Surface preparation and coating application** Supply, prepare and apply corrosion protection in accordance with *Employer's* Specification on new steel, in the shop and on site (shown above)				
QS	8.2.3.a	a) In shop (new structural steelwork shown above)	t	1.74		
QT	8.2.3.b	b) On site (new structural steelwork shown above)	t	1.74		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS a) b) c)				

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
14		**SECTION 13 : CIVIL**				
		NOTE Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
		SUBSTATION M				
	SANS 1200 C	**SITE CLEARANCE**				
A	8.2.1	Clear and grub	ha	-		Rate only
	PSC 8.2.2	Clearing of vegetated areas and treatment by grinding and mulching				
B	PSC 8.2.2.a)	a) Clear trees and shrubs by hand	m²	-		Rate only
C	PSC 8.2.2.b)	b) Treatment by grinding and mulching	Sum	-		Rate only
D	PSC 8.2.2.c)	c) Stockpiling and protection of recovered organic materials	Sum	-		Rate only
	PSC 8.2.4	Location of existing services				
E	PSC 8.2.4.a)	a) Site survey by ground-penetrating radar and cable detector	Sum	-		Rate only
F	PSC 8.2.4.b)	b) Excavation by hand in soft and intermediate materials to expose existing services	m³	25.38		
G	PSC 8.2.10	Temporary protection and relocation of unknown existing services	PS	-		N/A
H	PSC 8.2.11	Remove and dispose of asphalt surfacing	m³	-		Rate only
I	PSC 8.2.17	Remove existing base material and stockpile for re-use	m³	-		Rate only
J	PSC 8.2.19	Remove and dispose of existing unstabilized subbase and stockpile for re-use	m³	-		Rate only
K	PSC 8.2.20	Remove existing granular layers and stockpile for re-use	m³	-		Rate only
	SANS 1200 D	**EARTHWORKS**				
L	PSD 8.3.1.2	Remove topsoil to a nominal depth of 200mm and stockpile on Site	m³	-		Rate only
	PSD 8.3.1.3	Carry out topographic survey of the Site:				
M	PSD 8.3.1.3.a)	a) After search and rescue, Site clearance and removal of topsoil	m²	-		Rate only
N	PSD 8.3.1.3.b)	b) After exposure of rock surface	m²	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.2	Bulk Excavations				
	PSD 8.3.2.a)	a) Excavate in soft and intermediate materials and use for embankment or backfill or dispose, as ordered				
O		i) Cut to spoil	m³	-		Rate only
P		ii) Cut to fill	m³	-		Rate only
	8.3.2.b)	b) Extra-over for:				
Q		2) hard rock excavation	m³	-		Rate only
	8.3.4	Importing of Materials				
R	8.3.4.a)	a) Extra-over for importation of materials from borrow pits (Tippler 3 construction site or designated stockpile area)	m³	50.00		
S	PSD 8.3.6	Overhaul	m³.km	1 000.00		
T	PSD 8.3.14	Additional processing of materials by heavy, vibratory grid or padfoot rollers	m³	25.00		
U	PSD 8.3.15	Removal of oversize materials	m³	-		Rate only
	SANS 1200 DA	**EARTHWORKS (SMALL WORKS)**				
	PSDA 8.3.1	Excavation				
	PSDA 8.3.1.b)	b) Excavate in all soft and intermediate materials, use for backfill or dispose of excess material				
V		i) For concrete foundations and thickenings	m³	-		Rate only
	SANS 1200 DB	**EARTHWORKS (PIPE TRENCHES)**				
	PSDB 8.3.2	Excavation and backfilling of all trenches				
	PSDB 8.3.2.a)	a) Excavate in all soft and intermediate materials for all trenches, backfill, compact and dispose of surplus material				
		i) By conventional methods (machine excavation), for:				
		1) 35mm Ø water pipe				
W		i) Exceeding 0.5m but not exceeding 1.0m	m	10.00		
X		ii) Exceeding 1.0m but not exceeding 2.0m	m	5.00		
		2) 110mm Ø fire water pipe				
Y		i) Exceeding 0.5m but not exceeding 1.5m	m	90.00		
Z		ii) Exceeding 1.5m but not exceeding 2.0m	m	10.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		3) 110mm Ø single sleeve				
AA		i) Exceeding 0.5m but not exceeding 1.0m	m	24.00		
AB		ii) Exceeding 1.0m but not exceeding 2.0m	m	6.00		
		4) 160mm Ø single sleeve				
AC		i) Exceeding 0.5m but not exceeding 1.0m	m	24.00		
AD		ii) Exceeding 1.0m but not exceeding 2.0m	m	6.00		
		5) 160mm Ø sleeve bundles (8 sleeves per bundle)				
AE		i) Exceeding 0.5m but not exceeding 1.5m	m³	120.00		
AF		ii) Exceeding 1.5m but not exceeding 2.0m	m³	50.00		
		6) Reinforced concrete stormwater grated channel (900mm wide)				
AG		i) Exceeding 0.5m but not exceeding 1.0m	m	25.00		
AH		ii) Exceeding 1.0m but not exceeding 2.0m	m	5.00		
		ii) By hand, for:				
		1) 160mm Ø single split sleeve				
AI		i) Exceeding 0.5m but not exceeding 1.0m	m	10.00		
AJ		ii) Exceeding 1.0m but not exceeding 2.0m	m	10.00		
		2) Earthing mat installations				
AK		i) 500mm wide x 1,000mm deep trench	m	-		Rate only
	PSDB 8.3.2.b)	b) Extra-over item a) above for:				
AL		1) Hard rock excavation	m³	-		Rate only
AM	8.3.2.c)	c) Excavate and dispose of unsuitable material from trench bottom (provisional)	m³	-		Rate only
	PSDB 8.3.3	Excavation Ancillaries				
	8.3.3.1	Make up deficiency in backfill material (provisional):				
AN	8.3.3.1.a)	a) from other necessary excavations on Site	m³	3.00		
AO	8.3.3.1.c)	c) by importation from commercial or off-site sources selected by the *Contractor*	m³	3.00		
	PSDB 8.3.5	Existing services that intersect or adjoin a trench:				
	PSDB 8.3.5.a)	a) Services that intersect a trench:				
AP		i) Electrical	No.	1.00		
AQ		ii) Communication	No.	1.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
AR		iii) Water	No.	1.00		
AS		iv) Sewer	No.	1.00		
AT		v) Conveyor	No.	1.00		
AU		vi) HV Cable	No.	1.00		
AV		vii) Fence	No.	1.00		
AW		viii) Stormwater	No.	1.00		
	PSDB 8.3.5.b)	b) Services that adjoin a trench:				
AX		i) Electrical	m	25.00		
AY		ii) Communication	m	25.00		
AZ		iii) Water	m	25.00		
BA		iv) Sewer	m	25.00		
BB		v) Conveyor	m	25.00		
BC		vi) HV Cable	m	25.00		
BD		vii) Fence	m	25.00		
BE		viii) Stormwater	m	25.00		
	SANS 1200 DM	**EARTHWORKS (ROADS, SUBGRADE)**				
	PSDM 8.3.3	Treatment of Roadbed				
	PSDM 8.3.3.c)	c) Surface preparation and compaction of in-situ materials to minimum of 93% of MOD AASHTO maximum density (100% for sand)				
BF		i) For building platforms	m³	-		Rate only
BG		ii) For roads, parking and hardstand platforms	m³	125.00		
BH		iii) For general landscaping areas	m³	120.00		
BI	PSDM 8.3.17	Imported 150mm gravel G7 selected layer compacted to 95% of MOD AASHTO maximum density (for road and hardstand layerworks)	m³	75.00		
	PSDM 8.3.18	G5 subbase engineered fill for:				
BJ	PSDM 8.3.18.a)	a) Substation M building platform	m³	-		Rate only
	PSDM 8.3.19	400mm Ø augured holes for conductive concrete applications, for:				
BK	PSDM 8.3.19.a)	a) 3.0m to 5.0m depth	No.	-		Rate only
BL	PSDM 8.3.19.b)	b) 5.0m to 7.0m depth	No.	-		Rate only
BM	PSDM 8.3.19.c)	c) 7.0m to 10.0m depth	No.			Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	PSG 8.9	**CONCRETE SURFACE BED FOR ROADS/YARDS**				
BN	PSG 8.9.a)	a) As per drawing number 1924701-2-510-C-LA-0047-01	m²	119.00		
	SANS 1200 L	**MEDIUM-PRESSURE PIPELINES**				
	PSL 8.2.1	Supply, handle, lay, bed (for flexible pipes), joint, test and disinfect pipes complete with couplings (waste and cut lengths to be allowed for in these rates):				
BO	PSL 8.2.1.a)	a) 110mm Ø uPVC class 16 fire water pipe	m	100.00		
BP	PSL 8.2.1.b)	b) 35mm Ø polycop class 10 domestic water pipe	m	15.00		
	PSL 8.2.2	Extra-over PSL-8.2.1 for the supplying, laying, and bedding of fittings and specials complete with couplings, including cutting pipes to length where required, test and disinfect:				
BQ	PSL 8.2.2.a)	a) 110mm Ø x 1¼" saddle with 32mm Ø male threaded 90° bend as per detail LA-0048-01.L of drawing number 1924701-2-510-C-LA-0048-01	No.	1.00		
BR	PSL 8.2.2.b)	b) 110mm Ø uPVC class 16 90° bend	No.	3.00		
BS	PSL 8.2.2.c)	c) 110mm Ø uPVC class 16 11.25° bend	No.	2.00		
BT	PSL 8.2.2.d)	d) 32mm Ø x 32mm Ø Philmac (or equivalent approved) PN16 elbow	No.	2.00		
	PSL 8.2.3	Extra-over PSL-8.2.1 for the supplying, handling, fixing, bedding and commissioning of valves and flow meters complete with couplings (including bolts, nuts, washers and packings)				
BU	PSL 8.2.3.a)	a) New DN100 PN16 isolating valve	No.	1.00		
BV	PSL 8.2.3.b)	b) New DN100 PN16 flow meter	No.	1.00		
BW	PSL 8.2.11	Anchor/thrust blocks and pedestals (30MPa concrete/19mm stone)	m³	2.00		
	PSL 8.2.13	Valve, hydrant and flow meter chambers, for:				
BX	PSL 8.2.13.a)	a) New DN100 PN16 isolating valve	No.	1.00		
BY	PSL 8.2.13.b)	b) New DN100 PN16 flow meter	No.	1.00		
	PSL 8.2.16	Install internal cold water copper pipes for chiller plant with the following nominal diameters				
BZ	PSL 8.2.16.a)	a) 32mm	m	3.00		
	PSL 8.2.17	Connecting to existing water mains				
CA	PSL 8.2.17.a)	a) Connection of new 110mm Ø uPVC fire water pipe to existing 160mm Ø water main line (installed by Others) by means of "hot-tap" connection	No.	1.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSL 8.2.18	Install a combination set of 1 x pressure reducing valve and 2 x isolating valves complete in accordance with:				
CB	PSL 8.2.18.a)	a) Detail LA-0048-01.C of drawing 1924701-2-510-C-LA-0048-01	Set	1.00		
	PSL 8.2.19	Install external standard pillar type fire hydrant in accordance with:				
CC	PSL 8.2.19.a)	a) Detail LA-0048-01.D of drawing 1924701-2-510-C-LA-0048-01	No.	1.00		
	PSL 8.2.20	Pipe Markers				
CD	PSL 8.2.20.a)	a) Marker posts	No.	4.00		
CE	PSL 8.2.20.b)	b) Kerb/edging marks	No.	2.00		
	SANS 1200 LB	**BEDDING (PIPES)**				
	PSLB 8.2.2	Supply only of bedding by importation				
	PSLB 8.2.2.3	From commercial sources				
CF	8.2.2.3.a)	a) Selected granular material	m³	35.00		
CG	8.2.2.3.b)	b) Selected fill material	m³	100.00		
CH	PSLB 8.2.2.3.c)	c) 13mm stone bedding	m³	5.00		
	PSLB 8.2.4	Encasing of pipes and ducts in 30MPa (19m stone) concrete				
CI	PSLB 8.2.4.a)	a) 200mm Ø class 34 uPVC stormwater pipe	m	5.00		
	PSLB 8.2.6	Supply, handle and install nonwoven polyester geotextile				
CJ	PSLB 8.2.6.a)	a) A5 bidim (2.65m wide)	m	50.00		
	SANS 1200 LC	**CABLE DUCTS**				
	PSLC 8.2.5	Supply, lay, bed and prove ducts/sleeves including draw wires. Ducts to be "Kabelflex" or approved equivalent				
CK	PSLC 8.2.5.a)	a) 110mm HDPE single ducts/sleeves	m	30.00		
CL	PSLC 8.2.5.b)	b) 160mm HDPE single ducts/sleeves	m	30.00		
CM	PSLC 8.2.5.c)	c) 160mm Ø sleeves (for 8 sleeve bundles)	m	1 100.00		
	PSLC 8.2.8	Cable and cable duct markers				
CN	PSLC 8.2.8.a)	a) Route markers (marker posts)	No.	22.00		
CO	PSLC 8.2.8.b)	b) Kerb/edging marks	No.	6.00		
	PSLC 8.2.10	Closing and/or sealing of sleeve/duct ends				
CP	PSLC 8.2.10.a)	a) Sleeve/duct ends sealed with approved fire retardant material	No.	72.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
CQ	PSLC 8.2.10.b)	b) Sleeve/duct ends sealed with builders expander foam	No.	6.00		
CR	PSLC 8.2.10.c)	c) Sleeve/duct ends sealed with plastic end caps	No.	60.00		
	PSLC 8.2.11	Supply, lay, bed and prove split sleeve/duct				
CS	PSLC 8.2.11.a)	a) 160mm Ø HDPE Kableflex split ducts complete with draw wire	m	20.00		
CT	PSLC 8.2.13	Installation of danger tape	m	350.00		
	SANS 1200 LE	**STORMWATER DRAINAGE**				
	PSLE 8.2.8	Supply and install manholes, catch pits, and the like				
CU	PSLE 8.2.8.a)	a) 600mm x 450mm brick grating manhole in accordance with detail LA-0048-01.K of drawing 1924701-2-510-C-LA-0048-01	No.	1.00		
	PSLE 8.2.14	Supply and lay pipe inside concrete encasement (encasement measured elsewhere)				
CV	PSLE 8.2.14.a)	a) 200mm Ø class 34 uPVC stormwater pipe	m	5.00		
	PSLE 8.2.15	Reinforced concrete (40MPa/19mm stone) stormwater grated channel (900mm wide), complete with heavy duty hot dipped galvanised grating, benching and isolation joints all around, in accordance with detail:				
CW	PSLE 8.2.15.a)	a) LA-0048-01.E of drawing number 1924701-2-510-C-LA-0048-01	m	30.00		
	PSLE 8.2.16	400mm Ø x 10m deep augured stormwater soak away vertical drain filled with clean coarse grated sand in accordance with detail:				
CX	PSLE 8.2.16.a)	a) LA-0048-01.K of drawing number 1924701-2-510-C-LA-0048-01	No.	4.00		
	SANS 1200 ME	**SUBBASE**				
	8.3.3	Construct the subbase course with material from commercial sources				
CY	8.3.3.a)	a) 150mm C3 gravel subbase layer compacted to 97% of MOD AASHTO maximum density	m³	115.00		
CZ	8.3.3.b)	b) 150mm G6 gravel subbase layer compacted to 95% of MOD AASHTO maximum density	m³	30.00		
	8.3.3	Construct the subbase shoulders with material from commercial sources				
DA	8.3.3.a)	a) 150mm gravel wearing course layer compacted to 97% of MOD AASHTO maximum density	m³	5.00		
	8.3.5	Process subbase material by the following process:				
	8.3.5.d)	d) Stabilization				
DB		i) 150mm C3 gravel subbase layer	m³	115.00		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.8	Stabilizing agent				
	8.3.8.b)	b) Portland cement				
DC		i) 150mm C3 gravel subbase layer	t	9.00		
DD	PSME 8.3.11	Tie new C3 subbase layer in with existing road layerworks by means of benching	m	40.00		
	SANS 1200 MF	**BASE**				
	8.3.3	Construct base with material from commercial sources				
	8.3.3.a)	a) Gravel material				
DE		i) 150mm G4 gravel base layer, compacted to 98% of MOD AASHTO.	m³	25.00		
	SANS 1200 MH	**ASPHALT BASE AND SURFACING**				
	8.5.1	Prime Coat				
DF	8.5.1.a)	a) Invert bitumen emulsion (MSP 1) with application rate of 0.8ℓ/m²	m²	165.00		
	8.5.4	Asphalt				
DG	8.5.4.a)	a) 30mm Continuously graded medium asphalt surfacing mix with modified binder (type A-E2) manufactured from 50/70 penetration grade bitumen	t	12.50		
DH	PSMH 8.5.9	Extra over items 8.5.4 for the transportation cost of bitumen binder supplied by a refinery outside the Western Cape Province	t	0.50		
	SANS 1200 MK	**KERBING AND CHANNELLING**				
	PSMK 8.2.1	Concrete kerbing, edging and channelling				
DI	PSMK 8.2.1.b)	b) Type W4 stormwater precast channel on 30MPa bedding	m	145.00		
	SANS 1200 MM	**ANCILLARY ROADWORKS**				
	PSMM 8.6	**BOLLARDS**				
DJ	PSMM 8.6.1	Supply and install bollards in accordance with detail LA-0047-01.A of drawing number 1924701-2-510-C-LA-0047-01	No.	2.00		
	PSMM 8.7	**SIGNAGE**				
	PSMM 8.7.1	Road signs with painted background and symbols and with signboard constructed from aluminium sheeting (2mm thick) complete and in accordance to class III of SANS 1519				
DK	PSMM 8.7.1.a)	a) Yield sign (Type R2) 900mm high triangular size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 2,500mm high	No.	2.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
DL	PSMM 8.7.1.b)	b) Danger plate sign (Type W401) 150mm wide x 600mm high rectangular size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 1,500mm high	No.	1.00		
DM	PSMM 8.7.1.c)	c) Danger plate sign (Type W402) 150mm wide x 600mm high rectangular size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 1,500mm high	No.	1.00		
	PSS	**SOIL AND VEGETATION REHABILITATION**				
DN	PSS 12.1	Nominated soil and vegetation conservation specialist	PS	1		TBA
DO	PSS 12.2	Topsoiling	m²	700.00		
	PSS 12.3	Mulching				
DP	PSS 12.3.a)	a) Application of mulch from stockpiles on Site	m²	250.00		
DQ	PSS 12.3.b)	b) Procurement and application of mulch from commercial sources	m²	450.00		
	PSS 12.4	Hydroseeding				
DR	PSS 12.4.a)	a) Procure hydroseed mix	PS	1		TBA
DS	PSS 12.4.b)	b) Application of hydroseeding	m²	700.00		
DT	PSS 12.5	Erosion matting	m²	650.00		
DU	PSS 12.6	Watering after hydroseeding	ℓ	25 000.00		
	PSS 12.7	Provisional sums				
DV	PSS 12.7.a)	a) Fertilizer	PS	1		TBA
DW	PSS 12.7.b)	b) Herbicide	PS	1		TBA
DX	PSS 12.7.c)	c) Other proprietary products	PS	1		TBA
	PST	**LATERAL SUPPORT**				
	PST 11.2	**SHOTCRETE**				
DY	PST 11.2.1	Establishment on Site for shotcreting, including the provision and removal of equipment for shotcreting	Sum	-		Rate only
DZ	PST 11.2.2	25mm thick flash coat shotcrete (30MPa) strength applied as initial layer prior to placing mesh	m²	-		Rate only
EA	PST 11.2.3	175mm thick shotcrete (30MPa) strength with 2 x layers of galvanised ref. 395 mesh reinforcing	m²	-		Rate only
EB	PST 11.2.5	Place and maintain in position vertical geodrains (wickdrains) consisting of geofabric wrapped in geonet, spaced centrally between soil nails and rock bolts for the full height of the excavation zone, including discharging the geodrains into 50mm Ø HDPE weephole pipes protruding through the toe of the wall	m	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PST 11.3	**SOIL NAILS**				
EC	PST 11.3.1	Establishment on Site for drilling, including the provision and removal of equipment for installing and testing soil nails	Sum	-		Rate only
ED	PST 11.3.2	Moving to and setting up the equipment at each position for drilling the holes	No.	-		Rate only
EE	PST 11.3.3	Drilling of holes, installation, grouting, fixing and tightening of 2 rows of self-drilling soil nails (R25N or equivalent approved) of length 6.0m, installed 10° to 15° to the horizontal into the soft excavation zone	No.	-		Rate only
	PST 11.4	**PROVISIONAL AMOUNTS**				
EF	PST 11.4.1	50 No. off 125mm Ø mini-piles of length 5.0m each, installed at 1.5m c/c, each pile reinforced with 4 x Y12 bars with R08 spirals at 1.0m c/c	Sum	-		Rate only
		SUBSTATION N				
	SANS 1200 C	**SITE CLEARANCE**				
EG	8.2.1	Clear and grub	ha	-		Rate only
	PSC 8.2.2	Clearing of vegetated areas and treatment by grinding and mulching				
EH	PSC 8.2.2.a)	a) Clear trees and shrubs by hand	m²	-		Rate only
EI	PSC 8.2.2.b)	b) Treatment by grinding and mulching	Sum	-		Rate only
EJ	PSC 8.2.2.c)	c) Stockpiling and protection of recovered organic materials	Sum	-		Rate only
	PSC 8.2.4	Location of existing services				
EK	PSC 8.2.4.a)	a) Site survey by ground-penetrating radar and cable detector	Sum	-		Rate only
EL	PSC 8.2.4.b)	b) Excavation by hand in soft and intermediate materials to expose existing services	m³	20.00		
EM	PSC 8.2.7	Remove existing cable- and pipe markers for later re-use	No.	-		Rate only
	PSC 8.2.8	Remove all redundant underground services from Site				
EN	PSC 8.2.8.a)	a) 160mm Ø water main line	m	-		Rate only
EO	PSC 8.2.8.b)	b) 160mm Ø foulsewer rising main line	m	-		Rate only
EP	PSC 8.2.8.c)	c) HV electrical cables	m	-		Rate only
EQ	PSC 8.2.8.d)	d) Communication cables	m	-		Rate only
ER	PSC 8.2.8.e)	e) Electrical lighting cable	m	-		Rate only
ES	PSC 8.2.9	Remove all redundant light poles from Site	No.	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
ET	PSC 8.2.10	Temporary protection and relocation of unknown existing services	PS	-	-	N/A
	PSC 8.2.16	Demolish and remove from Site redundant manhole chambers				
EU	PSC 8.2.16.a)	a) Existing foulsewer line scour manhole chamber	No.	-		Rate only
EV	PSC 8.2.16.b)	b) Existing water line scour manhole chamber	No.	-		Rate only
EW	PSC 8.2.16.c)	c) Existing communications cable manhole chamber	No.	-		Rate only
	SANS 1200 D	**EARTHWORKS**				
EX	PSD 8.3.1.2	Remove topsoil to a nominal depth of 200mm and stockpile on Site	m³	-		Rate only
	PSD 8.3.1.3	Carry out topographic survey of the Site:				
EY	PSD 8.3.1.3.a)	a) After search and rescue, Site clearance and removal of topsoil	m²	-		Rate only
EZ	PSD 8.3.1.3.b)	b) After exposure of rock surface	m²	-		Rate only
	8.3.2	Bulk Excavations				
	PSD 8.3.2.a)	a) Excavate in soft and intermediate materials and use for embankment or backfill or dispose, as ordered				
FA		i) Cut to spoil	m³	-		Rate only
FB		ii) Cut to fill	m³	-		Rate only
	8.3.2.b)	b) Extra-over for:				
FC		2) hard rock excavation	m³	-		Rate only
	8.3.4	Importing of Materials				
FD	8.3.4.a)	a) Extra-over for importation of materials from borrow pits (Tippler 3 construction site or designated stockpile area)	m³	-		Rate only
FE	PSD 8.3.6	Overhaul	m³.km	3 000.00		
FF	PSD 8.3.14	Additional processing of materials by heavy, vibratory grid or padfoot rollers	m³	250.00		
FG	PSD 8.3.15	Removal of oversize materials	m³	-		Rate only
	SANS 1200 DA	**EARTHWORKS (SMALL WORKS)**				
	PSDA 8.3.1	Excavation				
	PSDA 8.3.1.b)	b) Excavate in all soft and intermediate materials, use for backfill or dispose of excess material				
FH		i) For concrete foundations and thickenings	m³	50.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	SANS 1200 DB	**EARTHWORKS (PIPE TRENCHES)**				
	PSDB 8.3.2	Excavation and backfilling of all trenches				
	PSDB 8.3.2.a)	a) Excavate in all soft and intermediate materials for all trenches, backfill, compact and dispose of surplus material				
		i) By conventional methods (machine excavation), for:				
		1) 35mm Ø water pipe				
FI		i) Exceeding 0.5m but not exceeding 1.0m	m	35.00		
FJ		ii) Exceeding 1.0m but not exceeding 2.0m	m	5.00		
		2) 110mm Ø fire water pipe				
FK		i) Exceeding 0.5m but not exceeding 1.5m	m	20.00		
FL		ii) Exceeding 1.5m but not exceeding 2.0m	m	5.00		
		3) 110mm Ø single sleeve				
FM		i) Exceeding 0.5m but not exceeding 1.0m	m	25.00		
FN		ii) Exceeding 1.0m but not exceeding 2.0m	m	25.00		
		4) new relocated 160mm Ø water line				
FO		i) Exceeding 0.5m but not exceeding 1.5m	m	45.00		
FP		ii) Exceeding 1.5m but not exceeding 2.5m	m	45.00		
		5) new relocated 160mm Ø sewer line				
FQ		i) Exceeding 0.5m but not exceeding 1.5m	m	45.00		
FR		ii) Exceeding 1.5m but not exceeding 2.5m	m	45.00		
		6) 160mm Ø single sleeve				
FS		i) Exceeding 0.5m but not exceeding 1.0m	m	25.00		
FT		ii) Exceeding 1.0m but not exceeding 2.0m	m	25.00		
		7) 160mm Ø sleeve bundles (8 sleeves per bundle)				
FU		i) Exceeding 0.5m but not exceeding 1.5m	m³	80.00		
FV		ii) Exceeding 1.5m but not exceeding 2.0m	m³	50.00		
		8) 200mm Ø stormwater pipe				
FW		i) Exceeding 0.5m but not exceeding 1.0m	m	30.00		
FX		ii) Exceeding 1.0m but not exceeding 2.0m	m	5.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		9) Reinforced concrete stormwater grated channel (900mm wide)				
FY		i) Exceeding 0.5m but not exceeding 1.0m	m	90.00		
FZ		ii) Exceeding 1.0m but not exceeding 2.0m	m	10.00		
		ii) By hand, for:				
		1) new relocated 160mm Ø water line				
GA		i) Exceeding 0.5m but not exceeding 1.5m	m	-		Rate only
GB		ii) Exceeding 1.5m but not exceeding 2.5m	m	-		Rate only
		2) new relocated 160mm Ø sewer line				
GC		i) Exceeding 0.5m but not exceeding 1.5m	m	-		Rate only
GD		ii) Exceeding 1.5m but not exceeding 2.5m	m	-		Rate only
		3) exposing existing 160mm Ø water line for removal				
GE		i) Exceeding 0.5m but not exceeding 1.5m	m	-		Rate only
GF		ii) Exceeding 1.5m but not exceeding 2.5m	m	-		Rate only
		4) exposing existing 160mm Ø sewer line for removal				
GG		i) Exceeding 0.5m but not exceeding 1.5m	m	-		Rate only
GH		ii) Exceeding 1.5m but not exceeding 2.5m	m	-		Rate only
		5) exposing existing HV electrical cables for removal				
GI		i) Exceeding 0.5m but not exceeding 1.5m	m	335.00		
GJ		ii) Exceeding 1.5m but not exceeding 2.5m	m	2.00		
		6) exposing existing communication cables for removal				
GK		i) Exceeding 0.5m but not exceeding 1.5m	m	75.00		
GL		ii) Exceeding 1.5m but not exceeding 2.5m	m	40.00		
		7) exposing existing electrical lighting cable for removal				
GM		i) Exceeding 0.5m but not exceeding 1.5m	m	17.00		
GN		ii) Exceeding 1.5m but not exceeding 2.5m	m	15.00		
		8) 160mm Ø single split sleeve				
GO		i) Exceeding 0.5m but not exceeding 1.0m	m	12.00		
GP		ii) Exceeding 1.0m but not exceeding 2.0m	m	12.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		9) Earthing mat installations				
GQ		i) 500mm wide x 1,000mm deep trench	m	100.00		
	8.3.2.b)	b) Extra-over item a) above for:				
GR		2) Hard rock excavation	m³	10.00		
GS	8.3.2.c)	c) Excavate and dispose of unsuitable material from trench bottom (provisional)	m³	10.00		
	PSDB 8.3.3	Excavation Ancillaries				
	8.3.3.1	Make up deficiency in backfill material (provisional):				
GT	8.3.3.1.a)	a) from other necessary excavations on Site	m³	15.00		
GU	8.3.3.1.c)	c) by importation from commercial or off-site sources selected by the *Contractor*	m³	15.00		
	PSDB 8.3.5	Existing services that intersect or adjoin a trench:				
	PSDB 8.3.5.a)	a) Services that intersect a trench:				
GV		i) Electrical	No.	5.00		
GW		ii) Communication	No.	2.00		
GX		iii) Water	No.	2.50		
GY		iv) Sewer	No.	2.50		
GZ		v) Conveyor	No.	0.50		
HA		vi) HV Cable	No.	2.50		
HB		vii) Fence	No.	0.50		
HC		viii) Stormwater	No.	0.50		
	PSDB 8.3.5.b)	b) Services that adjoin a trench:				
HD		i) Electrical	m	50.00		
HE		ii) Communication	m	60.00		
HF		iii) Water	m	50.00		
HG		iv) Sewer	m	50.00		
HH		v) Conveyor	m	50.00		
HI		vi) HV Cable	m	150.00		
HJ		vii) Fence	m	12.50		
HK		viii) Stormwater	m	12.50		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	SANS 1200 DM	**EARTHWORKS (ROADS, SUBGRADE)**				
	PSDM 8.3.3	Treatment of Roadbed				
	PSDM 8.3.3.c)	c) Surface preparation and compaction of in-situ materials to minimum of 93% of MOD AASHTO maximum density (100% for sand)				
HL		i) For building and walkway platforms	m³	95.00		
HM		ii) For roads and parking platforms	m³	310.00		
HN		iii) For general landscaping areas	m³	460.00		
HO	PSDM 8.3.17	Imported 150mm gravel G7 selected layer compacted to 95% of MOD AASHTO maximum density (for road and hardstand layerworks)	m³	325.00		
	PSDM 8.3.18	G5 subbase engineered fill for:				
HP	PSDM 8.3.18.a)	a) Substation N building platform	m³	1 100.00		
	PSDM 8.3.19	400mm Ø augured holes for conductive concrete applications for:				
HQ	PSDM 8.3.19.a)	a) 3.0m to 5.0m depth	No.	-		Rate only
HR	PSDM 8.3.19.b)	b) 5.0m to 7.0m depth	No.	-		Rate only
HS	PSDM 8.3.19.c)	c) 7.0m to 10.0m depth	No.			Rate only
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	PSG 8.9	**CONCRETE SURFACE BED FOR ROADS/YARDS**				
HT	PSG 8.9.b)	b) As per drawing number 1924701-2-510-C-LA-0052-02	m²	1 900.00		
	SANS 1200 L	**MEDIUM-PRESSURE PIPELINES**				
	PSL 8.2.1	Supply, handle, lay, bed (for flexible pipes), joint, test and disinfect pipes complete with couplings (waste and cut lengths to be allowed for in these rates):				
HU	PSL 8.2.1.a)	a) 160mm Ø uPVC class 16 water pipe (new relocated line)	m	180.00		
HV	PSL 8.2.1.b)	b) 110mm Ø uPVC class 16 fire water pipe	m	25.00		
HW	PSL 8.2.1.c)	c) 35mm Ø polycop class 10 domestic water pipe	m	40.00		
	PSL 8.2.2	Extra-over PSL-8.2.1 for the supplying, laying, and bedding of fittings and specials complete with couplings, including cutting pipes to length where required, test and disinfect:				
HX	PSL 8.2.2.a)	a) 110mm Ø x 1¼" saddle with 32mm Ø male threaded 90° bend as per detail LA-0053-01.J of drawing number 1924701-2-510-C-LA-0053-01	No.	1.00		
HY	PSL 8.2.2.b)	b) 110mm Ø uPVC class 16 90° bend	No.	1.00		
HZ	PSL 8.2.2.d)	d) 32mm Ø x 32mm Ø Philmac (or equivalent approved) PN16 elbow	No.	2.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSL 8.2.3	Extra-over PSL-8.2.1 for the supplying, handling, fixing, bedding and commissioning of valves and flow meters complete with couplings (including bolts, nuts, washers and packings)				
IA	PSL 8.2.3.a)	a) New DN100 PN16 isolating valve	No.	1.00		
IB	PSL 8.2.3.b)	b) New DN100 PN16 flow meter	No.	1.00		
IC	PSL 8.2.3.c)	c) New DN160 PN16 scour valve	No.	1.00		
ID	PSL 8.2.11	Anchor/thrust blocks and pedestals (30MPa concrete/19mm stone)	m³	2.00		
	PSL 8.2.13	Valve, hydrant and flow meter chambers, for:				
IE	PSL 8.2.13.a)	a) New DN100 PN16 isolating valve	No.	1.00		
IF	PSL 8.2.13.b)	b) New DN100 PN16 flow meter	No.	1.00		
IG	PSL 8.2.13.c)	c) New DN160 PN16 scour valve	No.	1.00		
	PSL 8.2.16	Install internal cold water copper pipes for chiller plant with the following nominal diameters:				
IH	PSL 8.2.16.a)	a) 32mm	m	3.00		
	PSL 8.2.17	Connecting to existing water mains				
II	PSL 8.2.17.b)	b) Connection of new, re-routed 160mm Ø water line, to existing 160mm Ø water line	No.	2.00		
IJ	PSL 8.2.17.c)	c) Connection of new 110mm Ø uPVC fire water pipe to new re-routed 160mm Ø water main line	No.	1.00		
	PSL 8.2.18	Install a combination set of 1 x pressure reducing valve and 2 x isolating valves complete in accordance with:				
IK	PSL 8.2.18.b)	b) Detail LA-0053-01.A of drawing 1924701-2-510-C-LA-0053-01	Set	1.00		
	PSL 8.2.19	Install external standard pillar type fire hydrant in accordance with:				
IL	PSL 8.2.19.b)	b) Detail LA-0053-01.B of drawing 1924701-2-510-C-LA-0053-01	No.	1.00		
	PSL 8.2.20	Pipe Markers				
IM	PSL 8.2.20.a)	a) Marker posts	No.	5.00		
IN	PSL 8.2.20.b)	b) Kerb/edging marks	No.	5.00		
	SANS 1200 LB	**BEDDING (PIPES)**				
	PSLB 8.2.2	Supply only of bedding by importation				
	PSLB 8.2.2.3	From commercial sources				
IO	8.2.2.3.a)	a) Selected granular material	m³	60.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
IP	8.2.2.3.b)	b) Selected fill material	m³	190.00		
IQ	PSLB 8.2.2.3.c)	c) 13mm stone bedding	m³	10.00		
	PSLB 8.2.6	Supply, handle and install nonwoven polyester geotextile				
IR	PSLB 8.2.6.a)	a) A5 bidim (2.65m wide)	m	100.00		
IS	PSLB 8.2.7	Bedding and padding for underground cables	m³	80.00		
	SANS 1200 LC	**CABLE DUCTS (Payment for HV & Data Cables)**				
	PSLC 8.2.5	Supply, lay, bed and prove ducts/sleeves including draw wires. Ducts to be "Kabelflex" or approved equivalent				
IT	PSLC 8.2.5.a)	a) 110mm HDPE single ducts/sleeves	m	50.00		
IU	PSLC 8.2.5.b)	b) 160mm HDPE single ducts/sleeves	m	50.00		
IV	PSLC 8.2.5.c)	c) 160mm Ø sleeves (for 8 sleeve bundles)	m	950.00		
	8.2.7	Draw pits/manholes				
IW	8.2.7.a)	a) 1,500mm x 1,500mm internal dimensions in accordance with detail LA-0053-01.D of drawing 1924701-2-510-C-LA-0053-01	No.	4.00		
	PSLC 8.2.8	Cable and cable duct markers				
IX	PSLC 8.2.8.a)	a) Route markers (marker posts)	No.	6.00		
IY	PSLC 8.2.8.b)	b) Kerb/edging marks	No.	22.00		
	PSLC 8.2.10	Closing and/or sealing of sleeve/duct ends				
IZ	PSLC 8.2.10.a)	a) Sleeve/duct ends sealed with approved fire retardant material	No.	120.00		
JA	PSLC 8.2.10.b)	b) Sleeve/duct ends sealed with builders expander foam	No.	8.00		
JB	PSLC 8.2.10.c)	c) Sleeve/duct ends sealed with plastic end caps	No.	56.00		
	PSLC 8.2.11	Supply, lay, bed and prove split sleeve/duct				
JC	PSLC 8.2.11.a)	a) 160mm Ø HDPE Kableflex split ducts complete with draw wire	m	24.00		
JD	PSLC 8.2.13	Installation of danger tape	m	300.00		
	SANS 1200 LD	**SEWERS**				
	PSLD 8.2.1	Supply, handle, lay, joint, bed and test pipelines				
JE	PSLD 8.2.1.a)	a) 160mm Ø uPVC class 16 sewer rising main pipe (new relocated line)	m	180.00		
	PSLD 8.2.2	Extra-over PSLD 8.2.1 for the supplying, fixing, and bedding of valves				
JF	PSLD 8.2.2.a)	a) New DN160 PN16 scour valve	No.	1.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSLD 8.2.3	Foulsewer Manholes				
JG	PSLD 8.2.3.a)	a) Scour valve manhole	No.	1.00		
JH	PSLD 8.2.8	Anchor/thrust blocks and pedestals (30MPa/19mm stone concrete)	m³	2.00		
	PSLD 8.2.9	Pipe Markers				
JI	PSLD 8.2.9.a)	a) Marker posts	No.	5.00		
JJ	PSLD 8.2.9.b)	b) Kerb/edging marks	No.	5.00		
	PSLD 8.2.11	Connection to existing sewer				
JK	PSLD 8.2.11.a)	a) Newly re-routed 160mm Ø sewer pipe to existing sewer line	No.	2.00		
	SANS 1200 LE	**STORMWATER DRAINAGE**				
	PSLE 8.2.1	Supply, handle, lay and bed spigot and socket stormwater pipes				
JL	PSLE 8.2.1.a)	a) 200mm class 34 uPVC stormwater pipe	m	35.00		
	PSLE 8.2.8	Supply and install manholes, catch pits, and the like				
JM	PSLE 8.2.8.a)	a) 600mm x 450mm brick grating manhole in accordance with detail LA-0053-01.G of drawing 1924701-2-510-C-LA-0053-01	No.	2.00		
	PSLE 8.2.15	Reinforced concrete (40Mpa/19mm stone) stormwater grated channel (900mm wide) complete with heavy duty hot dipped galvanised grating, benching and isolation joints all around, in accordance with detail:				
JN	PSLE 8.2.15.b)	b) LA-0053-01.C of drawing number 1924701-2-510-C-LA-0053-01	m	100.00		
	PSLE 8.2.16	400mm Ø x 10m deep augured stormwater soak away vertical drain filled with clean coarse grated sand in accordance with detail:				
JO	PSLE 8.2.16.b)	b) LA-0053-01.G of drawing number 1924701-2-510-C-LA-0053-01	No.	5.00		
	PSLE 8.2.18	30MPa (19mm stone) concrete stormwater headwalls complete as per the following details:				
JP	PSLE 8.2.18.a)	a) LA-0053-01.H of drawing number 1924701-2-510-C-LA-0053-01	No.	1.00		
JQ	PSLE 8.2.23	Drainage Dish behind Kerb Line	m	80.00		
	SANS 1200 ME	**SUBBASE**				
	8.3.3	Construct the subbase course with material from commercial sources				
JR	8.3.3.a)	a) 150mm C3 gravel subbase layer compacted to 97% of MOD AASHTO maximum density	m³	300.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.5	Process subbase material by the following process:				
	8.3.5.d)	d) Stabilization				
JS		i) 150mm C3 gravel subbase layer	m³	300.00		
	8.3.8	Stabilizing agent				
	8.3.8.b)	b) Portland cement				
JT		i) 150mm C3 gravel subbase layer	t	22.00		
JU	PSME 8.3.11	Tie new C3 subbase layer in with existing road layerworks by means of benching	m	20.00		
	SANS 1200 MK	**KERBING AND CHANNELLING**				
	PSMK 8.2.1	Concrete kerbing, edging and channelling				
JV	PSMK 8.2.1.b)	b) Type W4 stormwater precast channel on 30MPa bedding	m	25.00		
JW	PSMK 8.2.1.c)	c) Type BK4 barrier kerb on 30MPa bedding	m	170.00		
JX	PSMK 8.2.1.d)	d) Type C3 channel on 30MPa bedding	m	20.00		
JY	PSMK 8.2.1.g)	g) Type C1 channel on 30MPa bedding	m	70.00		
	SANS 1200 MM	**ANCILLARY ROADWORKS**				
	PSMM 8.7	**SIGNAGE**				
	PSMM 8.7.1	Road signs with painted background and symbols and with sign board constructed from aluminium sheeting (2mm thick) complete and in accordance to class III of SANS 1519				
JZ	PSMM 8.7.1.a)	a) Yield sign (Type R2) 900mm high triangular size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 2,500mm high	No.	3.00		
	PSS	**SOIL AND VEGETATION REHABILITATION**				
KA	PSS 12.1	Nominated soil and vegetation conservation specialist	PS	1		TBA
KB	PSS 12.2	Topsoiling	m²	3 050.00		
	PSS 12.3	Mulching				
KC	PSS 12.3.a)	a) Application of mulch from stockpiles on Site	m²	1 000.00		
KD	PSS 12.3.b)	b) Procurement and application of mulch from commercial sources	m²	2 050.00		
	PSS 12.4	Hydroseeding				
KE	PSS 12.4.a)	a) Procure hydroseed mix	PS	1		TBA
KF	PSS 12.4.b)	b) Application of hydroseeding	m²	3 050.00		
KG	PSS 12.5	Erosion matting	m²	1 250.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
KH	PSS 12.6	Watering after hydroseeding	ℓ	75 000.00		
	PSS 12.7	Provisional sums				
KI	PSS 12.7.a)	a) Fertilizer	PS	1		TBA
KJ	PSS 12.7.b)	b) Herbicide	PS	1		TBA
KK	PSS 12.7.c)	c) Other proprietary products	PS	1		TBA
	PST	**LATERAL SUPPORT**				
	PST 11.1	**SLURRY CUT-OFF WALL**				
KL	PST 11.1.1	Establishment on Site for slurry wall construction, including the provision and removal of equipment for constructing the slurry wall	Sum	-		Rate only
KM	PST 11.1.2	Construction of 550mm thick (3.0MPa minimum strength) slurry cut-off wall by means of a Cutter-Soil-Mixer (CSM) or trench mixer	m²	-		Rate only
	PST 11.2	**SHOTCRETE**				
KN	PST 11.2.1	Establishment on Site for shotcreting, including the provision and removal of equipment for shotcreting	Sum	-		Rate only
KO	PST 11.2.4	200mm thick shotcrete (30MPa) strength with 2 x layers of galvanised ref. 617 mesh reinforcing	m²	-		Rate only
KP	PST 11.2.5	Place and maintain in position vertical geodrains (wickdrains) consisting of geofabric wrapped in geonet, spaced centrally between soil nails and rock bolts for the full height of the excavation zone, including discharging the geodrains into 50mm Ø HDPE weephole pipes protruding through the toe of the wall	m	-		Rate only
	PST 11.3	**SOIL NAILS**				
KQ	PST 11.3.1	Establishment on Site for drilling, including the provision and removal of equipment for installing and testing soil nails	Sum	-		Rate only
KR	PST 11.3.2	Moving to and setting up the equipment at each position for drilling the holes	No.	-		Rate only
KS	PST 11.3.4	Drilling of holes, installation, grouting, fixing and tightening of 4 rows of self-drilling soil nails (R32N or equivalent approved) of length 9.0m, installed 10° to 15° to the horizontal through the new 550mm thick slurry wall into the soft excavation zone	No.	-		Rate only
		MAIN INTAKE SUBSTATION				
	SANS 1200 C	**SITE CLEARANCE**				
KT	8.2.1	Clear and grub	ha	-		Rate only
	PSC 8.2.2	Clearing of vegetated areas and treatment by grinding and mulching				
KU	PSC 8.2.2.a)	a) Clear trees and shrubs by hand	m²	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
KV	PSC 8.2.2.b)	b) Treatment by grinding and mulching	Sum	-		Rate only
KW	PSC 8.2.2.c)	c) Stockpiling and protection of recovered organic materials	Sum	-		Rate only
KX	PSC 8.2.3	Remove existing steel palisade fences and hand over to *Employer*	m	-		Rate only
	PSC 8.2.4	Location of existing services				
KY	PSC 8.2.4.a)	a) Site survey by ground-penetrating radar and cable detector	Sum	-		Rate only
KZ	PSC 8.2.4.b)	b) Excavation by hand in soft and intermediate materials to expose existing services	m³	42.00		
	PSC 8.2.5	Temporary protection of known undergound services				
LA	PSC 8.2.5.a)	a) 1 x 160mm Ø water main line	Sum	-		Rate only
LB	PSC 8.2.5.b)	b) 1 x 160mm Ø foulsewer rising main line	Sum	-		Rate only
LC	PSC 8.2.5.c)	c) 3 x HV electrical cables	Sum	-		Rate only
LD	PSC 8.2.5.d)	d) 2 x Communication cables	Sum	-		Rate only
LE	PSC 8.2.5.e)	e) 1 x Electrical lighting cable	Sum	-		Rate only
LF	PSC 8.2.5.f)	f) 1 x Existing duct at northern entrance to Main Intake substation on Access Road 1	Sum	-		Rate only
LG	PSC 8.2.10	Temporary protection and relocation of unknown existing services	PS	-		TBA
LH	PSC 8.2.21	Remove existing road signs	No.	4.00		
	SANS 1200 D	**EARTHWORKS**				
LI	PSD 8.3.1.2	Remove topsoil to a nominal depth of 200mm and stockpile on Site	m³	-		Rate only
	PSD 8.3.1.3	Carry out topographic survey of the Site:				
LJ	PSD 8.3.1.3.a)	a) After search and rescue, Site clearance and removal of topsoil	m²	-		Rate only
LK	PSD 8.3.1.3.b)	b) After exposure of rock surface	m²	-		Rate only
	8.3.2	Bulk Excavations				
	PSD 8.3.2.a)	a) Excavate in soft and intermediate materials and use for embankment or backfill or dispose, as ordered				
LL		i) Cut to spoil	m³	-		Rate only
LM		ii) Cut to fill	m³	-		Rate only
	8.3.2.b)	b) Extra-over for:				
LN		2) hard rock excavation	m³	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.4	Importing of Materials				
LO	8.3.4.a)	a) Extra-over for importation of materials from borrow pits (Tippler 3 construction site or designated stockpile area)	m³	320.00		
LP	PSD 8.3.6	Overhaul	m³.km	200.00		
LQ	PSD 8.3.14	Additional processing of materials by heavy, vibratory grid or padfoot rollers	m³	150.00		
LR	PSD 8.3.15	Removal of oversize materials	m³	-		Rate only
	SANS 1200 DA	**EARTHWORKS (SMALL WORKS)**				
	PSDA 8.3.1	Excavation				
	PSDA 8.3.1.b)	b) Excavate in all soft and intermediate materials, use for backfill or dispose of excess material				
LS		i) For structural steel concrete foundations	m³	50.00		
LT		ii) For concrete foundations and thickenings at Main Intake substation building	m³	-		Rate only
LU		iii) For concrete foundations and thickenings at the Ystervark building	m³	10.00		
LV		iv) For 40MVA Transformer concrete plinths	m³	-		Rate only
	SANS 1200 DB	**EARTHWORKS (PIPE TRENCHES)**				
	PSDB 8.3.2	Excavation and backfilling of all trenches				
	PSDB 8.3.2.a)	a) Excavate in all soft and intermediate materials for all trenches, backfill, compact and dispose of surplus material				
		i) By conventional methods (machine excavation), for:				
		1) 35mm Ø water pipe				
LW		i) Exceeding 0.5m but not exceeding 1.0m	m	50.00		
LX		ii) Exceeding 1.0m but not exceeding 2.0m	m	20.00		
		2) 110mm Ø foulsewer pipe				
LY		i) Exceeding 0.5m but not exceeding 1.0m	m	25.00		
LZ		ii) Exceeding 1.0m but not exceeding 2.0m	m	5.00		
		3) 110mm Ø fire water pipe				
MA		i) Exceeding 0.5m but not exceeding 1.5m	m	80.00		
MB		ii) Exceeding 1.5m but not exceeding 2.0m	m	30.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		4) 110mm Ø single sleeve				
MC		i) Exceeding 0.5m but not exceeding 1.0m	m	25.00		
MD		ii) Exceeding 1.0m but not exceeding 2.0m	m	25.00		
		5) 160mm Ø single sleeve				
ME		i) Exceeding 0.5m but not exceeding 1.0m	m	25.00		
MF		ii) Exceeding 1.0m but not exceeding 2.0m	m	25.00		
		6) 160mm Ø sleeve bundles (8 sleeves per bundle)				
MG		i) Exceeding 0.5m but not exceeding 1.5m	m³	15.00		
MH		ii) Exceeding 1.5m but not exceeding 2.0m	m³	7.00		
		7) 160mm Ø sleeve bundles (4 sleeves per bundle)				
MI		i) Exceeding 0.5m but not exceeding 1.5m	m³	5.00		
MJ		ii) Exceeding 1.5m but not exceeding 2.0m	m³	5.00		
		8) 160mm Ø sleeve bundles (2 sleeves per bundle)				
MK		i) Exceeding 0.5m but not exceeding 1.5m	m³	15.00		
ML		ii) Exceeding 1.5m but not exceeding 2.0m	m³	10.00		
		9) 160mm Ø sleeve bundles (2 sleeves per bundle from Transformer, as per section LA-0057-04-3)				
MM		i) Exceeding 0.5m but not exceeding 1.5m	m³	65.00		
MN		ii) Exceeding 1.5m but not exceeding 2.0m	m³	40.00		
		10) Sleeve bundle consisting of 6 x 160mm Ø and 4 x 110mm Ø HDPE sleeves (Black Kableflex), in accordance with drawing number 19247001-2-300-E-DE-0018-01				
MO		i) Exceeding 0.5m but not exceeding 1.5m	m³	20.00		
MP		ii) Exceeding 1.5m but not exceeding 2.0m	m³	10.00		
		11) Sleeve bundle consisting of 8 x 160mm Ø and 6 x 110mm Ø HDPE sleeves (Black Kableflex), in accordance with drawing number 19247001-2-300-E-DE-0012-01				
MQ		i) Exceeding 0.5m but not exceeding 1.5m	m³	40.00		
MR		ii) Exceeding 1.5m but not exceeding 2.0m	m³	15.00		
		12) 160mm Ø sleeve bundles (9 sleeves per bundle from the Main Intake substation towards the west)				
MS		i) Exceeding 0.5m but not exceeding 1.5m	m³	500.00		
MT		ii) Exceeding 1.5m but not exceeding 2.0m	m³	115.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		13) Sleeve bundle consisting of 6 x 160mm Ø HDPE sleeves (Black Kableflex), from the Main Intake substation towards the west				
MU		i) Exceeding 0.5m but not exceeding 1.5m	m³	-		Rate only
MV		ii) Exceeding 1.5m but not exceeding 2.0m	m³	8.00		
		14) 160mm Ø sleeve bundles (6 sleeves per bundle from the Main Intake substation towards the south)				
MW		i) Exceeding 0.5m but not exceeding 1.5m	m³	36.69		
MX		ii) Exceeding 1.5m but not exceeding 2.0m	m³	25.00		
		15) 160mm Ø sleeve bundles (20 sleeves per bundle from the Main Intake substation towards the east)				
MY		i) Exceeding 0.5m but not exceeding 1.5m	m³	41.86		
MZ		ii) Exceeding 1.5m but not exceeding 2.0m	m³	30.00		
		16) Sleeve bundle consisting of 19 x 160mm Ø HDPE sleeves (Black Kableflex), from the Main Intake substation towards the east				
NA		i) Exceeding 0.5m but not exceeding 1.5m	m³	11.40		
NB		ii) Exceeding 1.5m but not exceeding 2.0m	m³	3.20		
		17) 160mm Ø sleeve bundles (10 sleeves per bundle from the Main Intake substation towards draw pits east of the building)				
NC		i) Exceeding 0.5m but not exceeding 1.5m	m³	-		Rate only
ND		ii) Exceeding 1.5m but not exceeding 2.0m	m³	6.00		
		18) Sleeve bundle consisting of 12 x 160mm Ø HDPE sleeves (Black Kableflex), from the Main Intake substation towards the south				
NE		i) Exceeding 0.5m but not exceeding 1.5m	m³	70.00		
NF		ii) Exceeding 1.5m but not exceeding 2.0m	m³	10.00		
		19) Sleeve bundle consisting of 10 x 160mm Ø HDPE sleeves (Black Kableflex), crossing the internal road to the north of the Main Intake substation				
NG		i) Exceeding 0.5m but not exceeding 1.5m	m³	20.00		
NH		ii) Exceeding 1.5m but not exceeding 2.0m	m³	11.00		
		20) 160mm Ø subsoil pipe				
NI		i) Exceeding 0.5m but not exceeding 1.5m	m	683.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		21) 110mm Ø class 34 uPVC stormwater pipe				
NJ		i) Exceeding 0.5m but not exceeding 1.5m	m	35.00		
NK		ii) Exceeding 1.5m but not exceeding 2.0m	m	10.00		
		22) 200mm Ø class 34 uPVC stormwater pipe				
NL		i) Exceeding 0.5m but not exceeding 1.5m	m	45.00		
NM		ii) Exceeding 1.5m but not exceeding 2.0m	m	10.00		
		23) 250mm Ø class 34 uPVC stormwater pipe				
NN		i) Exceeding 0.5m but not exceeding 1.5m	m	73.00		
NO		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		24) 300mm Ø class 100D concrete stormwater pipe				
NP		i) Exceeding 0.5m but not exceeding 1.5m	m	-		Rate only
NQ		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		25) 300mm Ø class 100D concrete waste water pipe				
NR		i) Exceeding 0.5m but not exceeding 1.5m	m	112.56		
NS		ii) Exceeding 1.5m but not exceeding 2.0m	m	10.00		
		26) 450mm Ø class 100D concrete stormwater pipe				
NT		i) Exceeding 0.5m but not exceeding 1.5m	m	15.00		
NU		ii) Exceeding 1.5m but not exceeding 2.0m	m	30.00		
		27) 600mm Ø class 100D concrete stormwater pipe				
NV		i) Exceeding 0.5m but not exceeding 1.5m	m	-		Rate only
NW		ii) Exceeding 1.5m but not exceeding 2.0m	m	20.00		
		28) Cable trench, 0.6m wide (for control cables to equipment)				
NX		i) Exceeding 0.5m but not exceeding 1.0m	m	100.00		
		29) Cable trench, 0.25m wide (for control cables to lights)				
NY		i) Exceeding 0.5m but not exceeding 1.0m	m	230.00		
		30) 50mm Ø foulsewer vent pipe				
NZ		i) Exceeding 0.5m but not exceeding 1.0m	m	15.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		ii) By hand, for:				
		1) 160mm Ø single split sleeve				
OA		i) Exceeding 0.5m but not exceeding 1.0m	m	30.00		
OB		ii) Exceeding 1.0m but not exceeding 2.0m	m	10.00		
		2) Earthing mat installations				
OC		i) 500mm wide x 1,000mm deep trench	m	-		Rate only
		3) Cable trench, 0.6m wide (for control cables to equipment)				
OD		i) Exceeding 0.5m but not exceeding 1.0m	m	100.00		
		4) Cable trench, 0.25m wide (for control cables to lights)				
OE		i) Exceeding 0.5m but not exceeding 1.0m	m	32.00		
OF		5) 1,200mm wide x 100mm deep excavation for in-situ cast concrete lined V-drain	m	550.00		
OG		6) 4,000mm wide x 800mm deep excavation for precast concrete lined V-drain	m	45.00		
	8.3.2.b)	b) Extra-over item a) above for:				
OH		2) Hard rock excavation	m³	5.00		
OI	8.3.2.c)	c) Excavate and dispose of unsuitable material from trench bottom (provisional)	m³	8.00		
	PSDB 8.3.3	Excavation Ancillaries				
	8.3.3.1	Make up deficiency in backfill material (provisional):				
OJ	8.3.3.1.a)	a) from other necessary excavations on Site	m³	50.00		
OK	8.3.3.1.c)	c) by importation from commercial or off-site sources selected by the *Contractor*	m³	50.00		
	PSDB 8.3.5	Existing services that intersect or adjoin a trench:				
	PSDB 8.3.5.a)	a) Services that intersect a trench:				
OL		i) Electrical	No.	1.00		
OM		ii) Communication	No.	1.00		
ON		iii) Water	No.	1.00		
OO		iv) Sewer	No.	1.00		
OP		v) Conveyor	No.	1.00		
OQ		vi) HV Cable	No.	1.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
OR		vii) Fence	No.	1.00		
OS		viii) Stormwater	No.	1.00		
	PSDB 8.3.5.b)	b) Services that adjoin a trench:				
OT		i) Electrical	m	25.00		
OU		ii) Communication	m	25.00		
OV		iii) Water	m	25.00		
OW		iv) Sewer	m	25.00		
OX		v) Conveyor	m	25.00		
OY		vi) HV Cable	m	25.00		
OZ		vii) Fence	m	25.00		
PA		viii) Stormwater	m	25.00		
	SANS 1200 DM	**EARTHWORKS (ROADS, SUBGRADE)**				
	PSDM 8.3.3	Treatment of Road-bed				
	PSDM 8.3.3.c)	c) Surface preparation and compaction of in-situ materials to minimum of 93% of MOD AASHTO maximum density (100% for sand)				
PB		i) For building and walkway platforms	m³	18.00		
PC		ii) For general landscaping areas	m³	1 800.00		
PD		iii) For access roads and hardstand areas	m³	2 800.00		
PE		iv) For electrical yard areas	m³	170.00		
PF	PSDM 8.3.17	Imported 150mm gravel G7 selected layer compacted to 95% of MOD AASHTO maximum density (for road and hardstand layerworks)	m³	398.00		
PG	PSDM 8.3.20	Imported 150mm gravel G7 selected layer compacted to 93% of MOD AASHTO maximum density (for road shoulders)	m³	510.00		
	PSDM 8.3.18	G5 subbase engineered fill for:				
PH	PSDM 8.3.18.c)	c) Main Intake substation buildings and yard platform	m³	7 875.00		
	PSDM 8.3.19	400mm Ø augured holes for conductive concrete applications for:				
PI	PSDM 8.3.19.a)	a) 3.0m to 5.0m depth	No.	-		Rate only
PJ	PSDM 8.3.19.b)	b) 5.0m to 7.0m depth	No.	-		Rate only
PK	PSDM 8.3.19.c)	c) 7.0m to 10.0m depth	No.			Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	PSG 8.9	**CONCRETE SURFACE BED FOR ROADS/YARDS**				
PL	PSG 8.9.c)	c) As per drawing number 1924701-2-510-C-LA-0056-04	m²	1 500.00		
	SANS 1200 L	**MEDIUM-PRESSURE PIPELINES**				
	PSL 8.2.1	Supply, handle, lay, bed (for flexible pipes), joint, test and disinfect pipes complete with couplings (waste and cut lengths to be allowed for in these rates):				
PM	PSL 8.2.1.a)	a) 110mm Ø uPVC class 16 fire water pipe	m	110.00		
PN	PSL 8.2.1.b)	b) 35mm Ø polycop class 10 domestic water pipe	m	70.00		
	PSL 8.2.2	Extra-over PSL-8.2.1 for the supplying, laying, and bedding of fittings and specials complete with couplings, including cutting pipes to length where required, test and disinfect:				
PO	PSL 8.2.2.a)	a) 110mm Ø x 1¼" saddle with 32mm Ø male threaded 90° bend as per detail LA-0057-01.C of drawing number 1924701-2-510-C-LA-0057-01	No.	1.00		
PP	PSL 8.2.2.d)	d) 32mm Ø x 32mm Ø Philmac (or equivalent approved) PN16 elbow	No.	2.00		
	PSL 8.2.3	Extra-over PSL-8.2.1 for the supplying, handling, fixing, bedding and commissioning of valves and flow meters complete with couplings (including bolts, nuts, washers and packings)				
PQ	PSL 8.2.3.a)	a) New DN100 PN16 isolating valve	No.	2.00		
PR	PSL 8.2.3.b)	b) New DN100 PN16 flow meter	No.	2.00		
PS	PSL 8.2.11	Anchor/thrust blocks and pedestals (30 MPa concrete/19mm stone)	m³	4.00		
	PSL 8.2.13	Valve, hydrant and flow meter chambers, for:				
PT	PSL 8.2.13.a)	a) New DN100 PN16 isolating valve	No.	2.00		
PU	PSL 8.2.13.b)	b) New DN100 PN16 flow meter	No.	2.00		
	PSL 8.2.16	Install internal cold water copper pipes for chiller plant with the following nominal diameters				
PV	PSL 8.2.16.a)	a) 32mm	m	3.00		
	PSL 8.2.17	Connecting to existing water mains				
PW	PSL 8.2.17.d)	d) Connection of new 110mm Ø uPVC fire water pipe to existing 160mm Ø existing water main line by means of "hot-tap" connection	No.	2.00		
	PSL 8.2.18	Install a combination set of 1 x pressure reducing valve and 2 x isolating valves complete in accordance with:				
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
PX	PSL 8.2.18.c)	c) Section LA-0057-01.3 of drawing 1924701-2-510-C-LA-0057-01	Set	1.00		
	PSL 8.2.19	Install external standard pillar type fire hydrant in accordance with:				
PY	PSL 8.2.19.c)	c) Section LA-0057-01.2 of drawing 1924701-2-510-C-LA-0057-01	No.	2.00		
	PSL 8.2.20	Pipe Markers				
PZ	PSL 8.2.20.a)	a) Marker posts	No.	6.00		
QA	PSL 8.2.20.b)	b) Kerb/edging marks	No.	4.00		
	PSL 8.2.21	Install internal cold water copper pipes at Eskom Ystervark building at Main Intake Substation, with the following nominal diameters:				
QB	PSL 8.2.21.a)	a) 32mm	m	2.00		
QC	PSL 8.2.21.b)	b) 15mm	m	2.00		
	PSL 8.2.22	Install internal/building cold water brass shut-off gate valve at Eskom Ystervark building at Main Intake Substation, with the following nominal diameter:				
QD	PSL 8.2.22.a)	a) 32mm	No.	1.00		
	SANS 1200 LB	**BEDDING (PIPES)**				
	PSLB 8.2.2	Supply only of bedding by importation				
	PSLB 8.2.2.3	From commercial sources				
QE	8.2.2.3.a)	a) Selected granular material	m³	58.18		
QF	8.2.2.3.b)	b) Selected fill material	m³	10.00		
QG	PSLB 8.2.2.3.c)	c) 13mm stone bedding	m³	30.00		
	PSLB 8.2.6	Supply, handle and install nonwoven polyester geotextile				
QH	PSLB 8.2.6.a)	a) A5 bidim (2.65m wide)	m	196.96		
	PSLB 8.2.7	Bedding and padding for underground cables				
QI	PSLB 8.2.7.a)	a) For cable trench, 0.6m wide (for control cables to equipment)	m³	20.00		
QJ	PSLB 8.2.7.b)	b) For cable trench, 0.25m wide (for control cables to lights)	m³	20.00		
	SANS 1200 LC	**CABLE DUCTS**				
	PSLC 8.2.5	Supply, lay, bed and prove ducts/sleeves including draw wires. Ducts to be "Kableflex" or approved equivalent				
QK	PSLC 8.2.5.a)	a) 110mm Ø HDPE single ducts/sleeves (placed as single unit)	m	14.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
QL	PSLC 8.2.5.b)	b) 110mm Ø HDPE ducts/sleeves (part of bundle placed in accordance with drawing 19247001-2-300-E-DE-0018-01)	m	40.00		
QM	PSLC 8.2.5.c)	c) 110mm Ø HDPE ducts/sleeves (part of bundle placed in accordance with drawing 19247001-2-300-E-DE-0012-01)	m	60.00		
QN	PSLC 8.2.5.d)	d) 160mm Ø HDPE single ducts/sleeves (placed as single unit)	m	50.00		
QO	PSLC 8.2.5.e)	e) 160mm Ø HDPE sleeves (part of 8 sleeve bundles)	m	-		Rate only
QP	PSLC 8.2.5.f)	f) 160mm Ø HDPE sleeves (part of 4 sleeve bundles)	m	113.00		
QQ	PSLC 8.2.5.g)	g) 160mm Ø HDPE sleeves (part of 2 sleeve bundles)	m	55.00		
QR	PSLC 8.2.5.h)	h) 160mm Ø HDPE ducts/sleeves (part of bundle placed in accordance with drawing 19247001-2-300-E-DE-0018-01)	m	60.00		
QS	PSLC 8.2.5.i)	i) 160mm Ø HDPE ducts/sleeves (part of bundle placed in accordance with drawing 19247001-2-300-E-DE-0012-01)	m	25.00		
QT	PSLC 8.2.5.j)	j) 160mm Ø HDPE sleeves (part of 2 sleeve bundles from Transformer, as per section LA-0057-04-3))	m	380.00		
QU	PSLC 8.2.5.k)	k) 160mm Ø HDPE sleeves (part of 9 sleeve bundles)	m	-		Rate only
QV	PSLC 8.2.5.l)	l) 160mm Ø HDPE sleeves (part of 6 sleeve bundle)	m	6.44		
QW	PSLC 8.2.5.m)	m) 160mm Ø HDPE sleeves (part of 6 sleeve bundles) from the Main Intake substation towards the south	m	234.00		
QX	PSLC 8.2.5.n)	n) 160mm Ø HDPE sleeves (part of 20 sleeve bundles) from the Main Intake substation towards the east	m	18.00		
QY	PSLC 8.2.5.o)	o) 160mm Ø HDPE sleeves (part of 19 sleeve bundle) from the Main Intake substation towards the east	m	-		Rate only
QZ	PSLC 8.2.5.p)	p) 160mm Ø HDPE sleeves (part of 10 sleeve bundles) from the Main Intake substation towards the draw pits east of the building	m	24.00		
RA	PSLC 8.2.5.q)	q) 160mm Ø HDPE sleeves (part of 12 sleeve bundle) from the Main Intake substation towards the south	m	331.00		
RB	PSLC 8.2.5.r)	q) 160mm Ø HDPE sleeves (part of 10sleeve bundle) crossing the internal road to the north of the Main Intake substation	m	-		Rate only
	8.2.7	Draw pits/manholes				
RC	8.2.7.a)	a) 1,200mm x 1,050mm internal dimensions in accordance with section LA-0057-03.6 of drawing 1924701-2-510-C-LA-0057-03	No.	-		Rate only
	PSLC 8.2.8	Cable and cable duct markers				
RD	PSLC 8.2.8.a)	a) Route markers (marker posts)	No.	100.00		
RE	PSLC 8.2.8.b)	b) Kerb/edging marks	No.	30.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSLC 8.2.10	Closing and/or sealing of sleeve/duct ends				
RF	PSLC 8.2.10.a)	a) Sleeve/duct ends sealed with approved fire retardant material	No.	142.00		
RG	PSLC 8.2.10.b)	b) Sleeve/duct ends sealed with builders expander foam	No.	50.00		
RH	PSLC 8.2.10.c)	c) Sleeve/duct ends sealed with plastic end caps	No.	208.00		
	PSLC 8.2.11	Supply, lay, bed and prove split sleeve/duct				
RI	PSLC 8.2.11.a)	a) 160mm Ø HDPE Kableflex split ducts complete with draw wire	m	150.00		
	PSLC 8.2.12	Cable Trenches				
RJ	PSLC 8.2.12.a)	a) Install brick cable service trench complete with precast concrete cover slabs, and the like in accordance with section LA-0057-03.1 of drawing number 1924701-2-510-C-LA-0057-03	m	80.00		
RK	PSLC 8.2.12.b)	b) Install cable trench/sleeve transition units complete with precast concrete cover slabs, and the like in accordance with section LA-0057-03.2 and section LA-0057-03.3 of drawing number 1924701-2-510-C-LA-0057-03	No.	2.00		
RL	PSLC 8.2.12.c)	c) Install cable/sleeve road crossing Type 1 complete in accordance with section LA-0057-03.4 of drawing number 1924701-2-510-C-LA-0057-03	m	1.96		
RM	PSLC 8.2.12.d)	d) Install cable/sleeve road crossing Type 2 complete in accordance with section LA-0057-03.5 as well as details LA-0057-03.A and LA-0057-03.B of drawing number 1924701-2-510-C-LA-0057-03	No.	1.00		
RN	PSLC 8.2.13	Installation of danger tape	m	2 500.00		
	SANS 1200 LD	**SEWERS**				
	8.2	SCHEDULED ITEMS				
	PSLD 8.2.1	Supply, handle, lay, joint, bed and test pipelines				
RO	PSLD 8.2.1.b)	b) 110mm Ø uPVC class 34 heavy duty foulsewer gravity pipes	m	-		Rate only
	PSLD 8.2.3	Foulsewer Manholes				
RP	PSLD 8.2.3.b)	b) 450mm x 450mm brick manhole (internal size)	No.	-		Rate only
RQ	PSLD 8.2.13	Installation of 6,000ℓ conservancy tank system complete with all fittings, manholes, strapping, and the like in accordance with detail LA-0057-02.A of drawing number 1924701-2-510-C-LA-0057-02	Sum	1.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSLD 8.2.14	Install uPVC sewer vent pipes with the following nominal diameters:				
RR	PSLD 8.2.14.a)	a) 110mm Ø	m	2.00		
RS	PSLD 8.2.14.b)	b) 50mm Ø	m	20.00		
	PSLD 8.2.15	Install uPVC sewer waste water pipes with the following nominal diameters:				
RT	PSLD 8.2.15.a)	a) 50mm Ø	m	2.00		
	PSLD 8.2.16	Supply, handle, lay and bed spigot and socket wastewater pipes				
RU	PSLD 8.2.16.a)	a) 300mm Ø class 100D concrete wastewater pipes	m	159.00		
	PSLD 8.2.17	Wastewater manholes/structures				
RV	PSLD 8.2.17.a)	a) 600mm x 600mm (internal size) wastewater drainage sump	No.	18.00		
RW	PSLD 8.2.17.b)	b) 600mm x 600mm (internal size) wastewater drainage manhole	No.	3.00		
RX	PSLD 8.2.17.c)	c) 44,000ℓ oil dam	No.	1.00		
RY	PSLD 8.2.17.d)	d) Oil trap	No.	1.00		
	PSLD 8.2.18	Install one-way vent valves with the following nominal diameters:				
RZ	PSLD 8.2.18.a)	a) 110mm Ø	No.	1.00		
SA	PSLD 8.2.18.b)	b) 50mm Ø	No.	1.00		
	SANS 1200 LE	**STORMWATER DRAINAGE**				
	PSLE 8.2.1	Supply, handle, lay and bed spigot and socket stormwater pipes				
SB	PSLE 8.2.1.a)	a) 110mm Ø class 34 uPVC stormwater pipe	m	45.00		
SC	PSLE 8.2.1.b)	b) 200mm Ø class 34 uPVC stormwater pipe	m	5.00		
SD	PSLE 8.2.1.c)	c) 250mm Ø class 34 uPVC stormwater pipe	m	60.00		
SE	PSLE 8.2.1.d)	d) 300mm Ø class 100D concrete stormwater pipe	m	60.00		
SF	PSLE 8.2.1.e)	e) 450mm Ø class 100D concrete stormwater pipe	m	28.00		
SG	PSLE 8.2.1.f)	f) 600mm Ø class 100D concrete stormwater pipe	m	-		Rate only
	PSLE 8.2.8	Supply and install manholes, catch pits, and the like				
	PSLE 8.2.8.b)	b) 600mm x 600mm catch pit in accordance with detail LA-0057-01.B of drawing 1924701-2-510-C-LA-0057-01				
SH		i) Exceeding 0.5m but not exceeding 1.0m	No.	-		Rate only
SI		ii) Exceeding 1.0m but not exceeding 2.0m	No.	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSLE 8.2.8.c)	c) 900mm x 900mm catch pit in accordance with detail LA-0057-01.A of drawing 1924701-2-510-C-LA-0057-01				
SJ		i) Exceeding 0.5m but not exceeding 1.5m	No.	-		Rate only
SK		ii) Exceeding 1.5m but not exceeding 2.0m	No.	-		Rate only
	PSLE 8.2.17	Supply, handle, lay, joint and bed spigot and socket HDPE perforated subsoil pipes				
		a) 160mm Ø subsoil pipe in 500mm wide trench lined with A2 bidim and filled with 19mm clean, washed drainage stone, in accordance with section LA-0057-01.1 of drawing 1924701-2-510-C-LA-0057-01				
SL		i) Exceeding 0.5m but not exceeding 1.5m	m	80.00		
	PSLE 8.2.18	30MPa (19mm stone) concrete stormwater headwalls complete as per the following details:				
SM	PSLE 8.2.18.b)	b) LA-0055-03.A of drawing number 1924701-2-510-C-LA-0055-03	No.	1.00		
SN	PSLE 8.2.19	Lining of detention pond base, headwall outflow area and pond overflow area with Armorflex blocks (or equivalent approved)	m²	835.00		
	PSLE 8.2.20	Lining of open V-drain channels, with:				
SO	PSLE 8.2.20.a)	a) 1,200mm wide x 100mm thick 30MPa (19mm stone) in-situ cast concrete	m	550.00		
SP	PSLE 8.2.20.b)	b) 4,000mm wide x 800mm deep precast concrete Armorflex blocks (or equivalent approved) in accordance with section LA-0055-03.2 of drawing 1924701-2-510-C-LA-0055-03	m	45.00		
SQ	PSLE 8.2.21	Supply, handle, place on pedestal (measured elsewhere) an external 2,500ℓ horizontal stormwater harvesting tank (Jo-Jo tank or similar/equivalent approved) complete with fittings, lid and the like	No.	1.00		
SR	PSLE 8.2.22	Grouted stone pitching on a concrete bed	m²	20.00		
SS	PSLE 8.2.24	Connection of 110mm Ø Drainage Pipes to Sleeve Trenches	No.	10.00		
	SANS 1200 ME	**SUBBASE**				
	8.3.3	Construct the subbase gravel wearing course with material from commercial sources				
ST	8.3.3.a)	a) 200mm subbase gravel wearing course for access roads compacted to 98% of MOD AASHTO maximum density	m³	750.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
SU	8.3.3.b)	b) 150mm subbase gravel wearing course for access roads compacted to 98% of MOD AASHTO maximum density	m³	250.00		
	8.3.3	Construct the subbase course with material from commercial sources				
SV	8.3.3.a)	a) 150mm C3 gravel subbase layer (for concrete and block paved roads) compacted to 97% of MOD AASHTO maximum density	m³	575.00		
SW	8.3.3.b)	b) 150mm G5 gravel subbase layer (for gravel access roads) compacted to 95% of MOD AASHTO maximum density	m³	600.00		
	8.3.5	Process subbase material by the following process:				
	8.3.5.d)	d) Stabilization				
SX		i) 150mm C3 gravel subbase layer	m³	575.00		
	8.3.8	Stabilizing agent				
	8.3.8.b)	b) Portland cement				
SY		i) 150mm C3 gravel subbase layer	t	42.00		
SZ	PSME 8.3.12	Tie new G5 gravel subbase layer in with existing road layerworks by means of benching	m	30.00		
TA	PSME 8.3.13	Tie new G7 gravel selected layer in with existing road layerworks by means of benching	m	60.00		
TB	PSME 8.3.14	Construct 100mm thick drainage layer/wearing course from 37.5mm clean single-sized crushed concrete stone aggregate compacted until stone interlocking is achieved	m³	1 275.00		
	PSME 8.3.15	Supply, handle and install nonwoven polyester geotextile				
TC	PSME 8.3.15.a)	a) A4 bidim (or similar/equivalent approved)	m²	1 300.00		
	SANS 1200 MJ	**SEGMENTED PAVING**				
TD	8.2.2	Construction of paving complete	m²	2 200.00		
TE	8.2.3	Cutting units to fit edge restraints	m	850.00		
	SANS 1200 MK	**KERBING AND CHANNELLING**				
	PSMK 8.2.1	Concrete kerbing, edging and channelling				
TF	PSMK 8.2.1.a)	a) Type E3 precast edging on 30MPa bedding	m	500.00		
TG	PSMK 8.2.1.b)	b) Type W4 stormwater precast channel on 30MPa bedding	m	350.00		
TH	PSMK 8.2.1.e)	e) Type MK1 precast kerbing (mountable kerb) on 30MPa bedding	m	550.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSMK 8.2.7	Trimming of excavations for concrete-lined open drains in soft and intermediate material, for:				
TI	PSMK 8.2.7.a)	a) 1,200mm wide x 100mm thick 30MPa in-situ cast concrete open V-drain	m	550.00		
TJ	PSMK 8.2.7.b)	b) 4,000mm wide x 800mm deep precast concrete Armorflex blocks (or equivalent approved) in accordance with section LA-0055-03.2 of drawing 1924701-2-510-C-LA-0055-03	m	45.00		
	SANS 1200 MM	**ANCILLARY ROADWORKS**				
	PSMM 8.7	SIGNAGE				
	PSMM 8.7.1	Road signs with painted background and symbols and with signboard constructed from aluminium sheeting (2mm thick) complete and in accordance to class III of SANS 1519				
TK	PSMM 8.7.1.b)	b) Danger plate sign (Type W401) 150mm wide x 600mm high rectangular size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 1,500mm high	No.	12.00		
TL	PSMM 8.7.1.c)	c) Danger plate sign (Type W402) 150mm wide x 600mm high rectangular size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 1,500mm high	No.	12.00		
TM	PSMM 8.7.1.d)	d) Stop sign (Type R1) 900mm high octagon size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 2,500mm high	No.	2.00		
TN	PSMM 8.7.1.e)	e) Speed limit sign (Type R201) 900mm circular size including galvanized steel post 75mm diameter including concrete base with excavations and backfilling, 2,500mm high	No.	8.00		
	PSQ	**STEEL PALISADE FENCING AND GATES**				
TO	PSQ 3.1	Clearing the fence line, 2.0m wide strip	m	875.00		
TP	PSQ 3.2	Supply and erect new 2.4 m high steel palisade fencing in accordance with drawing numbers 1924701-2-510-C-LA-0056-03, 1924701-2-510-C-DE-0011-01 and 1924701-2-510-C-DE-0011-02	m	875.00		
TQ	PSQ 3.3	Extra over item PSQ 3.2 for supplying and erecting new fencing for corners	No.	20.00		
TR	PSQ 3.4	Extra over item PSQ 3.2 for supplying and erecting new 5.0m long removable palisade fence panels	No.	6.00		
	PSQ 3.5	Supply and erect new steel palisade gates in accordance with drawing numbers 1924701-2-510-C-LA-0056-03, 1924701-2-510-C-DE-0011-01 and 1924701-2-510-C-DE-0011-02, for:				
TS	PSQ 3.5.a)	a) 5.0m double leaf swing gate	No.	3.00		
TT	PSQ 3.5.b)	b) 5.5m sliding gate	No.	7.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
TU	PSQ 3.5.c)	c) 1.0m single leaf pedestrian swing gate	No.	2.00		
TV	PSQ 3.6	30MPa (19mm stone) Concrete gate ramp in accordance with section LA-0056-01.6 of drawing 1924701-2-510-C-LA-0056-01 to be constructed with the 5.5m sliding gate	No.	7.00		
	PSS	**SOIL AND VEGETATION REHABILITATION**				
TW	PSS 12.1	Nominated soil and vegetation conservation specialist	PS	1		TBA
TX	PSS 12.2	Topsoiling	m²	18 800.00		
	PSS 12.3	Mulching				
TY	PSS 12.3.a)	a) Application of mulch from stockpiles on Site	m²	5 000.00		
TZ	PSS 12.3.b)	b) Procurement and application of mulch from commercial sources	m²	13 800.00		
	PSS 12.4	Hydroseeding				
UA	PSS 12.4.a)	a) Procure hydroseed mix	PS	1		TBA
UB	PSS 12.4.b)	b) Application of hydroseeding	m²	18 800.00		
UC	PSS 12.5	Erosion matting	m²	7 500.00		
UD	PSS 12.6	Watering after hydroseeding	ℓ	200 000.00		
	PSS 12.7	Provisional sums				
UE	PSS 12.7.a)	a) Fertilizer	PS	1		TBA
UF	PSS 12.7.b)	b) Herbicide	PS	1		TBA
UG	PSS 12.7.c)	c) Other proprietary products	PS	1		TBA
		BULK POWER RETICULATION				
	SANS 1200 C	**SITE CLEARANCE**				
UH	8.2.1	Clear and grub	ha	-		Rate only
	PSC 8.2.2	Clearing of vegetated areas and treatment by grinding and mulching				
UI	PSC 8.2.2.a)	a) Clear trees and shrubs by hand	m²	11.00		
UJ	PSC 8.2.2.b)	b) Treatment by grinding and mulching	Sum	-		Rate only
UK	PSC 8.2.2.c)	c) Stockpiling and protection of recovered organic materials	Sum	-		Rate only
	PSC 8.2.4	Location of existing services				
UL	PSC 8.2.4.a)	a) Site survey by ground-penetrating radar and cable detector	Sum	-		Rate only
UM	PSC 8.2.4.b)	b) Excavation by hand in soft and intermediate materials to expose existing services	m³	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	PSC 8.2.6	**Temporary protection of known above-ground services:**				
UN	PSC 8.2.6.a)	a) 66kV Overhead electrical lines	Sum	-		Rate only
UO	PSC 8.2.7	Remove existing cable- and pipe markers for later re-use	No.	15.00		
	PSC 8.2.8	Remove all redundant underground services from site				
UP	PSC 8.2.8.e)	e) Electrical lighting cable	m	150.00		
UQ	PSC 8.2.9	Remove all redundant light poles from Site	No.	5.00		
UR	PSC 8.2.10	Temporary protection and relocation of unknown existing services	PS			TBA
US	PSC 8.2.11	Remove and dispose of asphalt surfacing	m³	-		Rate only
UT	PSC 8.2.12	Remove and dispose of concrete from existing pavements	m³	-		Rate only
UU	PSC 8.2.13	Remove and stockpile 80 mm thick segmental paving blocks for re-use	m²	-		Rate only
UV	PSC 8.2.14	Remove and stockpile gravel wearing course of existing gravel for re-use	m³	-		Rate only
UW	PSC 8.2.15	Remove existing precast concrete edgings	m	-		Rate only
	PSC 8.2.16	Demolish and remove from site redundant manhole chambers				
UX	PSC 8.2.16.c)	c) Existing communications cable manhole chamber	No.	-		Rate only
UY	PSC 8.2.17	Remove existing base material and stockpile for re-use	m³	-		Rate only
UZ	PSC 8.2.18	Remove and dispose of existing stabilized subbase	m³	-		Rate only
VA	PSC 8.2.20	Remove existing granular layers and stockpile for re-use	m³	-		Rate only
	SANS 1200 D	**EARTHWORKS**				
VB	PSD 8.3.1.2	Remove topsoil to a nominal depth of 200mm and stockpile on Site	m³	-		Rate only
	SANS 1200 DA	**EARTHWORKS (SMALL WORKS)**				
	PSDA 8.3.1	Excavation				
	PSDA 8.3.1.b)	b) Excavate in all soft and intermediate materials, use for backfill or dispose of excess material				
VC		i) For structural steel concrete foundations	m³	-		Rate only
	SANS 1200 DB	**EARTHWORKS (PIPE TRENCHES)**				
	PSDB 8.3.2	Excavation and backfilling of all trenches				
	PSDB 8.3.2.a)	a) Excavate in all soft and intermediate materials for all trenches, backfill, compact and dispose of surplus material				
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		i) By conventional methods (machine excavation), for:				
		1) Sleeve trench, 0.87m wide (for a set of 4 sleeves)				
VD		i) Exceeding 1.0m but not exceeding 1.5m	m	24.00		
VE		ii) Exceeding 1.5m but not exceeding 2.0m	m	6.00		
		2) Sleeve trench, 1.49m wide (for a set of 8 sleeves)				
VF		i) Exceeding 1.0m but not exceeding 1.5m	m	24.00		
VG		ii) Exceeding 1.5m but not exceeding 2.0m	m	6.00		
		3) Sleeve trench, 2.11m wide (for a set of 12 sleeves)				
VH		i) Exceeding 1.0m but not exceeding 1.5m	m	24.00		
VI		ii) Exceeding 1.5m but not exceeding 2.0m	m	6.00		
		4) Cable trench type 1, (4.1m wide trench for electrical and fibre optic cables)				
VJ		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
VK		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		5) Cable trench type 2 (2.8m wide trench for electrical and fibre optic cables)				
VL		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
VM		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		6) Cable trench type 3 (1.5m wide trench for electrical and fibre optic cables)				
VN		i) Exceeding 1.0m but not exceeding 1.5m	m	45.00		
VO		ii) Exceeding 1.5m but not exceeding 2.0m	m	5.00		
		7) Cable trench type 4 (1.5m wide trench for electrical and fibre optic cables)				
VP		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
VQ		ii) Exceeding 1.5m but not exceeding 2.0m	m	50.00		
		8) Cable trench type 5 (1.35m wide trench for electrical and fibre optic cables)				
VR		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
VS		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		9) Cable trench type 6 (2.7m wide trench for electrical and fibre optic cables)				
VT		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
VU		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		10) Cable trench type 7 (0.45m wide trench for fibre optic cables)				
VV		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
VW		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		11) Iscor substation cable trench, 0.6 m wide (for control cables)				
VX		i) Exceeding 0.5 m but not exceeding 1.0 m	m	-		Rate only
		ii) By hand, for:				
		1) Sleeve trench, 0.87m wide (for a set of 4 sleeves)				
VY		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
VZ		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		2) Sleeve trench, 1.49m wide (for a set of 8 sleeves)				
WA		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WB		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		3) Sleeve trench, 2.11m wide (for a set of 12 sleeves)				
WC		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WD		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		4) Cable trench type 2 (2.8m wide trench for electrical and fibre optic cables)				
WE		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WF		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		5) Cable trench type 3 (1.5m wide trench for electrical and fibre optic cables)				
WG		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WH		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		6) Cable trench type 4 (1.5m wide trench for electrical and fibre optic cables)				
WI		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WJ		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		7) Cable trench type 5 (1.35m wide trench for electrical and fibre optic cables)				
WK		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WL		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		8) Cable trench type 6 (2.7m wide trench for electrical and fibre optic cables)				
WM		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WN		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		9) Cable trench type 7 (0.45m wide trench for fibre optic cables)				
WO		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WP		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		10) Cable trench type 8 (0.45m wide trench for electrical cables)				
WQ		i) Exceeding 1.0m but not exceeding 1.5m	m	-		Rate only
WR		ii) Exceeding 1.5m but not exceeding 2.0m	m	-		Rate only
		11) Iscor substation cable trench, 0.6m wide (for control cables)				
WS		i) Exceeding 0.5 m but not exceeding 1.5 m	m	20.00		
	PSDB 8.3.2.b)	b) Extra-over item a) above for:				
WT		1) Hard rock excavation	m³	-		Rate only
WU	8.3.2.c)	c) Excavate and dispose of unsuitable material from trench bottom (provisional)	m³	-		Rate only
	PSDB 8.3.3	Excavation Ancillaries				
	8.3.3.1	Make up deficiency in backfill material (provisional):				
WV	8.3.3.1.a)	a) from other necessary excavations on site	m³	-		Rate only
WW	8.3.3.1.c)	c) by importation from commercial or off-site sources selected by the *Contractor*	m³	20.75		
	PSDB 8.3.5	Existing services that intersect or adjoin a trench:				
	PSDB 8.3.5.a)	a) Services that intersect a trench:				
WX		i) Electrical - lighting	No.	2.00		
WY		ii) Communication	No.	22.00		
WZ		iii) Water	No.	8.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
XA		iv) Sewer	No.	8.00		
XB		v) Conveyor	No.	8.00		
XC		vi) HV Cable	No.	40.00		
XD		vii) Fence	No.	3.00		
XE		viii) Stormwater	No.	3.00		
	PSDB 8.3.5.b)	b) Services that adjoin a trench:				
XF		i) Electrical - lighting	m	25.00		
XG		ii) Communication	m	306.00		
XH		iii) Water	m	692.00		
XI		iv) Sewer	m	107.00		
XJ		v) Conveyor	m	75.00		
XK		vi) HV Cable	m	306.00		
XL		vii) Fence	m	114.00		
XM		viii) Stormwater	m	100.00		
	SANS 1200 DM	**EARTHWORKS (ROADS, SUBGRADE)**				
XN	PSDM 8.3.17	Imported 150mm gravel G7 selected layer compacted to 95% of MOD AASHTO maximum density (for road and hardstand layerworks)	m³	50.00		
	SANS 1200 G	**CONCRETE (STRUCTURAL)**				
	PSG 8.9	**CONCRETE SURFACE BED FOR ROADS/YARDS**				
XO	PSG 8.9.d)	d) For reinstatement of road crossings	m²	5.00		
	SANS 1200 LB	**BEDDING (PIPES)**				
	PSLB 8.2.2	Supply only of bedding by importation				
	PSLB 8.2.2.3	From commercial sources				
XP	8.2.2.3.a)	a) Selected granular material	m³	182.00		
XQ	8.2.2.3.b)	b) Selected fill material	m³	607.00		
XR	PSLB 8.2.2.3.c)	c) 13 mm stone bedding	m³	10.00		
	PSLB 8.2.6	Supply, handle and install nonwoven polyester geotextile				
XS		a) A5 bidim (2.65 m wide)	m	100.00		
	PSLB 8.2.7	Bedding and padding for underground cables, for:				
XT	PSLB 8.2.7.a)	a) Cable trenches for electrical cables	m³	850.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
XU	PSLB 8.2.7.b)	b) Iscor substation cable trench, 0.6m wide (for control cables)	m³	6.00		
	SANS 1200 LC	**CABLE DUCTS**				
	PSLC 8.2.5	Supply, lay, bed and prove ducts/sleeves including draw wires. Ducts to be "Kabelflex" or approved equivalent				
XV	PSLC 8.2.5.a)	a) 160mm Ø HDPE sleeves (set of 4)	m	220.00		
XW	PSLC 8.2.5.b)	b) 160mm Ø HDPE sleeves (set of 8)	m	370.00		
XX	PSLC 8.2.5.c)	c) 160mm Ø HDPE sleeves (set of 12)	m	150.00		
XY	PSLC 8.2.5.d)	c) 32mm HDPE green sleeve/pipe (Eskom specification)	m	353.00		
	8.2.7	Draw pits/manholes				
XZ	8.2.7.a)	a) 1,500mm x 1,500mm internal dimensions in accordance with detail LA-0053-01.D of drawing 1924701-2-510-C-LA-0053-01	No.	-		Rate only
YA	8.2.7.b)	b) 600mm x 600mm internal dimensions	No.	2.00		
	PSLC 8.2.8	Cable and cable duct markers				
YB	PSLC 8.2.8.a)	a) Route markers (marker posts)	No.	10.00		
YC	PSLC 8.2.8.b)	b) Kerb/edging marks	No.	10.00		
	PSLC 8.2.10	Closing and/or sealing of sleeve/duct ends				
YD	PSLC 8.2.10.a)	a) Sleeve/duct ends sealed with approved fire retardant material	No.	62.00		
YE	PSLC 8.2.10.b)	b) Sleeve/duct ends sealed with builders expander foam	No.	96.00		
YF	PSLC 8.2.10.c)	c) Sleeve/duct ends sealed with plastic end caps	No.	10.00		
	SANS 1200 ME	**SUBBASE**				
	8.3.3	Construct the subbase course with material from commercial sources				
YG	8.3.3.a)	a) 150mm C3 gravel subbase layer compacted to 98% of MOD AASHTO maximum density	m³	10.00		
YH	8.3.3.b)	b) 150mm C4 gravel subbase layer compacted to 98% of MOD AASHTO maximum density	m³	11.00		
YI	8.3.3.c)	c) 150mm C2 gravel subbase layer compacted to 98% of MOD AASHTO maximum density	m³	35.00		
	8.3.3	Construct the subbase shoulders with material from commercial sources				
YJ	8.3.3.a)	a) 150mm gravel wearing course for road shoulders compacted to 97% of MOD AASHTO maximum density	m³	2.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	8.3.3	Construct the subbase gravel wearing course with material from commercial sources				
YK	8.3.3.a)	a) 150mm subbase gravel wearing course for roads compacted to 97% of MOD AASHTO maximum density	m³	25.00		
	8.3.5	Process subbase material by the following process:				
	8.3.5.d)	d) Stabilization				
YL		i) 150 mm C3 gravel subbase layer	m³	35.00		
YM		ii) 150 mm C4 gravel subbase layer	m³	30.00		
YN		iii) 150 mm C2 gravel subbase layer	m³	35.00		
	8.3.8	Stabilizing agent				
	8.3.8.b)	b) Portland cement				
YO		i) 150 mm C3 gravel subbase layer	t	8.00		
	SANS 1200 MF	**BASE**				
	8.3.3	Construct base with material from commercial sources				
YP	8.3.3.a)	a) 150mm G1 crushed stone base layer, compacted to 88% of apparent relative density.	m³	40.00		
	SANS 1200 MH	**ASPHALT BASE AND SURFACING**				
	8.5.1	Prime Coat				
YQ		a) Invert bitumen emulsion (MSP 1) with application rate of 0.8ℓ/m²	m²	280.00		
	8.5.3	Tack Coat				
YR		a) Tack coat of 30% stable grade emulsion with application rate of 0.2ℓ/m²	m²	280.00		
	8.5.4	Asphalt				
YS	8.5.4.a)	a) 30mm Continuously graded medium asphalt surfacing mix with modified binder (type A-E2) manufactured from 50/70 penetration grade bitumen	t	21.00		
YT	8.5.4.b)	b) 40mm Continuously graded medium asphalt surfacing mix with modified binder (type A-E2) manufactured from 50/70 penetration grade bitumen	t	28.00		
YU	PSMH-8.5.9	Extra over items 8.5.4 for the transportation cost of bitumen binder supplied by a refinery outside the Western Cape Province	t	3.00		
	SANS 1200 MJ	**SEGMENTED PAVING**				
YV	8.2.2	Construction of Paving Complete	m²	100.00		
YW	8.2.3	Cutting units to fit edge restraints	m	50.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
	SANS 1200 MK	**KERBING AND CHANNELLING**				
	PSMK 8.2.1	Concrete kerbing, edging and channelling				
YX	PSMK 8.2.1.a)	a) Type E3 precast edging on 30MPa bedding	m	50.00		
	PSR	**HORIZONTAL DIRECTIONAL DRILLING**				
YY	PSR 11.1	Site establishment	Sum	1.00		
	PSR 11.2	Accommodation of traffic for:				
YZ	PSR 11.2.a)	a) HDD entry pits	No.	5.00		
ZA	PSR 11.2.b)	b) HDD exit pits	No.	5.00		
	PSR 11.3	Excavation for entry and exit pits				
ZB	PSR 11.3.a)	a) Excavations in soft and intermediate material	m³	650.00		
ZC	PSR 11.3.b)	b) Extra-over item a) above for excavating in hard rock material	m³	225.00		
	PSR 11.4	Backfilling for entry and exit pits				
ZD	PSR 11.4.a)	a) Available from pit excavations	m³	425.00		
ZE	PSR 11.4.b)	b) G4 subbase material imported from commercial sources	m³	225.00		
	PSR 11.5	Supply, handle, join, insert and test pipe to be pulled back for horizontal directional drilling, for the following:				
ZF	PSR 11.5.a)	a) 160mm Ø HDPE pipe (set of 4)	m	200.00		
ZG	PSR 11.5.b)	b) 160mm Ø HDPE pipe (set of 8)	m	600.00		
	PSR 11.6	Horizontal drilling of ducts through:				
ZH	PSR 11.6.a)	a) Soft and intermediate material	m	640.00		
ZI	PSR 11.6.b)	b) Hard rock material	m	160.00		
	PSS	**SOIL AND VEGETATION REHABILITATION**				
ZJ	PSS 12.1	Nominated soil and vegetation conservation specialist	PS	1		TBA
ZK	PSS 12.2	Topsoiling	m²	17 000.00		
	PSS 12.3	Mulching				
ZL	PSS 12.3.a)	a) Application of mulch from stockpiles on site	m²	3 000.00		
ZM	PSS 12.3.b)	b) Procurement and application of mulch from commercial sources	m²	14 000.00		
	PSS 12.4	Hydroseeding				
ZN	PSS 12.4.a)	a) Procure hydroseed mix	PS	1		TBA
ZO	PSS 12.4.b)	b) Application of hydroseeding	m²	17 000.00		
TOTAL CARRIED FORWARD						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
ZP	PSS 12.5	Erosion matting	m²	500.00		
ZQ	PSS 12.6	Watering after hydroseeding	ℓ	170 000.00		
	PSS 12.7	Provisional sums				
ZR	PSS 12.7.a)	a) Fertilizer	PS	1		TBA
ZS	PSS 12.7.b)	b) Herbicide	PS	1		TBA
ZT	PSS 127.c)	c) Other proprietary products	PS	1		TBA
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
15		**SECTION 14 : ANCILLARY EQUIPMENT AND WORKS**				
		NOTE				
		This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc.				
		DISMANTLING/REMOVAL OF EXISTING FIBRE OPTIC LINE				
A		a) Complete dismantling and removal of existing fibre optic/ telecommunications combination overhead line, including poles, excavations, backfilling, compaction, disconnections, roll on to drum(s) the cable etc. **Note: All costs to be included**	m	100		
B		b) Complete loading, offloading, rigging, transport, labour etc. to *Employer's* storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		
		ANY OTHER ITEM(S) THE *CONTRACTOR* DEEMS NECESSARY TO COMPLETE THE INSTALLATION FULLY AND TO SPECIFICATIONS (SPECIFY DETAILS) NOTE: IF NOTHING SPECIFIED AND PRICED, PLACE AT EACH ITEM 'N/A' IN 'DESCRIPTION', 'UNIT', 'QTY' AND 'AMOUNT COLUMNS				
		a)				
		b)				
		c)				
TOTAL CARRIED TO SUMMARY						

TRANSNET GROUP CAPITAL
TENDER NO XXXXX E004

DESCRIPTION: Supply and Install Bulk Electrical Supply Including Transformers, Switchgear, MCC and Sub-Station Buildings

Section 16 : Fibre Optic Cables
BILL OF QUANTITIES
Date: January 2024

BOQ

SECTION : SUMMARY

SECTION	DESCRIPTION	AMOUNT (R)
1	FIBRE OPTIC CABLES	R 0.00
2	CIVIL WORKS	
	TOTAL CARRIED TO SUMMARY	R 0.00

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
16		**SECTION 15 : FIBRE OPTIC CABLES** **NOTE** This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc.				
		FIBRE OPTIC CABLES **Polyethylene sheathed, corrugated steel tape armouring, polyethylene bedded fibre optic cables. All cables to be of the UV stabilised, fire retardant, self-extinguishing, zero toxic emission type** **Single Mode Fibre Optic (SMFO) Armoured Cable** b) 48 core				
A		i) Supply	m	14 000		-
B		ii) Install	m	14 000		-
		FIBRE OPTIC CABLE TERMINATIONS Complete termination kits for fibre optic cable, including connectors, shrouds, fixing materials and all other accessories **Single Mode Fibre Optic Armoured Cable** b) 48 core LC type indoor termination for SMFO cable				
C		i) Supply	No.	4		-
D		ii) Install	No.	4		-
		FIBRE OPTIC CABLE JOINTS Complete outdoor heat shrink joint kit for SMFO armoured type cables, complete with all material and accessories as required, in accordance with the cable manufacturer's requirements etc. **Note: No joints allowed in cables unless approval has been obtained from the *Employer*** b) 48 core outdoor joint for SMFO cable				
E		i) Supply	No.	14		-
F		ii) Install	No.	14		-
		ELECTRICAL WARNING/DANGER TAPE a) Orange, 450mm wide, 150mm micron thick electrical warning/danger tape, with thunder flash triangle (or skull bone triangle) and wording “DANGER/INGOZI/GEVAAR”				
H		i) Supply	m	14 000		-
I		ii) Install	m	14 000		-
		b) Eskom specification yellow electrical warning/danger tape or other as per their requirements				
J		i) Supply	m	1 600		-
K		ii) Install	m	1 600		-

		CONCRETE COVER SLABS/TILES				
		a) 450mm x 230mm x 50mm Concrete cover slab/tiles. **Note: Eskom spec type (D-DT-5246 SH1A3)**				
L		i) Supply	No.	850		-
M		ii) Install	No.	850		-
		LABELLING				
N		a) Labelling of this section of the installation as specified and/or required by any applicable SANS standard(s), including all necessary and correct fixing materials etc. complete	Sum	1		-
		TESTING AND COMMISSIONING				
O		a) Complete testing and commissioning of this section of the installation as required. **Note: Suitably qualified and experienced personnel only to test and commission the relevant equipment / installations**	Sum	1		-
		SUNDRY ITEMS				
P		a) Provision of design **Type Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		-
Q		b) Inspection of all **Type Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer* . Note: All costs to be included.	Sum	1		-
R		c) Provision of any **Routine Test Certificates** of any of the equipment as may be required by the *Employer*	Sum	1		-
S		d) Inspection of all **Routine Tests** at the premises of the manufacturer, of any of the equipment as may be required by the *Employer* . Note: All costs to be included.	Sum	1		-
T		e) Factory acceptance tests and certificates. Note: All costs to be included	Sum	1		-
U		f) Site acceptance tests and certificates. Note: All costs to be included	Sum	1		-
V		g) Complete fire stopping materials supply and application e.g. fire stopping foam, covering paint etc. **Note: Samples to be provided to *Employer* for approval prior to the purchasing and application thereof**	Sum	1		-
W		h) Any paint, industrial silicon, cement, polyfilla, coprox etc. as required for the repair and/or sealing to any building or concrete surfaces etc.	Sum	0		-
X		i) Provision of all manufacturer(s) prescribed critical and recommended spares	Sum	1		-
Y		j) High melting point, non-oxidant electrical contact grease. **Note: Eskom requirements to be included**	Sum	0		-
Z		k) Complete loading, offloading, rigging, transport, labour etc. to *Employer* 's storage facility(ies) of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	1		-
AA		l) Complete loading, offloading, rigging, transport, labour etc. to Eskom Brackenfell depot of remaining and/or any removed equipment etc. **Note: All costs to be included**	Sum	0		-
AB		m) Compilation and provision to the *Employer* of all as-built documentation as stipulated in the technical specifications and any other associated contract documentation, including but not limited to hard and soft copy as-built drawings, operations and maintenance manuals where applicable, Certificate(s) of Compliance, any test certificates and the like	Sum	1		-
		TOTAL CARRIED TO SUMMARY				-

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
		NOTE Tenderers are to price this Schedule strictly in accordance with the Specifications and SANS 1200, where a conflict arises between these two documents the Specifications shall take precedence. Where a conflict arises between this Schedule and the Specifications, the Specifications shall take precedence. Tenderers shall study the Drawings before pricing this Schedule and the Schedule shall be priced to provide the complete Works				
	SANS 1200 C	**SITE CLEARANCE**				
A	8.2.1	Clear and grub	ha	2		-
	PSC 8.2.2	Clearing of vegetated areas and treatment by grinding and mulching				
B	PSC 8.2.2.a)	a) Clear trees and shrubs by hand	m²	500		-
C	PSC 8.2.2.b)	c) Stockpiling and protection of recovered organic materials	PS	1		TBA
	PSC 8.2.4	Location of existing services				
D	PSC 8.2.4.a)	a) Site survey by ground-penetrating radar and cable detector	Sum	1		-
E	PSC 8.2.4.b)	b) Excavation by hand in soft and intermediate materials to expose existing services	m³	150		-
F	PSC 8.2.10	Temporary protection and relocation of unknown existing services	PS	1		TBA
G	PSC 8.2.14	Remove and stockpile gravel wearing course of existing gravel for re-use	m³	50		-
H	PSC 8.2.17	Remove existing base material and stockpile for re-use	m³	50		-
I	PSC 8.2.18	Remove and dispose of existing stabilized subbase	m³	50		-
J	PSC 8.2.20	Remove existing granular layers and stockpile for re-use	m³	50		-
	SANS 1200 D	**EARTHWORKS**				
K	PSD 8.3.1.2	Remove topsoil to a nominal depth of 200mm and stockpile on Site (By Hand)	m³	50		-
L	PSD 8.3.1.2	Remove topsoil to a nominal depth of 200mm and stockpile on Site	m³	50		-
	SANS 1200 DA	**EARTHWORKS (SMALL WORKS)**				
	PSDA 8.3.1	Excavation				
	PSDA 8.3.1.b)	b) Excavate in all soft and intermediate materials, use for backfill or dispose of excess material				
M		i) Precast Manholes	m³	40		-

	SANS 1200 DB	**EARTHWORKS (PIPE TRENCHES)**					
	PSDB 8.3.2	Excavation and backfilling of all trenches					
N	PSDB 8.3.2.a)	a) Excavate in all soft and intermediate materials for all trenches, backfill, compact and dispose of surplus material					
		i) By conventional methods (machine excavation), for:					
		1) Sleeve trench, 0.75m wide (for a set of 4 sleeves)					
O		i) Exceeding 1.0m but not exceeding 1.5m	m	3 500			-
		ii) By hand, for:					
		1) Sleeve trench, 0.75m wide (for a set of 4 sleeves)					
		i) Exceeding 1.0m but not exceeding 1.5m	m	1 200			-
	PSDB 8.3.2.b)	b) Extra-over item a) above for:					
P		1) Hard rock excavation	m³	200			-
Q	8.3.2.c)	c) Excavate and dispose of unsuitable material from trench bottom (provisional)	m³	800			-
	PSDB 8.3.3	Excavation Ancillaries					
	8.3.3.1	Make up deficiency in backfill material (provisional):					
R	8.3.3.1.a)	a) from other necessary excavations on site	m³	300			-
R	8.3.3.1.c)	c) by importation from commercial or off-site sources selected by the *Contractor*	m³	300			-
T U V	PSDB 8.3.5	Existing services that intersect or adjoin a trench:					
	PSDB 8.3.5.a)	a) Services that intersect a trench:					
T		i) Electrical - lighting	No.	30			-
U		ii) Communication	No.	20			-
V		iii) Water	No.	15			-
W		iv) Sewer	No.	10			-
X		v) Conveyor	No.	10			-
Y		vi) HV Cable	No.	20			-
Z		vii) Fence	No.	10			-
AA		viii) Stormwater	No.	5			-

	PSDB 8.3.5.b)	b) Services that adjoin a trench:					
AB		i) Electrical - lighting	m	120			-
AC		ii) Communication	m	1 500			-
AD		iii) Water	m	1 100			-
AE		iv) Sewer	m	500			-
AF		v) Conveyor	m	500			-
AG		vi) HV Cable	m	1 500			-
AH		vii) Fence	m	800			-
AI		viii) Stormwater	m	100			-
	SANS 1200 LB	**BEDDING (PIPES)**					
	PSLB 8.2.2	Supply only of bedding by importation From commercial sources					
AJ	8.2.2.3.a)	a) Selected granular material	m³	1 100			-
AK	8.2.2.3.b)	b) Selected fill material	m³	1 100			-
AL	8.2.2.3.c	c) 13 mm stone bedding	m³	135			-
	PSLB 8.2.7	Bedding and padding for underground cables, for:					
AM	8.2.7.a)	a) Cable trenches for electrical cables	m	150			-
	SANS 1200 LC	**CABLE DUCTS**					
	PSLC 8.2.5	Supply, lay, bed and prove ducts/sleeves including draw wires. Ducts to be "Kabelflex" or approved equivalent					
AN	PSLC 8.2.5.a)	a) 160mm Ø HDPE sleeves (set of 4)	m	100			-
AO	PSLC 8.2.5.d)	c) 32mm HDPE green sleeve/pipe (Eskom specification)	m	14 000			-
	PSLC 8.2.9	Draw pits/manholes					
AP	8.2.7.a)	a) Manholes Constructed Complete as per Drawing - 19247-2-330-C-L-A-0001-02-05 AE - " Manhole Detail "	No.	30			-
	PSLC 8.2.8	Cable and cable duct markers					
AQ	PSLC 8.2.8.a)	a) Route markers (marker posts)	No.	140			-
AR	PSLC 8.2.8.b)	b) Kerb/edging marks	No.	28			-
	PSLC 8.2.10	Closing and/or sealing of sleeve/duct ends					
AS	PSLC 8.2.10.a)	a) Sleeve/duct ends sealed with approved fire retardant material	No.	240			-
AT	PSLC 8.2.10.c)	b) Sleeve/duct ends sealed with plastic end caps	No.	60			-

	PSR	**HORIZONTAL DIRECTIONAL DRILLING**				
	PSR 11.1	Site establishment and De-establishment	Sum	1		-
	PSR 11.2	Accommodation of traffic for:				
AU	PSR 11.2.a)	a) HDD entry pits	No.	12		-
AV	PSR 11.2.b)	b) HDD exit pits	No.	12		-
	PSR 11.3	Excavation for entry and exit pits				
AX	PSR 11.3.a)	a) Excavations in soft and intermediate material	m³	200		-
AY	PSR 11.3.b)	b) Extra-over item a) above for excavating in hard rock material	m³	100		-
	PSR 11.4	Backfilling for entry and exit pits				
AZ	PSR 11.4.a)	a) Available from pit excavations	m³	200		-
AB	PSR 11.4.b)	b) G4 subbase material imported from commercial sources	m³	50		-
	PSR 11.5	Supply, handle, join, insert and test pipe to be pulled back for horizontal directional drilling, for the following:				
BB	PSR 11.5.a)	a) 160mm Ø HDPE pipe (set of 4)	m	900		-
	PSR 11.6	Horizontal drilling of ducts through:				
BC	PSR 11.6.a)	a) Soft and intermediate material	m	900		-
BD	PSR 11.6.b)	b) Hard rock material	m	200		-
	PSS	**SOIL AND VEGETATION REHABILITATION**				
BE	PSS 12.1	Nominated soil and vegetation conservation specialist	PS	1		TBA
BF	PSS 12.2	Topsoiling	m²	16 700		-
	PSS 12.3	Mulching				
BG	PSS 11.3.a)	a) Application of mulch from stockpiles on site	m²	3 000		-
BH	PSS 11.3.B)	b) Procurement and application of mulch from commercial sources	m²	16 700		-
	PSS 12.4	Hydroseeding				
BI	PSS 11.4.a)	a) Procure hydroseed mix	PS	1		TBA
BJ	PSS 11.4.B)	b) Application of hydroseeding	m²	16 700		-
BK		Erosion matting	m²	0		-
BL		Watering after hydroseeding Provisional sums	ℓ	150 000		-
BM		a) Fertilizer	PS	1		TBA
BN		b) Herbicide	PS	1		TBA
BO		c) Other proprietary products	PS	1		TBA
		TOTAL CARRIED TO SUMMARY				**-**

Section 16 : Provisional Sums
Date: January 2024

BOQ

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
17		**SECTION 16 : PROVISIONAL SUMS**				
		NOTE				
		This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc.				
		The following PC Sums shall be allowed or deducted in whole or in part if not required. The PC Sums where applicable will be based on proven costs issued , plus the Contractors Profit %, and progress accessed and certified as per contractural procedures				
	PSA 8.5	**SUMS STATED PROVISIONALLY BY *EMPLOYER***				
		i) Checking of As-Built information	PS	1		TBA
		ii) Checking by independent surveyor	PS	1		TBA
		a) Additional Civilwork and Structural Works				
		i) Allow a Provisional Amount for modifications and alterations to Civil and Structural works previsouly not completed as instructed by the *Employer*	PS	1		TBA
		b) Additional Electrical Works				
		i) Provision, installation, commissioning, testing etc. of any *Employer* specified New equipment or Existing Equipment changes, modifications , including installations or any other requirements, over and above the Contract requirements as instructed by the *Employer* - all costs included	PS	1		TBA
		ii) Allow a Provisional Amount for Temporary Power installation as instructed by the *Employer*	PS	1		TBA
		c) Additional ESKOM works				
		i) Allow a Provisional Amount for ESKOM related works, supply and installation of VT's,Stuctures, etc as well as modifications and alterations to the ISCOR Substation previsouly not completed as instructed by the Employer	PS	1		TBA
		ii) Complete the Supply and installation of the new 66kV T-off branch line, incl the Shutdown works previsouly not completed as instructed by the Employer	PS	1		TBA
		d) Additional Information, Tests and Certificates				
		i) Additional test certificates, etc. and information and/or tests ordered by the *Employer*, over and above the Contract requirements	PS	1		TBA
TOTAL CARRIED FORWARD						-

TOTAL BROUGHT FORWARD						-
		e) Fire Detection and Suppression				
		i) Allow a Provisional Amount for Fire Detection and Protection works, inlcuding any Testing, Commissioing for All Substation etc required by the Employer, as per Contract requirements	PS	1		TBA
		f) Possible Rectification, Testing and Commissioing of High Mast lights				
		i) Possible Rectification, Testing and Commissioing of the High Mast Lights, etc required by the *Employer* , over and above the Contract requirements	PS	1		TBA
TOTAL CARRIED TO SUMMARY						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
18		**SECTION 17 : DAYWORKS AND MODIFICATIONS**				
		NOTE This bill shall be read in conjunction with the technical specifications, drawings, works information and any other associated contract documentation to price for the provision of a complete installation, i.e. the design (where applicable), supply, installation, testing and commissioning, handing over of the fully functional equipment / installation, provision of all as-built documentation and the like, associated operational and maintenance training for *Employer* staff where specified etc. The following hours shall be allowed or deducted in whole or in part if not required. **SCHEDULE OF CONTRACTOR'S LABOUR** The Tenderer shall price all categories of labour indicated herein. The rates shall be the total cost to the Company in respect of daywork carried out by the Contractor and shall include for all the Contractor's profits, overheads, timekeeping, clerical work, insurance, establishment, supervision, foremans time (working and non-working), wages, accommodation, travelling, subsistence and other costs relative to the employment by the Contractor of the personnel detailed and for hand and portable electric or pneumatic tools and consumables normal to the trade of the respective personnel . The application and use of these rates shall be at the sole discretion and subject to the prior approval of the Engineer. **LABOUR**				
A		a) Construction Manager	hr	50		
B		b) Site Supervisor	hr	50		
C		c) Assistant Site Supervisor	hr	50		
D		d) SHEQ Officer	hr	50		
E		e) Environmental Control Officer	hr	50		
F		f) Document Controller	hr	50		
G		g) Operator	hr	250		
H		h) Gang Boss	hr	250		
I		i) Skilled labourer	hr	250		
J		j) Semi-Skilled labourer	hr	250		
K		k) Unskilled labourer	hr	250		
TOTAL CARRIED FORWARD						

ITEM	PAY REF	DESCRIPTION	UNIT	QTY	RATE (R)	AMOUNT (R)
TOTAL BROUGHT FORWARD						
		PLANT AND EQUIPMENT The Tenderer shall price below the Equipment indicated in this Provisional Schedule for Equipment hours to be used in whole or in part and deducted if not required. The rates detailed shall include all supervision, overheads, profit, maintenance, fuel and running costs including the provision of drivers/operators where necessary. The application and use of these rates shall be at the sole discretion and subject to the prior approval of the Engineer. (Tenderer to fill in Model particulars, type, size etc.)				
L		a) Bakkie Model:	hr	50		
M		b) MPV/Bus Model:	hr	50		
N		c) Crane truck Model:	hr	100		
O		d) Excavator (20 ton) Model:	hr	100		
P		e) Digger/Loader Model:	hr	100		
Q		f) Roller (vib - self propelled) Model:	hr	100		
R		g) Wacker (machine driven) Model:	hr	100		
S		h) Plate Compactor (machine driven) Model:	hr	100		
T		i) Tip truck (10 m³) Model:	hr	100		
U		j) Water cart Model:	hr	100		
		k) Concrete mixer Model:	hr	100		
		MATERIALS				
V		Net cost of Additional materials purchased by the Contractor for inclusion in the Works	PS	1		TBA
TOTAL CARRIED TO SUMMARY						

TRANSNET GROUP CAPITAL

TENDER NO XXXXX E004

DESCRIPTION: Supply and Install Bulk Electrical Supply Including Transformers, Switchgear, MCC and Sub-Station Buildings

FINAL SUMMARY

Date: January 2024

SECTION		BOQ AMOUNT (R)
1	PRELIMINARY & GENERAL	
2	CABLES AND CONDUCTORS	
3	EARTHING AND LIGHTNING PROTECTION SYSTEMS	
4	SMALL POWER AND LIGHTING	
5	CABLE MANAGEMENT SYSTEMS	
6	FIRE DETECTION AND ACCESS CONTROL	
7	HVAC	
8	FIRE SUPPRESSION	
9	PROTECTION AND METERING	
10	MONITORING AND CONTROL	
11	MEDIUM VOLTAGE EQUIPMENT	
12	ARCHITECTURE	
13	STRUCTURES AND FOUNDATIONS	
14	CIVIL	
15	ANCILLARY EQUIPMENT AND WORKS	
16	FIBREOPTIC LINE BLOUWATER TO ISCOR SUB STATION	
17	PROVISIONAL SUMS	
18	DAYWORKS AND MODIFICATIONS	
A	**TOTAL (EXCL. VAT)**	0.00
B	**VAT**	0.00
C	**TOTAL (INCL. VAT)**	0.00

JAN G FOURIE – QUANTITY SURVEYOR

13 December 2023

DATE :

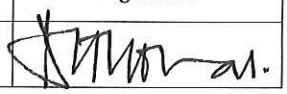
Technical Specification Tippler 3 Bulk Power Supply - Architectural

Document Number 1924701-2-300-A-SP-0001 Rev 00

Document Details

Ref (SA)	1924701-2-300-A-SP-0001
Date	27 May 2016
Prepared by	Ruche Uys
Reviewed by	Derek Thomas, Brett Sansom
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	20 April 2018	Issued for Construction	Derek Thomas	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

These specifications include the architectural requirements for the following new buildings that are to be constructed to accommodate the electrical equipment forming part of the new bulk electrical power supply installations:

- Main Intake Substation : Eskom Control Building.
- Main Intake Substation : 11 kV Switch House.
- Substation M Building.
- Substation N Building.

The 11 kV Switch House and Substation M and N buildings will consist of a concrete framed structure with brick intermediate walls and an external facebrick cavity wall. The roof will consist of a colour coated aluminium sheet with an integral insulation sandwich panel, supported by a steel portal frame system.

Internal wall finishes are generally of plaster and paint, and floors are finished in an epoxy. Certain areas, such as the transformer rooms and the switchgear rooms, will have blast protection facilities in the form of either ducts or individual blast curtains or louvres.

1.2 Purpose

The purpose of this specification is to set out the minimum technical requirements for quality and workmanship for the design (where required), fabrication, supply, installation and construction of the following architectural elements:

- Masonry.
- Waterproofing.
- Roof coverings.
- Carpentry and joinery.
- Ceilings and access flooring
- Floor coverings.
- Ironmongery.
- Metalworks.
- Glazing.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site Information.
- Drawings.
- Model Preambles for Trades.
- Further applicable requirements included in other parts of the contract documentation.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
AAAMSA	Association of Architectural Aluminium Manufacturers of South Africa
SWADA	Steel Window and Door Association

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 South African and International Standards

The *Contractor* shall also ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

The Model Preambles for Trades 2008 : Standard Specifications, published by the Association of South African Quantity Surveyors, and the South African National Building Regulations (SANS 10400) shall apply as the governing, standardized specification for workmanship and materials for all architectural *works*, with changes and amendments as detailed in these specifications.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include, but are not necessarily limited to, the following.

Table 4 : South African Standards

Code	Standard Title
SANS 4	Plumbing
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods
SANS 144	Metallic and oxide coatings - Measurement of coating thickness - Microscopical method
SANS 204	Energy Efficiency in Buildings
SANS 227	Burnt Clay Masonry Units
SANS 635	Elastomeric Structural Glazing And Panel Gaskets
SANS 999	Anodised coatings on aluminium (for architectural application)
SANS 1071	Welding Consumables
SABS 1165	Chlordane emulsifiable concentrates (soil insecticides)
SANS 1200H	Structural Steelwork
SANS 1263	Safety performance of glazing materials under human impact
SANS 1274	Coatings Applied By The Powder-coating Process
SANS 1391	Thermally sprayed metal coatings
SANS 1549	Raised Access Flooring
SANS 1578	Durable Organic Powders For Coating Of External Architectural Aluminium
SANS 1700	Fasteners
SANS 1796	Application of durable organic powder coating for architectural aluminium
SANS 2001 CM1	Masonry Walling
SANS 2931	Anodizing of aluminium and its alloys - Assessment of quality of sealed anodic oxide coatings by measurement of admittance or impedance
SANS 3210	Anodizing of aluminium and its alloys - Assessment of quality of sealed anodic oxide coatings by measurement of the loss of mass after immersion in phosphoric-chromic acid solution
SANS 6581	Anodizing of aluminium and its alloys - Determination of the comparative fastness to ultraviolet light and heat of coloured anodic oxidation coatings
SANS 10120	Code of practice for use with standardized specifications for civil engineering
SANS 10124	Application of Soil insecticides for the protection of buildings
SANS 10137	The Installation of Glazing in Buildings
SANS 10137	The installation of glazing in buildings
SANS 10164	Structural use of masonry
SANS 10177	Fire testing of materials and components used in buildings
SANS 10400	National Building Regulations
SANS 50572	Glass in building – Basic soda lime silicate glass products

International standards shall include, but are not necessarily limited to, the following.

Table 5 : International Standards

Code	Standard Title
BS EN 179	Building hardware - emergency exit devices operated by a lever handle or push pad
BS 476	Fire tests on building materials and structures. Guide to the principles, selection, role and application of fire testing and their outputs
BS EN 1125	Building hardware - panic exit devices operated by a horizontal bar
EN 485	Aluminium Alloy EN Standards for Rolled Aluminium
EN 515	Aluminium and aluminium alloys. Wrought products. Temper designations
EN 572	Glass in building. Basic soda lime silicate glass products. Float glass
ISO 1461:2009	Hot dip galvanized coatings on fabricated iron and steel articles -- Specifications and test methods
PrEN 179	Building hardware - emergency exit devices operated by a lever handle or push pad
PrEN 13633	Electrically controlled panic exit systems
PrEN 13637	Electrically controlled exit systems

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 6 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 PROJECT SPECIFICATIONS

5.1 Preamble

These specifications shall be read in conjunction with the project drawings issued for the various disciplines (i.e. structural, architectural, mechanical and electrical), the bill of quantities and any further, applicable requirements included in other parts of the contract documentation. Any errors, omissions and discrepancies between the drawings and documents shall be brought to the immediate attention of the *Employer* by the *Contractor*.

It remains the responsibility of the *Contractor* to compare all applicable documentation for the architectural *works* with the drawings and further documentation for the various other engineering disciplines and notify the relevant parties/disciplines and the *Employer* of any discrepancies within a reasonable time frame and in writing.

Where conflicting requirements between the drawings, specifications and the bill of quantities occur, the *Contractor* shall inform the *Employer* in writing of any such occurrence. The *Employer* will make a final determination.

Where conflicting specifications occur between these specifications and more recent detailed drawings, the *Contractor* shall inform the *Employer* in writing of any such occurrence.

The *Contractor* shall check all project dimensions, levels and setting out data on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*. No scaling off of drawings is allowed.

The *Contractor* shall confirm all invert levels of connection points to existing services on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*.

Where new construction ties into existing structures, the *Contractor* shall cross check and confirm all critical dimensions and levels related to the existing structures, before any construction or manufacturing commences.

5.2 Scope

In certain clauses the standard, standardised and particular specifications allow a choice to be specified in the project specifications between alternative materials or methods of construction and for additional requirements to be specified to suit a particular project. Details of such alternatives and additional requirements and specifications applicable to the *works* are contained in this part of the project specifications.

The number of each clause of the project specifications consists of the prefix PS, followed by a number corresponding to the number of the relevant clause in the standard Model Preambles. The number of a new clause or payment item, which does not form part of a clause or a payment item in the standard specifications and is included here, is also prefixed by PS followed by a new number. The new numbers follow on the last clause or item number used in the relevant section of the standard specifications.

5.3 PSC : General

Add the following new sub-clause:

5.3.1 "PSA-11 : Vermin, Rodent and Bird Protection

The building has been designed to prevent the entry of vermin, rodents and birds. The *Contractor* shall ensure that all openings into the building are sealed as far as this is possible. Should any special measures be required in this regard, the *Contractor* shall bring these to the attention of the *Employer*."

5.4 PSC : Earthworks

5.4.1 PSC-2 : Soil Insecticides

Add the following:

"Insecticides shall comply with SABS 1165. Soil poisoning shall carry a written ten year guarantee."

5.5 PSF : Masonry

5.5.1 PSF-7 : Brickwork Reinforcement

Add the following:

"Continuous brickforce shall be placed at every layer for the first four layers above and below the top of foundations and slabs, as well as at windows and over door openings. Minimum laps to be 300 mm.

Brickforce shall be placed at every fourth layer for any one or half brick wall."

All brickwork shall be fixed to concrete and steel columns by means of hoop irons, installed at every fourth course. For blockwork hoop irons shall be installed at every second course.

In cavity walls, wall ties shall join the leaves and shall be embedded in masonry joints at right angles to the leaves.

Additional ties shall be provided at openings, discontinuities (eg. control joints, external angles), at vertical intervals not exceeding 300 mm.

Lightly galvanized ties of 3.15 mm diameter shall be used.

For high-lift grouted walls, ties complying with the requirements of SANS 10164 Part 2 Annex A (14) shall be spaced at intervals not exceeding 900 mm horizontally and not exceeding 300 mm vertically, with each layer staggered by 450 mm.

Each tie shall be embedded to a depth of at least 50 mm in the mortar joint of each leaf."

5.5.2 PSF-10 : Brickwork

Add the following:

"Brickwork shall be built according to SANS 10400 Part K:Walls.

Tops of cavity walls shall be ventilated for as long as possible.

The minimum crushing strength of all load-bearing brickwork shall be 14 MPa.

All brickwork shown on the drawings are load bearing, unless indicated otherwise.

Clay bricks shall be wetted before being used.

Brick walls on unpiled foundations shall be separated from walls on piled foundations. Stability requirements of elements over joints must be met

Where ducts, sleeves or pipes are laid across a cavity, the construction shall prevent the transmission of moisture. The cavity in cavity wall construction shall be kept free of mortar and debris as the *works* proceed. Ties shall be cleaned of mortar droppings. Mortar droppings reaching the base of the cavity shall be removed daily through temporary openings. Care shall be taken not to damage the damp-proof course membrane while cleaning the cavity.

Two coats of "ABE Brixeal" waterproofing, or approved equivalent, shall be applied to cement bagged surfaces on inner cavity walls, in accordance with the supplier's recommendations. All surfaces shall be clean, dry, sound and free of oils and laitance. A special primer will not be required. The following application instructions shall apply:

- The waterproofing liquid shall be stirred well before use.
- Two coats shall be applied. The first coat shall be applied at a rate of 2 m^2/litre and left to dry before application of the second coat.
- The second coat shall be applied at a rate of 4 m^2/litre.

Add the following new sub-clauses:

5.5.3 "PSF-16 : Joints

Control joints between concrete and brickwork shall be formed with 12 mm bituminous impregnated softboard. Control joints shall be sealed with Polysulphide sealant (Sikaflex 11FC – i-cure or approved equivalent).

In framed structures, brick walls shall be built between concrete columns and up to within approximately 25 mm of the underside of concrete beams, slabs and the like. The gap shall be filled with joint filler (Sikaflex 11FC – i-cure or approved equivalent).

Brickwork shall be laid in half lap stretcher bond format with weather-struck joints.

The position of expansion joints in brickwork/blockwork shall be as shown on the drawings or as instructed by the *Employer*."

5.6 PSG : Waterproofing

5.6.1 PSG-2 : Waterproofing to Roofs, Basements, etc.

Add the following:

"The substrate/screed shall be to falls and cross falls as shown on the drawing. The substrate/screed shall be surface dry, clean and smooth, free of voids, protrusions and contaminants.

Sikalastic 841ST pure polyurea waterproof membrane, or approved equivalent, shall be spray applied to flat roof areas where indicated on the drawings. The colour of the membrane shall be grey (RAL 7005). The membrane shall be installed strictly according to manufacturer's installation guidelines."

5.7 PSH : Roof Coverings

5.7.1 PSH-6 : General

Change the clause to read as follows:

"Rates for profiled sheet roofing and rolled edges, ridge and hip coverings, flashing pieces and the like, comprising of metal, fibre-cement, plastic and the like, shall include fixing accessories, including poly-closures/buttons, rivets and cups as recommended by manufacturer/supplier."

Add the following new sub-clauses:

5.7.2 PSH-7 : Metal Roof Sheeting

Aluminium roof sheeting shall be IBR 686 profile (Global Roofing Solution or approved equivalent), 0.9mm with a mill finish and PVDF coating. The roof sheeting profile shall have trapezoidal ribs at 171.5mm centres with a nett cover of 686mm, with one stiffener rib in each pan and 37mm rib height.

Fixing shall comprise of Grade 316L stainless steel (Class 5) 65mm screws on every alternate flute, on each purlin and at every flute at the ridge and eaves. Sheeting shall be installed in strictly accordance with the manufacturer's installation guidelines.

5.7.3 PSH-8 : Fasteners

All fastening arrangements shall be suitable for the purlin/sheeting rail spacing indicated on the drawings and for wind uplift forces for the Saldanha Port area. Tests indicating sufficient strength may be required. The *Employer* may waive the test if the system is deemed sufficient and comprehensive.

Prior to construction the *Contractor* shall submit a detailed drawing to the *Employer*, for review and approval, showing the intended fixing arrangement and material specification of all fixing components The *Contractor* shall state the type of fastener, spacing of fasteners, envisaged lap length, sealing and other applicable items.

All sheeting fasteners shall be 316L stainless steel top speed screws with hexagonal heads or other suitable fasteners, as deemed acceptable by the sheeting supplier and approved by the *Employer*.

Saddle washers with sealer shall be used at all roof sheeting fixings. Saddle washers need not be used under stitching bolts as flat bonded washers only will suffice.

Aluminium sheet at fixings shall be isolated from any contact with the purlins using an approved, suitable isolation tape.

5.7.4 PSH-9 : Flashings, Trims and Laps

Aluminium flashings shall be formed from aluminium alloy sheets, fabricated from the most appropriate grade of material complying with EN 485, EN 515 and EN 572, in a temper suitable for the particular type of application and degree of forming to be used. In addition, the alloy shall be selected to satisfy the requirements of the chosen finishing process.

Aluminium flashing thickness shall be at least 1.6mm thick. A higher thickness may be required to provide a visually flat surface and to eliminate distortion and permanent deformation caused by solar radiation. Nominal 2450mm lengths shall be provided between joints to achieve the straightest runs possible.

Flashings shall be natural anodised, unless otherwise specified.

Longitudinal joints shall have lapped or interconnecting joints, which shall be fully weather- sealed. Simple butt joints and butt straps will not be acceptable. Joints, sealants and the like shall be designed to be capable of accommodating thermal movements of all flashings.

Electrical continuity shall be achieved between conductive parts. Provision shall be made for lightning protection integration requirements.

Sheet metal flashings shall have minimum 100mm laps and linings to valleys, secret gutters and the like with minimum 225mm laps.

5.7.5 PSH-10 : Accessories

Cappings, closure pieces, flashings, trims, sills, gutters, fillers, spacers, tapes, sealants, fixings and the like, which are not explicitly specified, shall be of types as recommended by the sheeting manufacturer.

5.7.6 PSH-11 : Storage

No moisture or pools of water may collect on the roof sheets during storage. Any sheets that are stained as a result of inadequate precautionary measures shall be removed and replaced in their entirety, at the *Contractor*'s cost.

5.7.7 PSH-12 : Installation

The *Contractor* shall provide the *Employer* with a schedule, detailing the erection sequence of sheeting to ensure that steelwork acceptance tolerances are achieved before sheeting commences.

Sheeting shall only commence once the *Employer* has approved the steelwork and certified that it is ready for cladding.

5.7.8 PSH-13 : Drilling & Cutting

Sheeting and cladding may only be cut with a nibbler or cold saw. Disc grinders may not be used

5.7.9 PSH-14 : Tolerances

The limit of sagging for sheeting rails and purlins is span/300 in the plane of the sheeting. Fixing of sheeting shall not commence before this tolerance has been achieved, by adjustment of anti-sag rods and angles.

Fixing of sheeting shall not commence before all columns have been permanently grouted and bolted down.

5.7.10 PSH-15 : Thermal Insulation

50mm thick, non-combustible, lightweight 'Factorylite', or approved equivalent, building insulation shall be installed, with reinforced aluminium foil facing on one side (facing down). Thermal insulation shall have a thermal resistance of 1.28m^2K/W, in accordance with SANS 204.

Thermal insulation shall be installed over purlins, using 2.5mm thick galvanised straining wires spaced at 300mm centres, as well as hoop irons and clamps. Thermal insulation shall be installed in strict accordance with the manufacturer's installation guidelines.

5.8 PSI : Carpentry and Joinery

5.8.1 PSH-1 : Materials and Workmanship

Add the following:

"All timber shall be free from decay or active insect attack, with no knots wider than half the section width. No knots, pitch pockets, splits and shakes will be allowed on faces to be exposed in finished work."

5.8.2 PSH-10 : Doors

Add the following:

"Doors shall be 'Bitcon Industries' SABS Class B & C fire doors, or approved equivalent, with 1.2mm stainless steel cladding on both side.

Heavy duty 100mm/4.2mm thick flanged 316L stainless steel hinges shall be installed, with nylon washers. Standard door leaves shall be fitted with 1.5 pairs of hinges and 2 pairs on non-standard door leaves. Door frames shall be double rebated 1.6mm 316L stainless steel, 52mm x 25mm."

5.9 PSJ : Ceilings, Partitions and Access Flooring

5.9.1 PSJ-5 : Exposed Tee-System Suspended Ceilings

Add the following:

"Gyproc Gyprex 1200 x 600mm Exposed Ceiling Grid (or approved equivalent system):

Gyproc Gyprex Gyprex White' 12000mm x 600mm smooth vinyl faced ceiling tile, or approved equivalent, shall be laid into the Donn ceiling grid. The ceiling grid, consisting of Donn wall angle (SM25), shall be fixed to the perimeter wall using fixings at 300mm centres. Donn main tees (T38V) shall be spaced at 1200mm centres.

The main tees shall be suspended using Donn Pre-stretched Galvanised Hanger wire 2.5mm thick at 1200mm centres. The hanger wire shall be put through the main tees hole and wound 3 times around itself.

Donn cross tees T38 (1200 long) shall be installed at 600mm centres to create a 1 200mm x 600mm ceiling grid. The main tee shall be fixed to the wall using angle cleats."

5.9.2 PSJ-5.1 Tolerances:

Add the following:

"PSJ-5.1.1 General

i. Grid dimensions as shown on the drawings shall be maintained at ±1mm.
ii. Finished ceiling levels as shown on the drawings shall be to a tolerance of ±2mm in 1000mm length.
iii. All dimensions shall be checked on Site before commencement of installations.
iv. Joints between ceiling panels shall be consistent, square and flush and clamped together by the support system.
v. Where gaskets are installed within joints, they shall not vary in width by more than 10% of the width of the gasket in place.
vi. Panel to panel lipping or plan offsets shall not exceed 0.5mm and be non-cumulative across any ceiling.
vii. Grid creep across any ceiling shall not exceed 1.5mm in a 10m length.
viii. Install square, regular to line, level and plane within specified tolerances.
ix. Top-fixing of wire hangers to concrete soffit shall be fixed strictly according to manufacturer's specifications and guidelines
x. Approvals shall be obtained before drilling or cutting parts of the structure.

PSJ-5.1.2 Suspended Grid

i. Suspended grids shall be accurately set out, to be free from undulations and lipping, with all lines and joints straight and parallel to the planning grid.
ii. The grid shall be securely fixed with additional bracing and stiffening as necessary to provide a rigid system.
iii. Light fittings, grilles, fire and smoke barriers and the like shall be in the correct positions relative to the ceiling grid, prior to commencing installation. Common setting-out points shall be used.
iv. The suspension system shall be installed in accordance with the manufacturer's recommendations.

PSJ-5.1.3 Movement Joints

i. Movement joints shall be as shown on the drawings.
ii. Movement joints shall be provided as appropriate for the area of ceiling and/or to coincide with movement joints in the surrounding structure.

PSJ-5.1.4 Fire Stopping:

i. The *Contractor* shall employ suitable fire stopping methods wherever deemed necessary in terms of these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer*'s specifications or any other applicable standards and documents related to the *works*.
ii. All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and approved standards.
iii. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like.
iv. All gaps at junctions with walls, cavity barriers, ducts, pipes and other penetrations shall be sealed.
v. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

Add the following new sub-clauses:

5.9.3 PSJ-7: Access Flooring

Access flooring shall comprise of "Pentafloor" (or approved equivalent) raised access floor system with 1.5mm high-pressure laminate (HPL) "Smart Edge" 600 x 600 x 35mm formica panels. The colour shall be "Grey Starlight". A snap-lock "Stringer" substructure system shall be provided, with a positive lock between the panel and the pedestal head bolted to the floor. The system shall be installed in accordance with the manufacturer's recommended installation guidelines. Further requirements for the installation of the flooring shall be as detailed below.

PSJ-7.1 Fixings:

i. Fixings and fasteners shall comply with these specifications and the manufacturer's recommendations.
ii. All bolts, screws, nuts and anchors shall be stainless steel and fit for purpose.
iii. All fixings shall conform to statutory requirements in respect of strength and type.

PSJ-7.2 Other Requirements:

i. Prefabricated bridging pieces shall be provided to span underfloor ducting/services, as indicated on the mechanical and electrical services drawings.
ii. Where pedestals cannot be positioned at the perimeter of the concrete, a 1.5mm nominal galvanized steel plate shall be provided, mechanically fixed to the floor at all such perimeters.
iii. 10mm sealed expansion joints shall be provided at the perimeters.
iv. Seals shall be provided at the perimeters and abutments to maintain the integrity of the *works*.
v. Earth bonding shall be provided as required.
vi. All gaps at the junction of the flooring and walls shall be sealed with fireproof material to prevent penetration of smoke and flames.
vii. All cut, encapsulated panels shall be sealed with a sealant or welding material to prevent ingress of water into the core material, as recommended by the panel manufacturer.

PSJ-7.3 Load Performance:

i. The panel and substructure system shall be suitable for a high/heavy load capacity, the maximum floor load, as per SANS 1549 and the manufacturer's guidelines. The *Contractor* shall confirm all equipment loads prior to placement of final orders for the floor system.

PSJ-7.4 Fire:

i. All concealed spaces below the access floor shall have firebreaks, in accordance with SANS 10400.
ii. "Pyro-Cote", or approved equivalent fire protection systems, shall be used to seal openings.
iii. Fire resistance shall be in accordance with SANS 10177.
iv. All gaps at junctions of the *works* with walls, cavity barriers, ducts, pipes, other floors at different levels shall be sealed with fireproof material, to prevent penetration of smoke and flames.

PSJ-7.5 *Raised Access Floor Construction Generally:*

i. The thickness and type of panels shall be determined, with due regard being taken of the performance requirements of SANS 1549, the specifications and the location within the building.
ii. Cut-outs within panels shall be made at the point of manufacture and not on Site.
iii. All exposed ends, cuts and the like shall be sealed.
iv. No panels to have any sharp edges.
v. Cutting and drilling of flooring panels and associated *works* shall take place before the application of finishes.
vi. All timber shall be of a suitable grade to meet the performance requirements.
vii. The flooring system shall have a panel location system that securely locates each panel and provides resistance to rolling loads, preventing any rocking without relying on the perimeter wall for lateral stability.
viii. Access panels to be epoxy powder coated.
ix. Pedestals to be powder coated.
x. The panel lifting device shall not cause any damage to the covering material when used in accordance with the manufacturer's instructions.

PSJ-7.6 *Manufacturing Tolerances:*

i. The pedestals shall be adjustable to provide a finished floor level within ±1.5mm over any 5m².
ii. Panel Flatness: The concavity or convexity of any panel under no-load conditions shall not exceed 0.75mm when measured across a 600mm module and parallel to any edge, or diagonally across the module.
iii. Panel Squareness: The panel deviation from square shall not exceed 0.06% of the diagonal length.
iv. Panel Dimensions: The deviation from the specified size of the panel shall not exceed ±1.00mm.

PSJ-7.7 *Site Installation:*

i. Pedestal positions shall be marked out in advance of any services installations, to ensure that clashes between the location of the pedestals and services do not occur.
ii. Before commencing work, all fixtures around which panels are to be cut or over which supports are to bridge shall be checked, to ensure that they are complete.
iii. The sub-floor shall be cleaned and sealed before installation commences.
iv. Surfaces to be sealed shall be clean, dry and free from dust, grease and other contaminants.
v. Two coats of contrasting colour, tinted sealer shall be applied to all concrete and masonry surfaces within the floor void, in accordance with the recommendations of the raised flooring manufacturer.
vi. The first coat shall be applied before the pedestals are erected and the second coat towards the end of the floor installation. Reference shall be made to the drawings for setting-out requirements.
vii. The location and installation of pedestals and supports shall be coordinated with the services requirements and *Employer's* requirements for raised structures/beams. The installed floor shall be free of any undulations, steps, ridges, bumps, ripples, rocking and lipping.
viii. Allowance shall be made in the designs for bay divisions and movement joints, taking account of wall joints and other fixed elements.
ix. Account shall be taken of any changes in the level of substrates, to ensure that the required finished floor datum level is achieved.

PSJ-7.8 *Floor Panels:*

i. Cutting of panels shall be kept to a minimum. Such cuts shall be located in unobtrusive locations.
ii. Oversized panels shall be used to ensure that cut panels are not less than half-width, particularly at doorways, thresholds, perimeters and the like. Suitable panel support arrangements shall be provided, which will not create a hazard to pedestrians.
iii. All cut panels adjacent to door thresholds, lift lobbies and other openings shall have an additional pedestal support at mid span.

PSJ-7.9 *Pedestals:*

i. Pedestals shall be fixed plumb using both mechanical fixings and epoxy resin adhesive.
ii. Bonded pedestals shall remain rigid and firmly secured to the sub-floor.

PSJ-7.10 *Cavity Barriers:*

i. Firebreaks shall be located on the line of the required compartments, as indicated on the plan area.
ii. All openings into voids or through any cavity barriers shall be fire stopped to provide fire resistance and provide a complete barrier to smoke and flame (Refer PSJ-5.1.4).
iii. Floor voids shall be subdivided into areas not exceeding 400m², by using cavity barriers.
iv. Barriers shall be fixed securely to the sub-floor without any gaps, to provide an effective barrier to smoke and flames.
v. Access panels shall be screwed down above cavity barriers or shall be firmly secured by other approved means.
vi. The floor system shall remain stable when groups of panels are removed for access, maintenance or other purposes.

PSJ-7.11 *Installation Tolerances:*

i. The difference in height between adjacent finished panels shall not exceed 1.0mm after the application of the specified load and shall not exceed 3.25mm between the edges of any panel being subjected to the specified maximum static load, adjacent to an unloaded panel.
ii. Deviation due to twisting under no load conditions of any corner in relation to the other three corners shall not exceed 1.0mm over a 600mm module.

PSJ-7.12 *Sealing of Cut Panels:*

i. All exposed cut edges of panels shall be sealed with Class 0 rated aluminium foil self-adhesive tape.

PSJ-7.13 *Perimeters:*

i. Sufficient lateral stability shall be provided to ensure that the floor is independent of any abutting elements.
ii. A 10mm gap shall be provided at all abutments, to be filled with resilient closed cell filler before fixing the skirting, cover strips and the like.

PSJ-7.14 *Panel Lifting Devices:*

i. Upon completion, two sets of lifting devices shall be provided, suitable for each of the floor finishes installed.

PSJ-7.15 *Post Installation Examination:*

i. A post-installation inspection will be undertaken in conjunction with the *Employer* after completion of the mechanical and electrical installation and other associated work. If required, a schedule of defects will be issued by the *Employer,* to be attended to by the *Contractor* prior to final handover. The cost of attending to such defects shall be borne by the *Contractor.*
ii. All accessible areas of the sub-floor shall be thoroughly cleaned and a further coat of sealer shall be applied to all accessible areas.

PSJ-7.16 *Movement Joints:*

i. Movement joints shall be provided within the building structure, to be installed in a manner that will not compromise the integrity, appearance or performance, in any way, of the panels or their supports.
ii. Reference shall be made to the specifications and drawings to identify the location and types of movement joints that need to be accommodated.

PSJ-7.17 *Protection:*

i. The flooring shall not be used as a platform for storage of builders' equipment and materials.
ii. The flooring shall not be subjected to static or dynamic loads exceeding the design loads. Adequate precautions, including the use of spreader plates, shall be taken during installation of equipment and any other elements, such as ceilings.

5.10 PSK : Floor Coverings, Wall Linings, etc.

Add the following new sub-clauses:

5.10.1 PSK-4 : Resin Flooring

i. PSK-4.1 Product:

Epoxy flooring shall comprise of the following, or approved equivalent:

- One coat of "Mastertop Primer 1200 Plus" resin with Solvent No 2 with "Mastertop 1210 Plus" aggregate, or approved equivalent.
- Top coat of light grey "Mastertop 1210 Plus" or approved equivalent.

The above requirements shall be read in conjunction with *Employer's* finishes schedule.

ii. PSK-4.2 Applicator:

The *works* shall only be carried out by applicators that are registered with and are approved by the material manufacturer.

iii. PSK-4.3 Guarantee:

The *Contractor* shall obtain, and forward to the *Employer*, a written guarantee from the flooring material manufacturer to cover the installation and material for a minimum period of twelve months

iv. PSK-4.3 Protection:

The *Contractor* shall protect the *works* during and after completion of the installations and ensure that the floor is not damaged or scratched.

5.11 PSL : Ironmongery

5.11.1 PSL-3 : Keys

Add the following:

PSL-3.1 *Master Key Provision*

i. Unless explicitly stated to the contrary, all cylinders and lever mechanism locks shall be under a master key plan.
ii. Master key and suiting proposals shall be agreed in writing with the *Employer* and manufacturer prior to order placement.
iii. At practical completion the *Contractor* shall adequately label all keys and provide the *Employer* with an itemised schedule of door locks and keys.
iv. Two sets of keys for each door shall be handed over to the *Employer.*

PSL-3.2 *Hinges*

i. Hinges shall be of a suitable strength class to suit the door weight, duty and number of hinges.
ii. All butt hinges shall be template drilled, with removable or fixed pins and shall incorporate stainless steel bearing washers or self-lubricating bearings, as specified.
i. Three butt hinges shall be provided to all fire doors, external doors and doors with closers, unless specified otherwise.
iii. All hinges shall be of 316L stainless steel.

PSL-3.3 *Door Closing Devices:*

i. All closers shall be from a suite of matching closers from one manufacturer, offering a complete range of optional functions, such as mechanical and/or electromagnetic stand open and delayed closing.
ii. Unless otherwise stated, closers shall have the following features:

- Hydraulic control from 180°.
- Thermo-constant.
- Separate adjustable closing speed.
- Separate adjustable latching speed.
- Separate sweep and latch valve.
- Self-adjusting backcheck.
- Fully adjustable delayed closing function.
- Spring strength and delayed action functions shall be fully adjustable by means of an Allen key, or acceptable equivalent, for ease of use.

PSL-3.4 *Lever Handles*

i. Lever handles shall comply with SANS 4.
ii. All lever handles shall be of 316L stainless steel.

PSL-3.5 *Emergency Exit Devices*

i. Emergency exit devices, operated by a lever handle or push pad, shall comply with BS EN 179.
ii. Horizontal panic exit devices shall comply with BS EN 1125.
iii. Electronically controlled panic exit systems shall comply with prEN 13633 and other applicable specifications.
iv. Electronically controlled emergency exit systems shall comply with prEN 13637 and other applicable specifications.
v. Emergency exit devices shall be suitable for any size of door leaf up to 1220mm x 2440mm, with horizontal activating bars which operate when pushed or pulled downwards, at any point on their effective length. They shall have catches, which automatically hold bolts in the withdrawn position on operation and release them when fully closed.

vi. Panic devices shall generally be of mortice types (with concealed latches or vertical bolts), finished identically to other ironmongery and incorporating security anti-thrust devices. In transformer rooms or the like, rim mounted enamelled steel panic devices shall be acceptable.

PSL-3.6 *Door Plates:*

i. Plates shall be fixed with suitable countersunk screws located 5mm from the edges, with one screw at each corner and screws at equal centres, not more than 240mm apart, at top and bottom edges. The sizes of all kick, mid rail or trolley plates shall be checked on Site before placement of orders.

ii. All plates shall be of 316L stainless steel.

PSL-3.7 *Installation:*

i. Door hardware locations from finished floor level to centre-line of hardware to be as follows, unless noted otherwise:

- Lever handles/knobs: 1000mm.
- Push plate/pull handle: 1070mm.
- Cylinder pull: 1200mm.
- Provide ironmongery for each door in separate, clearly labelled packs.

PSL-3.8 *Fixings:*

i. All items of door ironmongery shall be supplied complete with matching screws to the type and length recommended by the manufacturer and suitable for fixing to wood or metal, as appropriate, to suit the door leaf and frame. All other visible fixings shall have countersunk heads.

ii. All fixings shall be of 316L stainless steel.

PSL-3.9 *Installation:*

i. Ironmongery shall be installed and checked for correct operation. Each item shall be maintained and protected against damage by other trades.

ii. The ironmongery installations shall be coordinated with other trades, taking account of the location of form holes, mortices, chases and the like. This shall include the following:

- Reinforce and prepare hollow constructions to receive ironmongery.
- Provide for wiring, conduits, accessories and the like for electrical items.
- Protect ironmongery during construction.
- Remove fixed items before finishing or painting as required.

PSL-3.10 *Completion:*

i. On completion all ironmongery shall be adjusted, cleaned and lubricated in accordance with the manufacturer's recommendations.

5.12 PSN : Metalworks

5.12.1 PSN-1 : Materials and Workmanship

Add the following:

"PSN-1.1 Welding/Brazing:

i. All surfaces to be joined shall be thoroughly cleaned.
ii. Accurate fit shall be ensured using clamps and jigs, wherever practicable. Tack welds shall only be used for temporary attachments.
iii. Joints shall be made with parent and filler metal, fully bonded throughout with no inclusions, holes, porosity or cracks.
iv. Weld spatter shall be prevented from falling on surfaces of materials that will be self-finished and visible in the completed *works.*
v. All traces of flux residue, slag and weld spatter shall be removed."

5.12.2 PSN-2 : Steel

Add the following:

"i. All mild steelwork that is to be coated shall comply with SANS 10120, unless stated otherwise.
ii. Fabrication of steelwork shall be in accordance with the specification.
iii. All fit-ups shall be checked for accuracy before and after making permanent connections in frames and other structural elements, which are assembled before delivery to Site.
iv. Welding procedures shall make allowances for eliminating or reducing distortions. Any local distortions shall be rendered negligible in the final fabrication.
v. No welds, other than those shown on the drawings, even for temporary attachments or repairs, will be accepted, unless specifically approved by the *Employer.*
vi. Vent holes in hollow sections shall be sealed to prevent the ingress of moisture.
vii. External visible lines and depressions, caused by the internal welding of hollow section steelwork, shall be positioned so as to be non-visible."

5.12.3 PSN-2.1 : Galvanising of Steel

Add the following:

"PSN-2.1.1 Galvanising - General

i. All galvanising shall comply to ISO1461:2009 and SANS 121.
ii. The coating thicknesses shall be a minimum of 85 micrometres.
iii. Where galvanising is visible, the final finish shall be smooth, continuous, consistent and free from flux staining and other forms of staining. Coating weight shall be consistent, maintaining a uniform appearance throughout the service life of the *works.*

PSN-2.1.2 Galvanised Steelwork to be painted:

i. A zinc-compatible duplex coating system shall be used.
ii. Surface preparation shall be in accordance with the Hot Dipped Galvaniser Association of South Africa coating guidelines and SANS 121.
iii. Hot dip galvanised or zinc-metal sprayed surfaces shall be cleaned prior to painting, to provide a water break-free surface, using a solvent detergent degreaser specifically formulated by the supplier of the paint system for cleaning new galvanising surfaces.
iv. All surfaces shall rinsed with water after cleaning, using a high-pressure water sprayer, to remove all traces of the cleaner, and allowed to dry.
v. Micro blasting may be carried out in accordance with SAHDGA 01- 1990 – Code of Practice for Surface Preparation and Application of Organic Coatings, provided that the micro-blasting does not damage or remove the hot dip galvanised or zinc metal-sprayed coating.
vi. Sprayed metal coatings shall comply with SANS 1391."

PSN-2.1.3 Coating System:

i. Primer coat: As soon as the surfaces are dry, one coat of twin pack epoxy primer, specifically formulated for zinc surfaces, shall be applied by airless spray to a dry film thickness of 80 to 100 micrometres.
ii. Stripe coat: After allowing sufficient time for the first coat to cure, all edges, weld seams, bolt holes and other crucial areas shall be given an additional stripe coat using the same product as the primer coat.
iii. Second coat: Sufficient time shall be allowed for the first and stripe coats to cure, in accordance with the manufacturer's recommendations, before application of the second coat. The second coat shall consist of one coat of twin-pack epoxy MIO, to be applied with a dry film thickness of 100 to 150 micrometres.
iv. Final coat: After allowing sufficient time for the second coat to cure, one coat of twin-pack, high-solids polyurethane acrylic finish shall be applied by airless spray, to a dry film thickness of 50 to 60 micrometres.
Total minimum dry film thickness of coating system to be 240 micrometres."

5.12.4 PSN-3 : Stainless Steel

Add the following:

"Unless otherwise specified, 316Lstainless steel shall be austenitic and non-magnetic. Specific grade designations shall be either as specified in the relevant sections of the specification or, where not specifically identified, selected to meet the performance criteria specified for the particular element or components.

316L stainless steel fasteners, bolts, screws, nuts and other fixings shall be to SANS 1700. The property class of fastenings shall be selected to meet the performance requirements as specified.

Unless otherwise specified, welds to visible areas of 316L stainless steel shall be ground smooth to achieve a seamless surface. Heat tints shall be removed using light abrasives, pickling paste, wire brushing or similar to achieve continuity with the specified finish. Areas that are difficult to access shall be manually finished if necessary.

Distortions due to thermal movement shall be minimised using jigs or other methods as appropriate during welding. Welding methods and consumables shall be chosen to be appropriate for the type, thickness, shape and location of joints, to meet the performance levels required and have mechanical properties at least equal to the original base metal. In addition, consumables shall have an equal or superior corrosion resistance to the base metal being welded. Further welding practices that are required to meet other relevant standards as specified shall also apply. Electrodes for manual metal arc welding shall comply with SANS 1071.

5.12.5 PSN-4 : Aluminium

Add the following:

"i Only appropriate grades, strengths and thicknesses of aluminium shall be used, to ensure that all structural and finishing requirements of the specification are met. The wall thicknesses of aluminium extrusions shall be sufficient to ensure their rigidity in the lengths required in the final installation.
ii. All aluminium fixing brackets and cleats shall be manufactured from the appropriate grade of alloy. If visible, the finish shall match the metal panels and framing members.
iii. Exposed aluminium shall be protected with low tack adhesive film during construction and prior to handover.
iv. Aluminium sheets shall not have any bowing, dimpling, oil canning, sagging, pillowing, rippling, warp, abrupt transitions or other visible deformation or irregularity.
v. Aluminium extrusions shall be of 6063-T6 alloy and temper."

Add the following new sub-clauses:

5.12.6 PSN-16 : Aluminium Windows and Doors

"PSN-16.1 General

i. Frames shall be manufactured from extruded aluminium, material alloy 6063-T6.
ii. All corners shall be mitred, flush, flat and true.
iii. Frames shall be factory-glazed, delivered and installed in one piece.
iv. Frames shall safely and securely retain the glass by means of a combination of dry gaskets, structural polysulphide and/or adequate aluminium/stainless steel locating pieces.
v. All framing shall utilise the minimum cross section necessary to maintain rigidity and performance.
vi. All glazing shall be executed according to SANS 10137.
vii. Dimensions and levels of the structure shall be verified.
viii. The framing members for the *works* shall be set out and installed in the correct position, within tolerance, and in the correct relationship to the building structure.
ix. The gaps between the panels and mullion structure shall be constant.
x. All fixing bolts and anchors shall be installed in accordance with the manufacturer's recommended procedures.
xi. Internally, the protection shall remain in place until the *works* are complete. All protective measures shall be replaced following inspections by the *Employer*.
xii. Isolating tape, plastics washers, or other suitable means shall be provided to prevent bi-metallic corrosion between dissimilar metals.
xiii. The frames shall be square, regular to line, level and plane, with all junctions fitting to the stated tolerances.
xiv. Gaskets shall be to SANS 635.

PSN-16.2 Fixings

i. All bolts, screws, nuts and anchors shall be of adequate strength for the intended purpose and shall be manufactured from 316L stainless steel.
ii. All necessary fasteners, fixings associated flashings and closures shall be provided.
iii. Fixings shall conform to all statutory requirements in respect of strength and type.
iv. Adequate measures shall be taken to prevent bi-metallic corrosion between dissimilar metals and to isolate aluminium components from cementitious surfaces.
v. Fixings within the aluminium framing components shall not be visible, unless so indicated on the drawings.
vi. Visible fixings shall be restricted to the assembly of the aluminium elements to the support steelwork using types described on the drawings.
vii. The gaps between the panels and mullion structure shall be constant.

PSN-16.3 Certification

i. Prior to commencing *works* on Site, the *Contractor* shall provide a copy of the AAAMSA performance test certificate from the supplier of the aluminium products.
ii. The *Contractor* shall also provide a copy of the installation subcontractor's current AAAMSA membership certificate.
iii. Prior to commencing work on Site, the *Contractor* shall provide a copy of the SWADA performance test certificate from the supplier of the steel products.
iv. The *Contractor* shall also provide a copy of the subcontractor's current SWADA membership certificate.
v. The *Contractor* shall provide an AAMSA glass and glazing certificate, confirming that the glazing has been carried out in strict accordance with SANS 10137 and SANS 10400.

PSN-16.4 Powder Coating Manufacturer's Guarantee

The *Contractor* shall make available to the *Employer* fully documented and signed copies of the powder manufacturer's marine guarantee for the coating process. The guarantees shall specifically cover peeling and discolouration and shall be valid be for a minimum duration of 15 years.

5.12.7 PSN-17 : Metal Safety Hooks

316L stainless steel "Ringanka Kee i-bolt®" safety eyebolts, as supplied by "Fall Protection Engineering Works", or approved equivalent, shall be fixed into concrete upstand using 102 mm, 316L stainless steel, M12 female threaded, with curled inserts spaced equally at a maximum spacing of 1.5 m centres."

5.12.8 PSN-18 : Handrails and Balustrades

Handrail and balustrade systems shall be "Maclock" balustrade and handrail system, or "Mentis Inter-link Handrail System", or approved equivalent. Handrails and balustrades shall be installed in strict accordance with the manufacturer's recommended guidelines. Finishes shall be as shown on the drawings or as instructed by the *Employer.*

PSN-18.1 General

i. All proposed fixings shall be approved by the *Employer* before installation.
ii. Tubular section wall thickness shall be designed to accommodate the required live and dead loads as indicated.
iii. All exposed work shall be finished so that there are no sharp edges at corners, fixings or joints, which may cause injury.
iv. All welds shall be ground perfectly smooth to present a visually jointless appearance.
v. All support posts shall be vertical.
vi. Wherever possible angle deviations shall be made by means of radius curves, using mandrel bending.
vii. Mitre joints will be allowed where space constraints render bending impractical.
viii. All open ends of tubular sections shall be capped and welded.
ix. All curved on plan handrails shall be rolled to the required radii to match Site conditions.
x. All mild steelwork shall comply with SANS 1200H and 10120, unless stated otherwise.
xi. Fabrication of steelwork shall be in accordance with the specification.
xii. All fit-ups shall be checked for accuracy before and after making permanent connections in frames and other structural elements, which are assembled before delivery to Site.
xiii. The welding procedures to be used shall make allowances for the elimination or minimizing of distortions, which shall be negligible in the final fabrication.
xiv. No welds, other than those shown on the drawings, will be accepted, even for temporary attachments or repairs, unless approved in advance by the *Employer.*
xv. Vent holes in hollow sections shall be sealed in a manner to effectively prevent the ingress of moisture.
xvi. External visible lines and depressions caused by the internal welding of hollow section steelwork shall be positioned so as to be non-visible.

5.12.9 PSN-19 : Powder Coatings

PSN-19.1 General

i. Only powder coating materials suitable for the intended purpose shall be used.
ii. Aluminium alloys shall be selected to ensure that the finished visual appearance of all components is consistent and identical.
iii. The aluminium alloy for extrusions shall be Grade 6063 or 6261 in temper T5 or T6.
iv. Pre- treat aluminium shall be in accordance with SANS 1796.
v. Powder coating architectural aluminium shall comply with SANS 1796:2013 or SANS 1274 for all other substrates.

PSN-19.2 Materials

i. Powder coating materials shall comply with SANS 1578 – 1 Durable Organic Powders.
ii. The colour of the powder coatings shall be selected by the *Employer,* based on the RAL powder manufacturer's ranges.
iii. All colour samples shall be submitted and approved by the *Employer* before coating commences.
iv. The minimum and maximum local dry film thickness on adjacent panels shall not vary by more than 20%.
v. The powder coating shall be identical in all respects, subject to the criteria as specified on all components.
vi. Adhesive/protective tapes/films shall be low-tack type, applied at room temperature, remaining in contact with the surface for a maximum period of 6 months.

PSN-19.3 *Preparation*

i. One coat of Powder – Lak Series 2000 zinc primer (ref. 27-0003), or approved equivalent, shall be applied, in strict accordance with the manufacturer's technical guidelines.
ii. Minimum dry film thickness shall be 50 microns.

PSN-19.4 *Application*

i. One coat of Powder - Lak Powder Coating Series 3000, or approved equivalent, shall be applied, in strict accordance with the manufacturer's technical guidelines.
ii. Powder coating shall be degassed.
iii. Minimum dry film thickness shall be 120 microns.

PSN-19.5 *Workmanship*

i. All powder coating shall be done only by applicators certified under SANS 1796 and approved by the powder manufacturer.
ii. Applicators shall follow the procedures as described in the ISO 9002 Quality Assurance Management System or other *Employer* approved standard.
iii. Powder coating application and stoving shall be carried out in strict accordance with the powder manufacturer's specification.
iv. Only one coating plant and one batch of powder shall be used for the full scope of the *works*, unless specifically approved otherwise by the *Employer*.
v. The *Contractor* shall provide the *Employer* with a fully documented and signed set of the powder manufacturer's marine guarantee for the coating process. The duration of the guarantees shall specifically cover peeling and discolouration and shall be valid for a minimum of 15 years.

PSN-19.6 *Protection of Cut Edges:*

i. Prior to assembly of the components, all cut/mitred edges and drilled holes shall be coated to avoid corrosion with the following products, or approved equivalents, applied in strict accordance with the manufacturers recommendations:

- Primer : Plascon Paints AW 255.
- Top Coat : Plascon Polyurethane Acrylic Top Coat, colour to be matched to the section being coated.

5.12.10 PSN-20 : Anodising

PSN-20.1 *Materials*

i. Aluminium anodising shall comply with SANS 999, unless specified otherwise.
ii. The *Contractor* shall provide a certificate of assurance for the manufacture and application of each batch of anodising.
iii. The colours for the anodising process shall be agreed with the *Employer*.
iv. Colouring of the anodic film shall be achieved by use of a two-stage electrolytic process, utilizing cobalt or nickel as the colouring metal, or by use of a single stage integral process. Tin electrolytes shall not be used.
v. Should the *Contractor* wish to propose an alternative colouring technique, further written confirmations shall be provided that the alternative process will meet all visual, physical and documentary requirements as detailed in the specification. This shall be supported by satisfactory independent evidence and samples, to verify that the alternate colouring process will provide an equal or superior standard of performance and life expectancy.
vi. All aluminium alloys shall be selected to ensure that the finished visual appearance of all components is identical. The alloy for extrusions shall be Grade 6063, or acceptable equivalent, and for sheet material grade J57S, or acceptable equivalent. The *Contactor* shall obtain, and submit to the *Employer*, a certificate from the material supplier stating the grade of material supplied.
vii. Base metal batching shall be controlled so that all areas are perfectly matched. This applies in particular to visible areas, which shall be coated from a single batch. The base metal batching shall be approved by the *Employer* in advance of production.

PSN-20.2 Workmanship

i. Anodic oxidation coating shall be carried out at a single place of manufacture. All critical visible areas shall be anodised in a single batch.
ii. Anodising shall, wherever possible, only commence after fabrication/machining is complete.
iii. Fabricated pieces shall meet the thickness requirements of SANS 999.
iv. The processes as adopted shall provide a product that is weather-, abrasion- and impact resistant and also provides protection against chemical attacks.
v. Corrosion resistance shall be equal to or greater than an anodised aluminium finish with a minimum thickness of 25 microns and sealing properties in accordance with SANS 999.
vi. For production control, the sealing value of the anodising shall be determined in accordance with SANS 2931. In the event of a dispute, the referee test as described in SANS 3210 shall be carried out. The maximum, acceptable weight loss as determined by the referee test shall be no greater than 30mg/dm^2. Impregnated cold sealing processes shall not be used.
vii. For production control the film thickness of the anodising shall be determined in accordance with ISO 2360. In the event of a dispute the referee test described in SANS 144 shall be carried out. The minimum local film thickness shall be 20 microns with a maximum of 35 microns.
viii. Anodic oxidation coating shall be carried out by the sulphuric acid bath process. The temperatures of the anodising bath and chemical content shall be set and maintained to achieve good quality control of the finished product in accordance with SANS 999.
ix. Notwithstanding the requirements of SANS 999, visible surfaces shall be free from coating or metallurgical defects when viewed from a distance of 1 metre.
x. A quality control system for cleaning extrusion dies shall be adopted. No lines shall be visible on the face of the extrusions. As a minimum, a check shall be done on every 5th extrusion.
xi. Rejected anodised extrusions may only be reprocessed once.
xii. Anodised finishes shall be within the control limits (established from range samples) or to standards approved by the *Employer*.
xiii. The finish shall be sealed in accordance with SANS 999.
xiv. Finishes shall be tested to SANS 6581.
xv. Variations in the final surface finish shall be limited to tolerances approved by the *Employer* prior to commencement. If excessive variations do occur, any components which do not achieve a uniform final surface finish, as assessed by the *Employer,* shall be replaced.
xvi. Lines, produced at the location of die connection points, shall only occur on non-visible surfaces.
xvii. The contact marks on sections where electrical connections are made shall not be visible on the external surfaces.
xviii. The normal, guaranteed cleaning frequency shall not be less than 18 months.

5.1 PSR : Glazing

5.1.1 PSR-1 : Materials and Workmanship

Add the following:

PSR-1.1 *Glass - General*

i. All glass shall be produced to SANS 50572. Safety glazing shall be marked in accordance with SANS 1263 Part 1.
ii. All glass shall be sourced from a single supplier, unless approved otherwise by the *Employer*.
iii. All glass shall be manufactured and processed in accordance with independently certified quality control procedures to SANS 9000.
iv. Glass shall be inspected for scratches and blemishes at a minimum distance of three metres under normal lighting conditions, i.e. reasonable lighting conditions under which the installation is normally viewed. If the installation will normally be viewed from a greater distance, then this distance will be used for the inspection. Normal viewing excludes viewing from areas only accessible for cleaning or maintenance.
v. Glass may be rejected if, when inspected under the above conditions, scratches, flaws, stains or other visible defects, which mar the aesthetic appearance of the glass, are visible.
vi. Glass may also be rejected if any structural or latent defects are evident, which may cause the installation to fail within the ten year warranty period.
vii. Edges shall be inspected prior to installation. All edge damages shall be assessed to determine if thermal cracking has occurred.
viii. All vented edges shall be treated to prevent cracks from running. Such failure will be classified as a latent defect and any repairs shall be to the account of the *Contractor*.
ix. Exposed edges of toughened glass shall be polished. The *Contractor* shall submit a sample which will, subject to the *Employer*'s approval, be used as a standard for these *works*.
x. Glazing shall be wind and water-tight under all conditions, taking account also of any deflections and movements that may be reasonably anticipated.
xi. All glass types shall be cut to accurate sizes with clean cut, arrissed edges. Damage, such as shark teeth, serration hackle, sharp flare, flake chips, rough chips, feathered edges, shells or other imperfections are not acceptable.
xii. Glass delivered to Site shall be of the required size. No cutting or nipping of glass will be allowed on Site.
xiii. Variations in manufacture and performance shall not affect the glass colour or appearance. All glass of the same type shall be visually consistent in appearance and colour, within the specified manufacturing tolerances, and in accordance with the approved samples and observations of previous installations of the same type of glass.
xiv. All glazing shall be carried out in accordance with the manufacturer's recommendations.
xv. All glass panes within frames shall be installed to provide the necessary edge cover and clearance to ensure a permanent and safe installation.
xvi. Under no circumstances may glass panes with damaged edges, including shelling and impact markings, be installed.
xvii. The *Contractor* shall provide to the *Employer* a warranty from the glass manufacturer, certifying that the glazing systems comply with the manufacturer's requirements and indicating the life expectancy of the glass, interlayers, spacers and other components.
xviii. Distortion shall be kept to an absolute minimum. Local defects, such as tong marks, producing irregular reflections are not permitted.
xix. Visual quality testing of float glass (jumbo sizes and stock size sheets) for dimensional requirements and visual defects shall be in accordance with SANS 50572: Part 2.

PSR-1.2 *Safety Glass*

i. Safety glass categories shall be selected for use in critical locations, as defined and recommended in the relevant parts of SANS 1263 and SANS 10400, and as required to comply with the local authority and other applicable health and safety requirements.
ii. All safety glass shall be marked with an internationally recognized symbol and labelled in a consistent position on the glass, as approved by the *Employer*.
iii. Safety glass shall be provided in accordance with the relevant parts of SANS 10137 and SANS 1263, as applicable, and shall meet the relevant requirements of SANS 10400 for safety glass.

PSR-1.3 *Annealed Glass*

i. Untinted annealed glass sheets shall provide a clear, undistorted vision and reflection.
ii. The tolerances on thickness and cut sizes for different thicknesses of material shall be as stipulated in SANS 50572.
iii. Visual quality testing of annealed glass for dimensional requirements and visual defects shall be in accordance with SANS 50572.

PSR-1.4 *Laminated Glass*

i. Laminated glass shall be in accordance with SANS 50572.
ii. Laminated glass shall consist of a number of sheets of flat glass with polyvinyl butyral (PVB) of not less than 0.375mm thick or methyl metacrylate resin interleaving between each layer. The layers shall be clear, translucent or coloured, depending on the intended design. The glass may be annealed, heat strengthened, or heat soak toughened, as required to meet the performance requirements of the specifications.

PSR-1.5 *Toughened Glass*

i. All toughened glass shall be heat-soaked to DIN 18516: Part 4.
ii. The glass shall conform to the following requirements in the horizontal toughening process:

- Maximum overall bow: 0.003mm per millimetre measured along the glass edge.
- Maximum local bow: The maximum deviation for flatness from peak to trough shall not exceed 0.3mm per 300mm or 0.15mm at the edge or 0.08mm in the middle.
- Rollerwave: Size of glass to provide for the consistent and horizontally aligned orientation of ripples throughout.
- The maximum deviation for flatness from peak to trough shall not exceed 0.08mm.

iii. Exposed edge working shall be flat ground with small ground arriss and have a frosted appearance. Small shells and/or chips, exceeding a maximum diameter of 2mm, shall be ground out prior to toughening.
iv. The surface compressive stress shall be demonstrated by non-destructive testing, to be controlled at manufacture at >=120N/mm^2.
v. All glass shall be cut to accurate sizes and deliver to Site in the required sizes. No on-Site cutting or nipping will be allowed.
vi. The glass shall be clearly marked to show its intended final position and orientation.

PSR-1.6 *Fire Resistant Glass*

i. The ratings for fire resisting glass shall be classified as safety glass in accordance with SANS 1263.
ii. Fire resistant glass shall be tested, assessed and certified in accordance with BS 476.
iii. Fire resisting glazing shall incorporate fire-rated beading and fixing methods to match the fire rating specified.
iv. Unless otherwise specified, wired glass shall not be used.
v. Glass shall be clear, with fire resisting properties as specified above.

6.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor*.

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

7.0 HANDOVER DOCUMENTATION

The following documentation shall be issued to the *Employer* as part of the handover documentation, or prior to commencement of the *works*:

- AAAMSA performance test certificate.
- Subcontractor's AAAMSA membership certificate.
- Copy of the SWADA performance test certificate from the supplier of steel products, to be issued prior to fabrication.
- Copy of subcontractors current SWADA membership certificate, to be issued prior to Site installations.
- AAMSA glass and glazing certificate, confirming that the glazing has been carried out in strict accordance with SANS 10137 and SANS 10400.
- Fully documented and signed copies of the powder manufacturer's marine guarantee for the coating process.

PEARL:

Measure Up. 80 hours × 386 = 30 880

Draw Up 120 hours × 386 = 46 320

Derek.

6 Visits × 4 hours 24 × 1238 = 29 712.

Cardno.

Site × 4. × 816

- Site - note all on plans. 16 × 816
- Draw 16.
- Estimate. 16

52 × 816 = 42432.

Structure.

Site Visit 4 × 1300

Report 8 × 1300

Heritage.

Site Visits

Preliminary Report

Arcadia

Site Visit 4 × 1300

Report. 16 × 1300

20 × 1300 26000

Technical Specification Tippler 3 Bulk Power Supply -

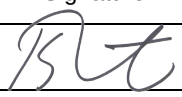
Structural Works

Document Number 1924701-2-300-B-SP-0001

Document Details

Ref (SA)	1924701-2-300-B-SP-0001
Date	27 May 2016
Prepared by	Schalk Marais
Reviewed by	Karel Biesot
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	17 April 2018	Issued for Use	Karel Biesot	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

The structural components for the bulk power facilities comprise of the following:

- 11kV Switch House at Main Intake Substation, consisting of 59m long x 17m wide x 11m high structure with reinforced concrete frame and slab, non-load bearing masonry panels and double pitch steel dome type roof.
- Substation M, consisting of 39m long x 12m wide x 8m high structure with reinforced concrete frame, non-load bearing masonry panels and double pitch steel roof.
- Substation N, consisting of 45m long x 12m wide x 8m high structure with reinforced concrete frame, non-load bearing masonry panels and double pitch steel roof.
- Various reinforced concrete foundation bases and supporting structural steel columns for equipment to be installed at the Main Intake Substation equipment yard.

1.2 Purpose

The purpose of this specification is to set out the minimum technical requirements for quality and workmanship for the design (where required), fabrication, supply, installation, construction, testing and commissioning of the following equipment/infrastructure to Substation M, Substation N as well as the Main Intake Substation:

- Concrete *works*, including, but not limited to, retaining walls, raft foundations, columns, beams and slabs.
- Structural steel *works*, including, but not limited to, outdoor lattice/tubular structures and roof trusses and wall stiffeners.
- Cladding and sheeting, consisting primarily of sheeting to the steel superstructure.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site Information
- General notes.
- Drawings.
- Specifications provided for architectural and other engineering disciplines.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns.
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns.
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor.*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns.
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
ISO	International Standards Organisation
AIA	Authorised Inspection Authority
BBBEE	Broad Based Black Economic Empowerment
CEMP	Construction Environmental Management Plan
CEMPr	Construction Environmental Management Programme
CD	Compact Disc
CDR	*Contractor* Documentation Register
CDS	*Contractor* Documentation Schedule
CRL	*Contractor* Review Label
CSHEO	*Contractor*'s Safety, Health and Environmental Officer
CM	Construction Manager
DTI	Department of Trade and Industry
EO	Environmental Officer
ECC	Engineering and Construction Contract
FEM	European Federation of Materials Handling
GGCS	Ground Granulated Corex Slag
HAW	Hazard Assessment Workshop

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
HSSP	Health and Safety Surveillance Plan
INC	Independent Nominated Consultant
IP	Industrial Participation
IR	Industrial Relations
IPP	Industrial Participation Policy
IPO	Industrial Participation Obligation
IPS	Industrial Participation Secretariat
IRCC	Industrial Relations Co-ordinating Committee
JSA	Job Safety Analysis
CIRP	*Contractor*'s Industrial Relations Practitioner
Native	Original electronic file format of documentation
PES	Project Environmental Specifications
PHA	Preliminary Hazard Assessment
PIRM	Project Industrial Relations Manager
PIRPMP	Project Industrial Relations Policy and Management Plan
PLA	Project Labour Agreements
PSIRM	Project Site Industrial Relations Manager
PSPM	Project Safety Program Manager
PSSM	Project Site Safety Manager
ProgEM	Programme Environmental Manager
ProjEM	Project Environmental Manager
QA	Quality Assurance
R&D	Research and Development
SANS	South African National Standards
SASRIA	South African Special Risks Insurance Association
SES	Standard Environmental Specification
SHE	Safety, Health and Environment
SHEC	Safety, Health and Environment Co-ordinator
SIP	Site Induction Programme
SMP	Safety Management Plan
SSRC	Site Safety Review Committee
TCP	Transnet Capital Projects
TPT	Transnet Port Terminals
TNPA	Transnet National Ports Authority
TFR	Transnet Freight Rail

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All test certificates shall be included in the on-Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 *Employer's* Standards

The *Contractor* shall be responsible for compliance of all *works* with the following *Employer* standards and specifications.

Table 3 : *Employer's* Standards and Specifications

Standard	Description
EEAM-Q-006	Structural Steelwork
EEAM-Q-008	Corrosion protection

3.4 South African and International Standards

The *Contractor* shall also ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include, but are not necessarily limited to, the following.

Table 4 : SANS 1200 Standards

Code	Standard Title
SANS 1200 D	Earthworks
SANS 1200 G : 1982	Concrete (Structural)
SANS 1200 H : 1990	Structural Steelwork
SANS 1200 HA	Structural steelwork (sundry items)
SANS 1200 HB : 1985	Cladding and sheeting
SANS 1200 HC : 1988	Corrosion protection of structural steelwork

Table 5 : Additional South African Standards

Code	Standard Title
Colto	Standard Specifications for Road and Bridge Works for State Road Authorities (1998 Edition)
SANS 28 (2010)	Metal ties for cavity walls
SANS 32 (1997)	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants
SANS 121 (2011)	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
SANS 227 (2007)	Burnt clay masonry units
SANS 282 (2011)	Bending dimensions and scheduling of steel reinforcement for concrete
SANS 285 (2010)	Calcium silicate masonry units
SANS 657-1	Steel tubes for non-pressure purposes : Part 1: Sections for scaffolding, general engineering and structural applications
SANS 675	Zinc-coated fencing wire
SANS 878 (2012)	Ready-mixed concrete
SANS 920 (2011)	Steel bars for concrete reinforcement
SABS 0237	Code of practice for roof and side cladding
SANS 1083	Aggregates from natural sources - aggregates for concrete
SANS 1215	Concrete masonry units

Table 5 : Additional South African Standards

Code	Standard Title
SANS 1700-7-1	Fasteners Part 5: General requirements and mechanical properties Section 1: Mechanical properties of fasteners made of carbon steel and alloy steel - Bolts, screws and studs
SANS 1700-7-2	Fasteners Part 5: General requirements and mechanical properties Section 2: Nuts with specified proof load values - Coarse thread
SANS 1700-7-3	Fasteners Part 7: External drive hexagon bolts and screws Section 3: Hexagon head bolts - Product grade C
SANS 1700-7-4	Fasteners Part 5: General requirements and mechanical properties Section 4: Nuts with specified proof load values - Fine pitch thread
SANS 1700-7-5	Fasteners Part 7: External drive hexagon bolts and screws Section 5: Hexagon head screws - Product grade C
SANS 1700-7-7	Fasteners Part 7: External drive hexagon bolts and screws Section 7: Hexagon bolts for high-strength structural bolting with large width across flats (thread lengths according to SABS ISO 888) - Product grade C - Property classes 8.8 and 10.9
SANS 1700-7-8	Fasteners Part 7: External drive hexagon bolts and screws Section 8: Hexagon bolts for high-strength structural bolting with large width across flats (short thread length) - Product grade C - Property classes 8.8 and 10.9
SANS 1700-14-1	Fasteners Part 14: Hexagon nuts Section 1: Hexagon nuts, style 1 – Product grades A and B
SANS 1700-14-2	Fasteners Part 14: Hexagon nuts Section 2: Hexagon nuts, style 2 - Product grades A and B
SANS 1700-14-3	Fasteners Part 14: Hexagon nuts Section 3: Hexagon nuts - Product grade C
SANS 1700-14-4	Fasteners Part 14: Hexagon nuts Section 4: Hexagon thin nuts (chamfered) - Product grades A and B
SANS 1700-14-5	Fasteners Part 14: Hexagon nuts Section 5: Hexagon thin nuts (unchamfered) - Product grade B
SANS 1700-14-8	Fasteners Part 14: Hexagon nuts Section 8: Hexagon nuts for high-strength structural bolting with large width across flats - Product grade B - Property classes 8 and 10
SANS 1700-14-9	Fasteners Part 14: Hexagon nuts Section 9: Hexagon nuts for structural bolting, style 1, hot-dip galvanized (oversize tapped) - Product grades A and B - Property classes 5, 6 and 8
SANS 1700-14-10	Fasteners Part 14: Hexagon nuts Section 10: Hexagon nuts for structural bolting with large width across flats, style 1 - Product grade B - Property class 10
SANS 2001-CC1	Construction Works Part CC1: Concrete Works (Structural)
SANS 2001-CC2	Construction Works Part CC2: Concrete Works (Minor Works)
SANS 2001-CS1	Construction works. Structural steelwork
SANS 3575	Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities
SANS 4998	Continuous hot-dip zinc-coated carbon steel sheet of structural quality
SANS 5862-1	Concrete tests - Consistence of freshly mixed concrete - Slump test
SANS 6245	Potential reactivity of aggregates with alkalis (accelerated mortar prism method)

Table 5 : Additional South African Standards

Code	Standard Title
SANS 878	Ready-mixed concrete
SANS 10100	The structural use of concrete Part 2: Materials and execution of work
SANS 10164	The Structural Use Of Masonry
SANS 10400	The Application Of The National Building Regulations
SANS 10237	Roof and side cladding
SANS 10244-1	Steel wire and wire products - Non-ferrous metallic coatings on steel wire Part 1: General principles
SANS 10244-2	Steel wire and wire products - Non-ferrous metallic coatings on steel wire Part 2: Zinc and zinc alloy coatings
SANS 50025-1	Hot-rolled products of structural steel – Part 1
SANS 50025-2	Hot-rolled products of structural steel – Part 2
SANS 50025-3	Hot-rolled products of structural steel – Part 3
SANS 50025-4	Hot-rolled products of structural steel – Part 4
SANS 50025-5	Hot-rolled products of structural steel – Part 5
SANS 50025-6	Hot-rolled products of structural steel – Part 6
SANS 50219-1	Cold formed welded structural hollow sections of non-alloy and fine grain steels : Part 1: Technical delivery conditions
SANS 51008	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete

International standards shall include, but are not necessarily limited to, the following.

Table 6 : International Standards

Code	Standard Title
BS 970 REPLACED	**BS EN 10095:1999** Heat resisting steels and nickel alloys **BS EN 10250-4:2000** Open steel die forgings for general engineering purposes. Stainless steels **BS EN 10085:2001** Nitriding steel. Technical delivery conditions **PD 970:2005** Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels **BS EN 10087:1999** Free cutting steels. Technical delivery conditions for semi-finished products, hot rolled bars and rods **BS EN 10083-1:2006** Steels for quenching and tempering. General technical delivery conditions **BS EN 10084:2008** Case hardening steels. Technical delivery conditions
BS 729 REPLACED	**BS EN ISO 1461:2009** Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

Table 6 : International Standards

Code	Standard Title
ISO 898	**ISO 2936:2014** Assembly tools for screws and nuts -- Hexagon socket screw keys **ISO 4162:2012** Hexagon bolts with flange -- Small series -- Product grade A with driving feature of product grade B **ISO 21670:2014** Fasteners -- Hexagon weld nuts with flange
ASME 9	Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators
ASTM C309	Standard specification for liquid membrane-forming compounds for curing concrete
ETAG 001	Guideline for European Technical Approval of Metal Anchors for use in Concrete
EN 934	Admixtures for concrete, mortar and grout
AWS-1.1	American Welding Society : AWS D1.1 “Structural welding code - Steel”

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 7 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 PROJECT SPECIFICATIONS

5.1 Preamble

These specifications shall be read in conjunction with the Works Information and drawings issued for the various disciplines (i.e. structural, architectural, mechanical and electrical) where applicable, the bill of quantities and any further applicable contract documentation. Any errors, omissions and discrepancies between the drawings and documents shall be brought to the immediate attention of the *Employer* by the *Contractor*.

It remains the responsibility of the *Contractor* to compare the drawings and applicable documentation of the various engineering and architectural disciplines and notify the relevant parties/disciplines of any discrepancies within a reasonable time frame and in writing.

Where conflicting requirements between the Works Information, drawings, specifications, bill of quantities and further applicable contract documentation occur, the drawings and specifications shall take preference over the bill of quantities. The *Contractor* shall inform the *Employer* in writing of any such occurrence.

The *Contractor* shall check all project dimensions, levels and setting out data on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*. No scaling off of drawings is allowed.

The *Contractor* shall confirm all invert levels of connection points to existing services on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*.

Where new construction ties into existing structures, the *Contractor* shall cross check and confirm all critical dimensions and levels related to the existing structures, before any construction or manufacturing commences.

5.2 Scope

The standard specifications on which the *works* in this contract is based are Standards South Africa's Standardized Specifications for Civil Engineering Construction SANS 1200.

In certain clauses the standard, standardised and particular specifications allow a choice to be specified in the project specifications between alternative materials or methods of construction and for additional requirements to be specified to suit a particular Contract. Details of such alternative or additional requirements applicable to this Contract are contained in this part of the project specifications. It also contains additional specifications required for this particular Contract.

The number of each clause and each payment item in this part of the project specifications consists of the prefix PS, followed by a number corresponding to the number of the relevant clause or payment item in the standard specifications. The number of a new clause or payment item, which does not form part of a clause or a payment item in the standard specifications and is included here, is also prefixed by PS followed by a new number. The new numbers follow on the last clause or item number used in the relevant section of the standard specifications.

5.3 PSG : Concrete (Structural)

5.3.1 PSG-1 : Scope

Add the following:

"These specifications cover the construction of reinforced concrete *works* to Substation M, Substation N, Main Intake Substation and Main Intake Substation Equipment Yard"

5.3.2 PSG-2 : Interpretations

PSG-2.1 : Supporting Specifications

Add the following:

"Plain and reinforced concrete shall comply with SABS 1200 G, with supplementary requirements as contained herein. In addition, the following specifications shall apply where relevant or referenced:

SANS 1083	:	Aggregates from natural sources - Aggregates for concrete
SANS 1200 D	:	Earthworks
SANS 1200 HA	:	Structural Steelwork (sundry items)
SANS 121 (ISO 1461)	:	Hot dip galvanized coatings on fabricated iron and steel articles Specifications and test methods
Colto	:	Standard Specifications for Road and Bridge Works for State Road Authorities (1998 Edition)
SANS 2001-CC1	:	Construction Works Part CC1: Concrete Works (Structural)
SANS 2001-CC2	:	Construction Works Part CC2: Concrete Works (Minor Works)"

5.3.3 PSG-3 : Materials

PSG-3.1 : Approval of Materials

Add the following:

"The *Contractor* shall submit for approval by the *Employer* samples and test results for aggregates. For aggregates sourced from commercial sources, the *Contractor* shall provide historical records of grading and other test results, covering the preceding 6 months. A statistical analysis of the means and variations per sieve size and test property shall also be provided.

The *Contractor* shall also furnish a sample of the water intended for use in the concrete mixes. Reference is made to the requirements of PSG-3.3 and PSG-3.4 below.

The samples shall be submitted at least eight weeks prior to commencement of concrete *works*, to enable testing and checking by independent laboratories."

PSG-3.2 : Cement

PSG-3.2.1 : Applicable Specifications

Add the following at the end of this clause:

"The standard cement and extender specifications shall be as follows:

SANS 50197-1	:	Cement Part 1: Composition, specifications and conformity criteria for common cements
SANS 50197-2	:	Cement Part 2: Conformity evaluation
SANS 1491-1	:	Portland Cement Extenders Part 1: Ground granulated blast-furnace slag
SANS 1491-2	:	Portland Cement Extenders Part 2: Fly ash
SANS 1491-3	:	Portland Cement Extenders Part 3: Silica fume
SANS 50413	:	Masonry cement"

PSG-3.2.2 : Alternative Types of Cement

Add the following sub-clauses:

"PSG-3.2.2.1 : Ground Granulated Corex Slag (GGCS) Cement

Watertight concrete with Ground Granulated Corex slag (GGCS) cement may be produced on Site by :

i. Blending 81% CEM III A-S 42,5 (PPC W.Cape Surebuild) and 19% Ground Granulated Corex slag (GGCS)
ii. Blending 50% CEM II A-L 52,5 (PPC W.Cape OPC) and 50% Ground Granulated Corex slag (GGCS)
iii. Blending 50% CEM I (42.5N or greater) and 50% Ground Granulated Corex slag (GGCS).

If aggregates to be used in this contract are alkali-reactive, the total alkali content of the concrete shall not exceed 2.1 kg/m^3 for aggregates falling in the rapidly expanding group (e.g. Malmesbury Group metasediments) or 4.0 kg/m^3 for Cape Granite. The *Contractor* shall submit the necessary SANS 6245 test results to prove the above.

Concrete mixes must be determined by means of a proper mix design by an accredited laboratory and must be approved by the *Employer*. Over and above the proportions of the mix, the following information shall also be provided in the mix design report:

i. The type, description and source of fine and coarse aggregate.
ii. Grading analysis and grading graphs of fine and coarse aggregates.
iii. Water demand of fine aggregate, determined in accordance with Colto Clause 8105 (e).
iv. Water absorption values of fine and coarse aggregates.
v. Average crushing values and flakiness index of coarse aggregate.
vi. Petrographic analysis of fine aggregate (see PSG-3.4.1).
vii. Exact composition of the cementitious material in case of a pre-blended cement.
viii. Exact brand name, manufacturer and dosage in mℓ of admixture per 100 kg of cementitious material, accompanied by a data sheet from the manufacturer containing in particular the percentage of Na2O equivalent total alkalis in the admixture.
ix. Workability retention tests (see PSG-3.4.1), if applicable.
x. At least the 3, 7 and 28 day cube test results for all structural concrete mixes.

PSG-3.2.2.2 : Crystalline Waterproofing Additive

All buried and watertight structures and other parts of the *works*, as instructed by the *Employer*, shall incorporate a cementitious crystalline waterproofing additive, such as "Xypex Admix C500NF" or similar approved, which shall be added to the cementitious material at a rate of 1% by mass of the total mass of the cementitious material (minimum dose 3 kg/m^3).

Only one product manufacturer/supplier shall be permitted to supply all the products for the crystalline waterproofing system.

The supplier of the crystalline waterproofing system shall provide documentary evidence that the crystallizing capability of the waterproofing material is evidenced and can be demonstrated by independent Scanning Electron Microscope photographs, showing the penetration of crystal-forming waterproofing material to a minimum depth of 50mm, measured relative to the surface of product application.

The product manufacturer/supplier shall have immediate local access to the full product range, including Crystalline Waterproofing additive (Xypex Admix C-500NF or similar), Crystalline Coating (Xypex Concentrate or similar), Crystalline Reinforced Coating (Xypex Modified or similar), Fast-setting, non-shrink Crystalline Patching and Resurfacing compound (Xypex Patch 'n Plug or similar) and Crystalline-based Thick Repair Mortar (Xypex Megamix 2 or similar)."

PSG-3.2.3 : Storage of cement

Add the following:

"It is of prime importance that the cement to be used is always stored in a cool environment. Cement silos shall therefore be painted white to reduce temperature rises in the stored cement.

The sides and tops of silos shall be insulated with 4 mm Alucushion double sided aluminium foil insulation, which shall be wrapped around silos and kept in position with galvanized steel hoop straps. Alucushion shall overlap by at least 100 mm at joints."

PSG-3.3 : Water

Add the following:

"All mixing water for concrete *works* shall fully comply with SANS 51008. To limit heat gain in watertight concrete, the temperature of mixing water must be below 20^{o} C when added to the concrete mix.

The sides and tops of water tanks for mixing water, including pipework leading to and from tanks, shall be insulated with 4 mm Alucushion double sided aluminium foil insulation, which shall be wrapped around silos and kept in position with galvanized steel hoop straps. Alucushion shall overlap by at least 100 mm at joints."

PSG-3.4 : Aggregates

PSG-3.4.1 : Applicable Specifications

Add the following:

"The aggregates shall comply with the requirements of SANS 1083. The maximum water absorption of both the fine and coarse aggregate shall not exceed 0.5 % each and the combined water absorption of fine and course aggregate shall not exceed 0.75% total.

The flakiness index of coarse aggregate shall not exceed 30. The maximum water demand of the fine aggregate shall be 190 ℓ/m^3. The fineness modulus (FM) of fine aggregate shall be 2.1 to 2.8. Coarse aggregate shall comply with the 10% FACT values specified for aggregate used in concrete subject to abrasion and minimum 150kN (dry). The 10% FACT wet to dry ratio shall be 0.70 minimum.

In addition to SANS 1083, the grading of fine aggregate shall comply with the requirements in the table below. If the *Contractor* proposes to use sand which complies with the prescribed grading of Table 1 of SANS 1083, he shall prove to the satisfaction of the *Employer* that the concrete produced will comply with the specifications.

Table 8 : Grading Requirements for Fine Aggregate

Sieve size (mm)	Cumulative % passing	
4,75	90-100	
2,36	75-100	
1,18	60-90	
0,60	40-60	
0,30	20-40	
0,15	10-20	
0,075	Natural sand 5-10	Crusher sand 5-20

Workability retention tests on the proposed mix design(s) shall be conducted by an accredited laboratory by measuring the slump of the mix at 15 minute intervals, starting immediately after mixing and extending over a period of 1½ h after mixing.

Petrographic analysis shall be conducted on natural sands to determine the presence of deleterious minerals (smectite, etc.), which may have a negative impact on workability of the fresh concrete or may be detrimental to the hardened concrete.

Fine aggregate shall contain more than 20% quartz by mass. The acid insolubility of fine aggregate, determined in accordance with Colto Clause 8105 (b), shall not exceed 40%. Aggregates shall be tested in accordance with SANS 6245 to determine whether they are potentially alkali-reactive. If they are alkali-reactive they shall either be replaced with aggregates that are non-reactive or the requirements of PSG-3.2.2.1 in respect of alkali-reactiveness shall apply.

The content of chloride ions in the aggregates shall be determined and shall be within the limits specified in SANS 1083. Test results shall be submitted to the *Employer*.

At tender stage the *Contractor* shall assure himself by means of tests and test mixes by an accredited laboratory that the fine and coarse aggregates that he intends to use comply with the specification. The *Contractor* shall be responsible for locating the sources of all aggregates. Coarse aggregates from the Table Mountain Group orthoquartzite shall not be used.

The tendered rates shall be deemed to allow for the importation of aggregates, if necessary, to comply with the specification."

PSG-3.4.3 : Storage of Aggregates

Add the following sub-clause:

"PSG-3.4.3.c) : the aggregate to be used shall at all times be stored in a cool environment and, if at time of mixing, the ambient temperature exceeds 30°C, only the coarse aggregate shall be sprayed with water to assist cooling by evaporation. All coarse- and fine- aggregate stockpiles shall be shaded from the sun by means of 80% shade netting.

The *Contractor* shall ensure adequate drainage of the coarse aggregate stockpile.

Aggregates exposed to a marine environment shall be covered to protect them from salt contamination."

PSG-3.5 : Admixtures

PSG-3.5.1 : Approval of Admixtures Required

Add the following sub-clause:

"PSG-3.5.1.1 : All proposed concrete admixtures shall fully comply with the latest revisions of ASTM C309 or EN 934 Parts 1 & 2."

PSG-3.5.2 : Air-Entraining Agents

Replace this sub-clause with the following:

"Air-entraining agents shall not be used."

PSG-3.6 : Reinforcement

Add the following:

"Reinforcing bars shall comply with the requirements of SANS 920 and satisfy the following:

Y-bars to have a minimum characteristic strength of fy = 450 MPa
R-bars to have a minimum characteristic strength of fy = 250 MPa"

5.3.4 PSG-4 : Plant

PSG-4.3 : Mixing Plant

PSG-4.3.1 : General Requirements for Mixing Plant

Add the following:

"On-Site mixing plants may be approved by the *Employer* only if the plant capacity exceeds 400 m^3 of concrete per day. The *Contractor* shall provide standby plant capacity and all necessary equipment to ensure that the maximum required daily production can be placed without interruption or delay."

Add the following sub-clauses:

"PSG-4.3.3 : Ready Mix Concrete (Should the *Contractor* Choose to Use Ready Mix Concrete)

The *Contractor* may choose to use ready-mixed concrete, subject to the prior approval by the *Employer*. Ready-mix concrete shall be mixed in accordance with the requirements of SANS 878.

The ready mix plant supplier shall be a South African Ready Mix Association (SARMA) member in good standing and have passed the latest round of SARMA audits.

Ready-mixed concrete shall not be delivered to Site before the *Contractor* has furnished the *Employer* with a copy of his order to supplier, in which he has included the following:

i. The target compressive strength of concrete at 28 days.
ii. The nominal maximum size of aggregate.
iii. The type of cement and extenders.
iv. The required slump at the point of delivery, being the Site.
v. An instruction to the supplier to provide details of the admixture he proposes to use, if applicable.
vi. The details/information provided shall be in accordance with the requirements of SANS 1200 G:3.5.1 - Concrete (Structural).

The *Contractor* shall have delivered, with each truck load of ready-mixed concrete, a delivery note from the supplier, on which the following information is noted.

i. The compressive strength of the mix.
ii. The slump.
iii. The date and time at which the mixing of the batch was commenced.
iv. The time of delivery.
v. The quantity of concrete supplied.
vi. Identify part of structure for which the concrete mix was used.

These delivery notes are to be kept on Site and shall be available for inspection at any time. Reference is made also to Clause PSG-5.5.3.2.

PSG-4.3.4 : Batching Plant (Should the *Contractor* Choose to Site Batch Concrete)

Batching on Site will be considered only if the plant is exclusively dedicated to the Site. The plant capacity shall be designed to meet all requirements of the *Contractor*s construction programme.

Use of additional external commercial sources for concrete supply will only be considered in extreme, critical and exceptional cases, provided that the mix design and all constituents are in accordance with the approved Site batched concrete.

Weigh batch plants shall be fully computerised and incorporate automated systems. The batching system shall provide computer-generated records, traceable to a load, materials used, quantity batched and placement location.

Cement and extender silo fill lines shall incorporate dedicated adapters, to prevent direct connection to standard tanker couplings. Each extender type shall incorporate differential couplings to their respective silos. All silo fill lines shall be locked and labelled.

All silos shall be painted white with solar reflective paint to reduce temperature of the contained cementitious material.

Water storage tanks shall be painted white and shall, as far as possible, be shaded on all sides from direct radiation from the sun or covered with 4 mm Alucushion double sided aluminium foil insulation.

Aggregate stockpiles shall, as far as this is possible, be shaded on all sides from direct radiation from the sun.

Adequate drainage shall be provided in and around the plant to accommodate and control all water from washing, run-off and rain."

PSG-4.5 : Formwork

PSG-4.5.1 : Design

Add the following:

"The *Contractor* shall appoint a suitably qualified and experienced Professional Engineer or Professional Technologist, registered with the Engineering Council of South Africa, to design all formwork and support *works*. The *Employer* is to be contacted if any loading requirements are unclear.

Formwork layout drawings prepared by the competent person are to be kept on Site for inspection at any time."

PSG-4.5.2 : Finish

Add the following:

"The quality of the formwork shall be in accordance with PSG-5.2.1."

PSG-4.5.3 : Ties

Add the following:

"Formwork ties in all structures shall be Form-scaff (or approved equivalent) continuous 12 mm extended coil tie type. No ferrules or ferrule pipes may be used in structural elements of watertight structures. The *Contractor* shall allow in his rates for the specified formwork ties and ensure that his formwork is compatible with these ties. The minimum cover to all ties shall be 25 mm. Plastic cones shall have 30 mm depth for use with the extended coil ties.

After removal of the plastic spacing cones of the extended coil ties from the concrete, the openings in the concrete shall be roughened with a mechanical wire brush. Thereafter the openings shall be painted with Xypex Concentrate slurry coat and filled with Xypex Megamix 2 (dry) / Patch 'n Plug (wet), or approved equivalent. Alternatively, only dry openings shall be painted with cement mortar and filled with a non-shrink grout such as "Sikagrout 212" or an approved equivalent. The grout filling shall be applied in such a way as to protect the ties against corrosion and ensure watertightness of the element.

Xypex materials and proprietary grout, or approved equivalent, shall be applied in accordance with the manufacturer's specifications and method statements."

5.3.5 PSG-5 : Construction

PSG-5.1 : Reinforcement

PSG-5.1.1 : Bending

Replace sub-clause PSG-5.1.1.1 with the following:

"PSG-5.1.1.1 : Bending of reinforcement shall be in accordance with SANS 282."

Replace sub-clause PSG-5.1.1.4 with the following:

"PSG-5.1.1.4 : No heat treatment, welding or cutting of steel without the written approval of the *Employer* shall be allowed."

Add the following sub-clause:

"PSG-5.1.1.5 : Should starter bars move during a preceding cast, they may not be bent back into position. The *Employer* is to be informed in writing and the supporting correspondence shall include sufficient photographs to identify the problem. Remedial measures shall be proposed by the *Contractor*, to be approved by the *Employer*."

PSG-5.1.2 : Fixing

Add the following sub-clauses:

"PSG-5.1.2.1 : No reinforcing may be cut without written approval from the *Employer*.

PSG-5.1.2.2 : The *Contractor* shall inspect and approve the fixed reinforcement before the *Employer* is notified of a required inspection. The *Employer* is to be notified in writing at least 24-hours in advance for the required inspection. All reinforcement shall be inspected and approved by the *Employer* before casting of concrete may commence.

PSG-5.1.2.3 : No slab will be inspected unless the reinforcing and cables (if present) have been fully fixed, all other services have been installed and the *works* area has been cleaned properly.

PSG-5.1.2.4 : Bend-out bars at construction joints shall be bent out with a suitable pipe so that no kink is formed in the bar."

PSG-5.1.3 : Cover

Replace PSG-5.1.3 with the following:

"PSG-5.1.3 : Minimum concrete cover to reinforcing shall be as follows:

Table 9 : Minimum Cover

Concrete Structure	Cover (mm)
Foundations cast against soil	75
Foundation cast against blinding	50
Columns (internal)	50
Columns (exposed)	50
Beams	50
Slabs	50
Retaining walls	50 mm non-fill side / 75 mm cut-fill side
Surface Beds	As per drawing

No tie-wire shall encroach on the specified minimum cover by more than a strand thickness. No plastic cover-blocks or spacers shall be permitted.

Pre-manufactured, high strength fibre-cement microconcrete spacers, as supplied by Joluka or equivalent, require approval by the *Employer* and shall only be permitted if galvanized tie wires (Class A in accordance with SANS 675) are used in all instances.

Concrete cover blocks shall be manufactured in accordance with the requirements of SANS 10100 Part 2 (8.4.1.2). Fixing wire shall be fully galvanised Class A in accordance with SANS 675. Blocks shall be fully cured in water for 14 days before use. Refer to SANS 10400 for minimum spacing of cover blocks."

PSG-5.1.4 : Splicing:

Add the following:

"Splice lengths in the case of all structures shall not be less than 50 x diameters. Where applicable, splices shall be staggered so that they are evenly spread throughout the structure."

PSG-5.2 : Formwork

PSG-5.2.1 : Classification of Finishes

Add the following:

"Formwork for all classes of finish shall be made of steel panels. High density polystyrene backing is required when 'Plain steel formwork' is used in cold weather (i.e. < 5ºC). The panels shall be free from rust, ridges, fins, bulges, imperfections, irregularities, chips and holes.

Small, approved laminated wooden board inserts to steel framed panels may only be used in confined places and the use thereof will be subject to approval by the *Employer*. New timber formwork may only be used, following the *Employer*s approval. The new timber formwork not coated with epoxy or similar finishing material is to be treated with cement slurry before the first use and to be cleaned and sprayed/painted with release agent at least twice.

Grout checks shall be used at all construction joints and chamfers at all corners.

Joints between panels shall be sealed tightly to prevent local honeycombing, grout loss or leaching of concrete. Joints between panels shall form straight, horizontal and vertical lines which shall be spaced evenly on the formed concrete surface, and shall be even and smooth, requiring minimal or no finishing. The layout of all formwork panels and construction joints shall be discussed with the *Employer* before application and shall be approved in writing prior to erection of formwork.

Replace sub-clauses PSG-5.2.1.a), PSG-5.2.1.b) and PSG-5.2.1.c) with the following:

"PSG-5.2.1.a) Rough: All unexposed concrete surfaces. Permissible deviation: Degree of Accuracy II for formwork as per SANS 1200G clause 6.2.

PSG-5.2.1.b) Smooth: All exposed/visible concrete surfaces shall be as per PSG-5.2.1 (c).

PSG-5.2.1.c) Special: All exposed/visible concrete surfaces shall be smooth-special formwork as per Table 1 - Surface Finishes of Formed Surfaces : SANS 2001-CC1: 2012. A surface using steel forms shall have a Degree of Accuracy II with permissible deviation for formwork as per SANS 1200 G Clause 6.2.

Concrete surfaces shall be smooth and completely rubbed or treated to form a finish of uniform texture, appearance and colour. The concrete surface shall be free of irregularities, bulges, ridges, imperfections, air bubbles, honeycomb or surface discolorations.

Only proven release agents, that leave no spots on the concrete, may be used. All release agents shall be used strictly as specified by the relevant manufacturer. Chemical compatibility of the release agent with concrete admixtures shall be verified before the commencement of construction *works*.

Reinforcement may not be soiled by the release agents. Timber formwork shall be treated with release agent in such good time, so that it has fully penetrated into the timber before the reinforcement is fixed."

PSG-5.2.5 : Removal of formwork

Replace subclause PSG-5.2.5.2 with the following:

"PSG-5.2.5.2 : Stripping times of shuttering and propping shall be in accordance with Clauses 4.3.8 and Table 2 : SANS 2001-CC1. If formwork is retained as a curing measure, it shall remain in place for a minimum of 5 days in summer, 8 days in windy conditions and 10 days in winter, or as specified by the *Employer*.

No brick or block walls are to be built on floor slabs before the slabs have reached their 14-day strengths. Propping underneath slabs and beams shall be completely removed before brickwork is built. All bricks required for brick walls on a specific slab panel shall be stacked evenly onto the slab panel before walls are being built."

Add the following sub-clauses:

"PSG-5.2.5.6 : The following elements or parts of the structure are to remain fully propped until the required 28 day characteristic (design) concrete strength has been reached:

i. Beams.
ii. Cantilevers.
iii. Slabs supporting hanging structures (Note that the portions being suspended cannot support the floor directly above).

Formwork/propping designs shall take account of any loads imposed on the propped structure.

When full-height concrete walls are cast on slabs or beams, they are to be fully propped until the wall and slab have reached their 28 day characteristic (design) strengths.

PSG-5.2.5.7 : Designs and method statements for back-propping shall be submitted to the *Employer* for approval."

PSG-5.4 : Pipes and Conduits

Add the following:

"The *Contractor* shall employ suitable fire stopping methods wherever deemed necessary in terms of these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer*'s specifications or any other applicable standards and documents related to the *works*.

All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and approved standards. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localised and contained and not propagate via any electrical and/or electronic infrastructure. The *Contractor* shall fully comply with these requirements."

PSG-5.5 : Concrete

PSG-5.5.1 : Quality

PSG-5.5.1.1 : General

Add the following:

"All casting procedures, construction methods and positions of construction joints shall be submitted to the *Employer* eight weeks prior to the commencement of any concrete placement.

The *Contractor* shall review and make allowance for all services drawings for details and positions of openings and sleeves required for storm water, sewerage, drainage, electrical, mechanical and other services. Any discrepancies shall be brought to the attention of the *Employer*.

The *Contractor* shall obtain approval from the *Employer* before any openings or services, which are not indicated on the drawings, may be introduced within any structural element or near to any column (within a radius of 5 x the slab thickness).

Penetrations less than 150 mm in diameter or square will not be indicated on the drawings. These penetrations are to be coordinated with the drawings showing the relevant services. Penetrations not indicated on drawings may not be introduced within a distance of 4 (four) times the slab depth from any column.

No chasing of services into concrete elements is allowed."

PSG-5.5.1.3 : Workability

Add the following:

"The consistency of concrete in the fresh state shall be determined using the slump test in accordance with SANS 5862-1. The workability range (slump) for all (except pumped) concrete shall be between minimum 75mm and maximum 125mm. The workability range (slump) for all pumped concrete shall be minimum 125mm and maximum 175mm."

PSG-5.5.1.5 : Durability

Replace PSG-5.5.1.5 with the following:

"All concrete mixes are to be designed by a specialist SANAS-accredited laboratory or ready-mix supplier and forwarded to the *Employer* for approval.

The maximum water/binder ratio and minimum cement content shall be as indicated in the table below.

The binder, except for the 15 MPa blinding mix, shall comply with the requirement of PSG 3.2.2.1 : Ground Granulated Corex Slag cement.

The 15 MPa blinding mix may contain binders consisting of 100% CEM I (42,5 or greater), 100% CEM II A-L 52.5 (PPC W.Cape OPC) or 100% CEM III A-S 42,5 (PPC W.Cape Surebuild)."

Table 10 : Maximum Water to Binder Ratio and Maximum Binder Content

Item	Max. water to binder ratio	Min. binder content (kg/m^3)
Retaining Wall Foundations, Retaining Walls, External Walls & Raft Foundations	0.50	350
Columns & Internal Walls	0.50	350
Surface Beds	0.45	350
Ground Floor Slabs, Suspended Slabs, Beams & Stairs	0.55	320
Mass Concrete	0.63	260
Blinding	n.a	n.a

PSG-5.5.1.7 : Strength Concrete

Add the following:

"The minimum cube strengths shall be as shown in the table below.

Table 11 : Minimum Cube Strengths

Item	Cube strength (28-day, MPa) (Min)	Aggregate size & type
Retaining Wall Foundations, Retaining Walls, External Walls & Raft Foundations	40	19mm Granite or 19mm Greywacke
Columns & Internal Walls	40	19mm Granite or 19mm Greywacke
Ground Floor Slabs, Suspended Slabs, Beams & Stairs	40	19mm Granite or 19mm Greywacke
Surface Beds	40	19mm Granite or 19mm Greywacke
Mass Concrete	30	19mm Granite or 19mm Greywacke
Blinding	15	19mm Granite or 19mm Greywacke

Add the following sub-clause:

"PSG-5.5.1.8 : Blinding

A 50 mm thick blinding layer of 15 MPa / 19 mm shall be cast under all reinforced foundations, as approved by the *Employer*. No blinding layer needs to be cast for unreinforced brickwork and mass concrete foundations, but these excavation surfaces require approval by the *Employer*.

No foundation or ground beam shall be cast on non-engineered fill.

Portions that are over-excavated beyond the depth required by the *Employer* or as indicated on the drawings are to be filled with mass concrete at the *Contractor*'s expense."

PSG-5.5.3 : Mixing

PSG-5.5.3.2 : Ready-mixed concrete

Replace PSG-5.5.3.2 with the following:

"The use of ready-mixed concrete for this contract shall be permitted, provided that it complies with the requirements of this specification. Test results obtained by such a production facility shall not be regarded as part of the quality control system. The *Contractor* shall take his own samples of concrete on Site and have them tested in accordance with Clause 7 of SANS 1200 G and Clause PSG-7.1.2.

Reference is made also to PSG-4.3.3."

PSG-5.5.5 : Placing

Add the following to sub-clause 5.5.5.1:

"PSG-5.5.5.1 : The *Contractor* shall give the *Employer* at least 48 hours' notice of his intention to cast concrete."

Replace sub-clause 5.5.5.5 with the following:

"PSG-5.5.5.5 : Concrete for any structures shall not be allowed to fall freely through a height of more than 2.0 m. The use of tremie or similar concrete handling equipment shall be used to ensure that the risk of wet concrete segregating is minimised at all times. When chutes are utilized to cast concrete, they shall incorporate baffles and spouts to minimize segregation."

Add the following sub-clauses:

"PSG-5.5.5.10 : During summer months, when maximum ambient temperatures exceed 25^{o}C, concreting shall start as early as possible in the mornings, but not later than 07h00. Pouring shall, as far as possible, be confined to the cooler parts of the day.

All steel-lined concrete mixer and transport vehicles (ready mix trucks) shall be cooled by the application of sufficient running water to the outside of the steel mixing drum surfaces for a continuous period of 5 minutes during the mixing process at the batchplant (including readymix operations) and again at the point of concrete discharge, if more than 20 minutes has elapsed since the initial treatment.

The *Contractor* shall provide appropriate hard standing areas with appropriate drainage and stormwater management facilities near all concrete discharge points, to facilitate the cooling of steel lined mixing drums of all concrete mixer and transport vehicles.

All concrete shall only be discharged if the temperature of the mixture is below 30^{o}C. In all instances where the temperature of concrete mixtures exceeds 30^{o}C, liquid nitrogen shall be directly injected into the mixer or transport vehicle until the concrete mixture reaches 20^{o}C, provided not more than 2 hours have elapsed since the addition of mixing water into the concrete mixer.

Concrete mixtures delivered in excess of 30^{o}C or more than two hours after the addition of mixing water to the concrete shall be rejected. During winter months, when minimum ambient temperatures are below 5^{o}C, concreting shall start towards mid-morning and only when a raising trend in ambient temperature is projected. The tendered rates shall be deemed to make adequate provisions for these requirements.

PSG-5.5.5.11 : All foundations shall be placed symmetrically below columns and brickwork, unless otherwise shown.

PSG-5.5.5.12 : Kickers shall have a minimum height of 150mm. Kickers shall be properly compacted, set, and cured as watertight concrete members. Raking of fresh concrete to form a rough surface shall not be permitted.

The surface of the kickers shall have a profile depth of between 6mm to 10mm, to be achieved by using a combination of wire brushing, water jetting within 24 hours of casting and light sandblasting techniques, to clearly expose the points of the coarse aggregates embedded in sound concrete and the partially exposed fine aggregates. The prepared surfaces shall be entirely free of cracks, spalling, damage, laitance, loose debris, concrete slush and any other form of contamination.

Scabbling, using light chipping hammers or similar mechanical techniques, as well as acid etching, shall not be permitted, as this may damage the bond line and compromise water tightness of the structure.

After the satisfactory preparation of the kicker surface, and following approval by the *Employer*, the surface shall be saturated with fresh, clean water for a period of at least 4 hours."

PSG-5.5.7 : Construction Joints

Add the following to subclause 5.5.7.1:

"PSG-5.5.7.1 : Before construction *works* commence the *Contractor* shall indicate on the drawings his proposal for positioning construction joints and submit these to the *Employer* for his comment and approval."

Replace clause 5.5.7.3 with the following:

"PSG-5.5.7.3 : Construction joints in all structures shall be as in sub-clause a) hereafter."

PSG-5.5.7.3.a) : Construction joints in all structures:

1. General Methods

Depending on the weather conditions and as instructed by the *Employer*, all construction joints surfaces of the concrete shall be roughened to have a profile of between 6 mm to 10 mm, using a combination of wire brushing, water jetting (water jetting only if deemed necessary by the *Employer*) within 24 hours of casting and light sandblasting techniques to clearly expose the points of coarse aggregate embedded within sound concrete and to partially expose fine aggregate particles. Subsequent concrete operations shall be completed before the first cast reaches the age of 24 hours.

Scabbling, using light chipping hammers or similar mechanical techniques, as well as acid etching, shall not be permitted, as this may damage the bond line.

PSG-5.5.8 : Curing and Protection

Replace sub-clause PSG-5.5.8 with the following:

"PSG-5.5.8.a) : General

In adverse weather conditions (refer PSG-5.5.9), in windy conditions (with intermittent wind gusts exceeding 35 km/h) and during periods of low ambient relative humidity (relative humidity is below 75%), the *Contractor* shall be required to protect the area to receive concrete. These protection measures shall be in place during the final pre-concreting inspections and shall continue until all curing measures have been fully implemented.

Protection measures shall include, but are not limited to, the following, to be applied individually or in combination with each other:

i. Use of high pressure water jetting machines sprayed into the air or irrigation mist-type sprayers to locally modify the ambient relative humidity.
ii. Erect sturdy screens to deflect and limit wind passing through the concreting area.
iii. Erection of solar screening to provide shade on the formwork and general concreting area.
iv. Other acceptable Site-developed methods to limit wind speed and direct solar exposure, to increase the relative humidity of the immediate ambient environment.

The *Contractor* shall ensure that concrete in the fresh state is not exposed to excessive thermal, humidity or wind fluctuations during the first 5 days after casting. Precautionary measures shall be taken by the *Contractor* during extreme hot, cold, dry or windy weather. One or more curing and protection measures may be applied to effectively counter the prevailing environmental risk(s).

Curing shall effectively promote and maintain the adequate hydration of the cementitious binder system to ensure the adequate development of the desired mechanical and durability properties of concrete in place. Curing shall be executed in such a manner as not to cause staining, contamination or marring of the surface of the concrete.

The *Contractor* shall take all necessary precautions to prevent water used for curing from penetrating adjacent structures, adjacent work areas and the soil beneath the structure.

Drainage shall be provided to prevent water ponding and to prevent curing water affecting other parts of the *works*. The required method of curing shall be by water, unless the temperature falls below 5°C. For temperatures below 5°C, a combination of curing compound, thermal insulating blankets and heavy-duty DPM shall be used, as approved by the *Employer*.

All costs for curing and protection shall be allowed for in the tendered rates and prices.

PSG-5.5.8.b) : Curing period

The curing period, based on prevailing ambient temperatures, is indicated in the table below.

Table 12 : Minimum Curing Period

Strength class of cement	Minimum Curing period, days		
	Ambient temperature		
	Higher than 20°C	20°C to 5°C	5°C and lower
CEM II, CEM III, CEM IV, CEMV and blends of CEM I with more than 20% slag or fly ash.	7	10	15

In windy conditions (gusts exceeding 35km/h) or periods of low ambient humidity (RH < 75%), the curing period shall be extended by 3 days.

PSG-5.5.8.c) : Floor slabs, beams and wall footings where concrete thickness equals or exceeds 600 mm
Curing shall be by covering the floor slabs and wall footings with a 75 mm thick polystyrene layer and flooding the surface area with water to a minimum depth of 50 mm. The minimum water depth shall be maintained at all times.

The water and polystyrene layer shall be applied after the specified surface finishing has been completed and the concrete has gained sufficient strength to prevent any damage to the surface, but not more than 24 hours after the concrete has been cast.
PSG-5.5.8.d) : Slabs, beams and stairs where the concrete thickness is less than 600 mm

Suspended slabs and stairs shall be cured by covering with mats of moisture-retaining materials. The mats shall be kept continuously moist and shall be placed after surface finishing has been completed and the concrete has gained sufficient strength to prevent any damage to the surface. The mats shall in no instance be placed later than 24 hours after the concrete has been cast. Moisture shall be delivered by irrigation type mist spraying system described in clause PSG-5.5.8.f) below.

PSG-5.5.8.e) : Walls and columns

Sides of walls and columns shall be kept moist by means of an irrigation-type mist spraying system, as specified in clause PSG-5.5.8.f) below, together with mats of moisture-retaining materials. Sprayers shall be spaced at such intervals to ensure that the whole concrete face is wetted. The overlaps of moisture-retaining materials shall be fastened at the top and secured to prevent them from flapping in windy conditions.

Curing shall commence the day after concrete has been cast and shall continue for the number of days as specified above. If formwork is to remain in position (e.g. to support subsequent lifts), it shall be loosened as soon as the concrete has gained sufficient strength (usually within a day) to allow curing water to thoroughly wet the surfaces of the concrete.

PSG-5.5.8.f) : Irrigation type mist spraying system

Irrigation-type mist spraying systems shall be controlled by an automatic, programmable timer, which can activate the system for any chosen time periods and intervals, such that curing will be continuous over week-ends, public holidays and builder's holidays. Sprayers shall be spaced at such intervals as to ensure that the whole area of concrete is wetted.

The design of the system shall be submitted to the *Employer* for approval. Should the existing water pressure on Site be insufficient, a pump shall be installed to operate the mist spraying system.

The duration of water application and the intervals of application shall be such as to prevent the concrete from drying out. Allowances shall be made for adverse conditions, such as high temperatures and/or dry, windy conditions, subject to approval and further instructions by the *Employer*.

PSG-5.5.8.g) : Plastic sheets and tubes

Plastic sheets and tubes used for curing shall be waterproof and shall cover every portion of concrete to be cured. Sheeting shall be white or light-coloured. Black or other dark coloured plastic sheets are not permitted. Sheets and tubes shall be held down or fixed securely to the elements being cured. Joints in sheets shall be firmly taped to prevent loss of moisture from the concrete. Care shall be exercised to prevent staining of any exposed concrete.

Plastic sheets shall be puncture-free tarpaulin or heavy-duty DPM – 500micron puncture-free, providing an impervious covering for the minimum number of days specified in paragraph (b) above.

The above-mentioned curing method shall be used in conjunction with the irrigation-type mist spraying system, wherever possible."

PSG-5.5.10 : Concrete surfaces

Replace sub-clause PSG-5.5.10.2 with the following:

"PSG-5.5.10.2 : When a wood-floated finish is specified, the surface shall first be treated as follows:

i. Immediately after placing and compaction, the concrete shall be screeded with true straight edged equipment, working between forms or other guides set accurately to line and level.
ii. No mortar shall be added to depressions and proud aggregate shall be tamped level.
iii. After the concrete has hardened sufficiently, it shall be floated to a uniform surface free from trowel marks with a wooden float.
iv. Within 2hrs of final set curing of the concrete shall commence.

When a steel-floated finish is specified, the surface shall be treated as specified for a wood-floated finish above. In addition the following is to be done:

i. When the bleed water has disappeared and the concrete has hardened sufficiently to prevent the migration of laitance foam to the surface, the levelled surface shall be floated with a steel trowel.
ii. Firm, uniform pressure shall be applied to provide a dense, smooth, uniform surface free from any irregularities.

When a power-floated finish is specified, the surface shall be treated as specified for a wood-floated finish above. In addition the following is to be done:

i. The levelled concrete surface shall be power-floated to provide a dense surface.
ii. After the bleed water has disappeared and the concrete has hardened sufficiently, the float-blades shall be replaced with trowel-blades.
iii. The surface will be power-trowelled with a single pass to provide a dense, smooth, uniform surface free from irregularities.

When a power-trowelled finish is specified, the surface shall be treated as specified for power-floated finish above. In addition the following is to be done:

i. After fitting the trowel-blades the surface shall be continually burnished to provide a dense, smooth, high quality polished surface free from any irregularities."

PSG-5.5.13 : Grouting

Add the following to sub-clause PSG-5.5.13:

"The following grouts, or approved equivalents, certified as per ETAG 001, may be used for dowel bars. Grouts shall be used strictly in accordance with the manufacturers' specifications:

Y10 up to Y16 bars (u.n.o.)	Fischer FIS-V
	Hilti HIT-HY 200
Y20 up to Y40 bars (u.n.o.)	Fischer FIS-EM
	HILTI HIT-RE 500
Moist substrate (u.n.o.)	Fischer FIS-EM
plus cored holes	Hilti HIT-RE 500

Should the *Contractor* wish to use an alternative product, full details shall be provided to the *Employer* for review and approval. The information to be provided shall include valid European Technical Approval (ETA) certification in accordance with ETAG 001 for installing reinforcement in cracked concrete for the intended use of the anchor."

PSG-5.5.14 : Defects

Delete Clause PSG-5.5.14.1 and replace with the following:

"PSG-5.5.14.1 : The concrete shall be homogeneous and free of honeycombing, interstices and planes of weakness. If, after the removal of forms, the concrete has any defects, the *Contractor* shall immediately report such defects to the *Employer*. The *Contractor* shall not carry out any patching or remedial *works* until authorized by the *Employer*."

Delete Clause PSG-5.5.14.2 and replace with the following:

"PSG-5.5.14.2 : After thorough inspection and investigation of quality and strength of the defective works, and after due consideration of the possible consequences of such defect, the *Employer* will either specify the extent and method of repair or order the demolition and reconstruction of the whole of the defective *works* to the extent that he considers necessary.

The cost of all such investigation, repair and remedial *works* and any demolition and reconstruction of the defective *works* shall be borne by the *Contractor* and all repair, remedial and reconstruction *works* shall be executed to the satisfaction of the *Employer*.

The method of repair of defects in dry concrete shall be by first applying an approved cement-based, epoxy-modified anti-corrosion and bonding agent like SikaTop-Armatec110 EpoCem, or approved equivalent, to the prepared surface, followed by an approved repair mortar (SikaMonoTop 612 or approved equivalent), a one component polymer modified repair mortar containing silica fume and synthetic reinforcement fibres supplied by Sika (or approved equivalent).

Where defects present wet or damp surfaces, a combination of Xypex "Patch 'n Plug", to arrest surface water flow, Xypex Concentrate as a slurry primer and Xypex Megamix 2 repair mortar shall be used. Alternative, equivalent products will be considered, subject to approval by the *Employer*.
Products shall be applied strictly in accordance with the manufacturer's specification or such other methods as may be approved to the *Employer*.

All repair materials shall be equivalent to the surrounding concrete in respect of thermal and structural properties. Such repairs will only be allowed after the defects were inspected by the *Employer* and approval of the method of repair has been given."

Add the following sub-clause:

"PSG-5.5.16 : Monitoring of Temperatures

The *Contractor* shall monitor and record the following for each batch of concrete on a form to be provided by the *Employer*, to ensure compliance with the specifications:

- Date and time of casting.
- Structural element and description of pour.
- Daily maximum and minimum temperatures.
- Ambient temperature at time of casting.

- Relative humidity at point of concreting.
- Wind speed at point of concreting.
- Temperature of mixing water.
- Temperature of concrete on arrival at the point of casting.
- Slump at concrete discharge.

The *Contractor* shall install a Major Tech (011-822 1551) MTD16 digital maximum/minimum thermometer, or similar approved, within a shaded area on Site. The *Contractor* shall furthermore provide and use a Major Tech MT605, or similar approved, digital pen type thermometer to record mixing water and concrete temperatures.

The *Contractor* shall also supply a Major Tech MT947 pocket anemometer to measure wind speed on Site and a Major Tech Mt667 humidity meter to measure humidity on Site."

5.3.6 PSG-6 : Tolerances

PSG-6.1 : Basis of Measurement

PSG-6.1.1 : General

Add the following to sub-clause PSG-6.6.1:

"Allowance has been made in the length of reinforcing for 150 mm high kickers at columns and walls. Kickers shall be cast simultaneous with the same class of concrete as the elements below them and shall be thoroughly compacted and cured.

All columns and walls shall be overcast by 30 mm, i.e. top of cast to be 30 mm above the slab or beam soffit level. The slab/beam soffit level is to be created with a 30 x 20 mm timber strip, fixed inside the shutter to form a rebate. The bottom edge of the rebate is to be at the beam/slab soffit level. The portion of excess concrete above the rebate is to be neatly roughened by lightly chipping and cleaned before the slab / beam reinforcing is fixed."

Add the following sub-clauses:

"PSG-6.1.3 : Holding Down (H.D.) Bolts

"PSG-6.1.3.1 : All H.D. bolts shall be hot-dipped galvanized to SANS 121 (ISO 1461).

"PSG-6.1.3.2 : Tolerances as per SANS 2001-CS1: Structural Steel Works Item 3, Table 7:

Horizontal Level : +5mm or -3mm
Vertical Alignment : 3mm

PSG-6.2 : Permissible Deviations

Replace sub-clause PSG-6.2.1 with the following:

"PSG-6.2.1 : General

Degree of Accuracy II shall apply for all *works* as set out in SANS 1200-G Clause 6.2.3, unless indicated otherwise."

PSG-6.2.3 : Specified Permissible Deviation (PD)

Replace subclause PSG-6.2.3.a)1) with the following:

"Spacing between adjacent bars shall be ±10 mm, irrespective of the Degree of Accuracy (additional bars have to be added at the *Contractor*'s expense if the number of detailed bars is insufficient due to incorrect bar placement by the *Contractor*)"

Replace subclause PSG-6.2.3.a)2) with the following:

"Cover to reinforcement: –5 to +15 mm, irrespective of the Degree of Accuracy"

Replace subclause PSG-6.2.3.d)7)ii) with the following:

"Abrupt changes in a continuous surface: Between different concrete pours at construction joints in floors: ± 5 mm irrespective of the Degree of Accuracy."

5.3.7 PSG-7 : Tests

PSG-7.1 : Facilities and Frequency of Sampling

PSG-7.1.2 : Frequency of Sampling

Add the following sub-clause:

PSG-7.1.2.5: The following minimum number of 150 mm cubes shall be sampled on Site for all structural concrete:

Table 13 : Sampling Frequency for Concrete Cubes

Volume of individual element/concrete pour/lot (m^3)	Minimum number of 150mm cubes
0 – 49	6
50 – 70	9
71 – 100	12
101 – 150	15
>150	18

PSG-7.2 : Testing

PSG-7.2.1 : General

Add the following:

"The *Contractor* shall allow in his tendered rates for all costs for quality and process control testing. Slump tests, concrete temperature, humidity, wind speed and compression strength tests shall be required for all concrete operations."

PSG-7.2.4 : Early-Strength Testing
Add the following:

"Of each sample of six 150 mm cubes, three cubes shall be tested at 7 days and the remaining three cubes at 28 days."

PSG-7.3 : Acceptance Criteria for Strength Concrete

Add the following subclause:

"PSG-7.3.6 : Reporting

Defective concrete *works* shall be reported to the *Employer* without delay. The *Contractor* may not proceed with any remedial *works* or patching unless approved by the *Employer*."

5.3.8 PSG-8 : Measurement and Payment

PSG-8.1 : Measurement and Rates

Replace the first sentence of sub-clause PSG-8.1.1.2 with the following:

"PSG-8.1.1.2 : No narrow widths will be measured."

PSG-8.1.2 : Reinforcement

Replace sub-clause PSG-8.1.2.2.a) with the following:

"PSG-8.1.2.2.a) : The mass of steel bars will be measured as the total mass of the steel, irrespective of diameters."

PSG-8.1.2.3.a) : Delete the words "of nominal size 25 mm" in the first line of this sub-clause."

PSG-8.1.2.3.b) : Delete sub-clause PSG-8.1.2.3.b).

PSG-8.1.3 : Concrete

Add the following to sub-clause PSG-8.1.3.3.a):

"The tendered rate for concrete to be used shall also include all measures necessary to store cement, water and aggregates in a cool environment to ensure that the ingredients of the concrete are cool at the time of mixing."

Add the following sub-clause:

"PSG-8.1.4 : Casting In of Pipes and Specials

No separate items will be scheduled for building in items that are included in the scope of the *works*, unless they are covered by specially measured items in the bill of quantities. The relevant rates for supply and installation shall cover the cost for casting in the items as supplied as part of the *works*, whether the items are positioned prior to construction or subsequently placed in blocked-out holes."

5.4 PSH : Structural Steelwork

5.4.1 PSH-1 : Scope

Add the following to sub-clause 1.1:

"These specifications cover the construction of structural steel *works* to Substation M, Substation N, Main Intake Substation and Main Intake Substation Equipment Yard."

5.4.2 PSH-2 : Interpretations

PSH-2.1 : Supporting Interpretations

Add the following:

"Structural steel shall comply with SABS 1200 H, with supplementary requirements as contained herein. In addition, the following specifications shall apply where relevant or referenced:

SANS 2001-CS1:2012 : Construction Works Part CS1: Structural steelwork"

5.4.3 PSH-3 : Materials

PSH-3.1 : Structural Steel

PSH-3.1.1

Replace with the following:

"All steel shall be new and comply with SANS 50025 Part 1 to 6.

The grade of the steelwork shall be S355JR. No special steels will be required.

All hot-rolled steel specified for stairs, ladders and cat-ladders will be of grade S355JR or mild steel complying with grade S240JR.

Handrails, handrail stanchions, and open grid flooring are proprietary products and are specified on the drawings."

PSH-3.4 : Structural Tubular and Hollow Steel Sections

Replace with the following:

"All steel shall be new and comply with SANS 657 and/or SANS 50219.

The grade of the steelwork shall be S355JRH."

PSH-3.6 : Bolts, Nuts and Washers

Add the following:

"All structural steel fasteners shall be provided new with hot-dip galvanized finish."

PSH-3.6.1 : Bolts And Nuts (Other Than Friction-Grip)

Replace with the following:

"All steel bolts shall comply with SANS 1700. The grade required shall be as specified on the drawings."

PSH-3.6.2 : Friction-Grip Fasteners

Replace with the following:

"All friction-grip fasteners shall comply with SANS 1700.

High tensile bolts used in friction grip mode are shown on the drawings and shall be HSFG bolts or 8.8S or 10.9S. These bolts shall be torqued using approved methods to achieve a pre-tension of 70% minimum of the tensile capacity of the bolt. The methodology of applying torque to the bolts to achieve the required pre-tension shall be submitted to the *Employer* for approval."

5.4.4 PSH-4 : Plant

Add the following to the beginning of the clause:

"The structures have features with approximately 12m clear span roof trusses with base plate positions situated +8m above ground level on reinforced concrete ring beams. Specialist lifting devices and bracing equipment shall be used to provide temporary support and to maintain stability without overstraining any component. Qualified riggers shall be in attendance to control the work at all times.

Specialist lifting equipment shall be used to ensure that sheets are not damaged in the handling process. Walk boards shall be used to prevent floor damage to sheets while installing the sheeting, particularly along heavily trafficked areas."

5.4.5 PSH-5 : Construction

PSH-5.1 : Drawings and Shop Details

PSH-5.1.2 : *Contractor* Provides Shop Drawings

Replace with the following:

"The *Contractor* shall be responsible for his own fabrication/shop drawings, which shall be submitted to the *Employer* for approval prior to fabrication and erection.

Such drawings shall show steelwork grades and all geometric details, hole positions and fasteners. The centres of gravity of the members should intersect at all nodes, unless indicated otherwise on the *Employer's* drawings.

The *Contractor* shall drill additional holes required for assemblies by other *Contractor*s. These holes will be indicated clearly on the construction drawings issued by the *Employer* in order to be added to the shop/workshop drawings.

All holes shall be drilled. No punching of holes is allowed.

All bolts shall be supplied with two washers, one washer under the nut and one washer under the bolt head.

All bolts shall protrude a minimum of 25mm beyond the nut.

Where the *Employer's* drawings show no weld sizes, the minimum weld size shall be that of the thickest plate of the connecting plates/elements. Unless otherwise shown the intention of connections are to transfer the full force that can be developed in connecting members through the connection.

A fully-detailed 3D model, compatible with Bentley/Microstation/AECOsim, shall be provided by the *Contractor*, showing all members, plates, holes and the like, which shall be submitted to the *Employer* for review and approval.

The *Contractor* shall provide the *Employer* with a schedule of material delivery and a fabrication schedule.

Hold points shall be agreed with the *Employer*, to include inspections and examination of the materials and workmanship during fabrication and before galvanizing. The *Employer* shall be notified at least two weeks in advance of the date and locations of such inspections and the *Employer* shall be granted unencumbered access to witness such inspections.

Galvanizing may only be applied to those parts of the steelwork that have been approved in writing by the *Employer*."

PSH-5.1.3 : Engineer Provides Shop Details

Delete sub-clause PSH-5.1.3.

PSH-5.1.4 : Variations From Drawings And Sections

Replace with the following:

"The member sizes shown on the design drawings shall not be changed without written consent of the *Employer*."

PSH-5.5 : Erection

PSH-5.5.1 : Procedure

Replace with the following:

"The *Contractor* shall provide to the *Employer* a schedule, indicating the detailed sequence for the erection of steelwork.

The sequence of erection shall be coordinated with the installation of the equipment of all other disciplines. This may involve leaving one bay open until all installation has been completed."

Add the following sub-clause:

"PSH-5.5.6 : Safety Lines – Fall Arrest System

The *Contractor* shall install the permanent fall arrest systems where indicated on the drawings."

PSH-5.6 : Grouting of Supports

PSH-5.6.1 : Responsibility

Replace with the following:

"Grouting under all plates and in holding-down bolt pockets shall be carefully coordinated between the *Contractor* and his subcontractors to ensure proper alignment and levelling of the structure.

Commercial non-shrink pourable grout shall be used for grouting between and beneath steel base plates and bolt pockets. The make and type of grout shall be submitted to the *Employer* for review and approval."

5.4.6 PSH-7 : Testing

PSH-7.1 : Test Certificates

Replace with the following:

"The *Contractor* shall provide copies of the mill materials certificates for all members ordered.

Mill material certificates shall be fully traceable to individual steelwork members."

PSH-7.3 : Inspection and Testing of Welds

Replace with the following:

"The *Contractor* shall produce evidence to show that both his welding procedures and welders have passed all the relevant tests required in terms of AWS-1.1.

The *Contractor* shall submit, for approval by the *Employer*, welding procedures for each of the thicknesses and material types that are to be welded, based on the specified welding code and including all consumables and methods that are to be used.

Before any welding is undertaken, each welder shall be qualified for the particular weld procedure. This shall include production, inspection and approval by a properly registered and authorized inspection authority (AIA), to be appointed by the *Contractor*, of a sample weld on a representative plate size, having the same physical and chemical properties as that to be used for the *works*.

Only welders that have been qualified for the weld procedure shall be permitted to undertake welding on Site.

The test welds shall be executed in the presence of a representative of the *Employer*. Samples of the test welds shall, after stress relieving or normalizing, be cut out and submitted for further metallurgical testing by the AIA.

Further testing of welds by radiographic or other approved means of inspection shall be undertaken, as directed by the *Employer*. These inspections shall all be conducted by the AIA.

Any welds that are found to fail shall be repaired in accordance with an approved weld repair procedure, or shall be cut out and re-placed, at the *Contractor*'s expense.

The costs attached to the appointment and services provided by the AIA shall be included in the tendered rates.

100% of welds at connections and within 500mm of any connection shall be tested by Magnetic Particle Inspection.

20% of all other weld lengths shall be tested. The welds to be tested shall be agreed upon by the *Employer* and the *Contractor*."

5.5 PSHB : Cladding and Sheeting

All cladding and sheeting shall be in accordance with Specification No : 1924701-2-300-A-SP-0001 : Architectural.

5.6 PSHC : Corrosion Protection of Structural Steelwork

5.6.1 PSHC-1 : Scope

Replace sub-clause 1.1 with the following:

"This specification covers the corrosion protection to be provided to structural steelwork on Substation M, Substation N and the Main Intake Substation, including supports for electrical equipment. The steel members consist of, but are not limited to, universal beams, universal columns, parallel flange channels, equal/unequal leg angles, and rectangular hollow sections in lengths of up to 15m."

5.6.2 PSHC-2 : Interpretations

PSHC-2.1 : Supporting Specifications

Add the following to:

"d) SANS 32, SANS 121, SANS 675, SANS 10244, SANS 3575, or SANS 4998 or a combination of these, as applicable."

5.6.3 PSHC-5 : Construction (Execution of Work)

PSHC-5.9 : Application of Metal Coatings (Hot-Dip Galvanizing, Metal Spraying)

Replace with the following:

"All steelwork and wires shall be hot-dip galvanised to SANS 32, SANS 121, SANS 675, SANS 10244, SANS 3575, and/or SANS 4998, as applicable.

All bolts, washers, and nuts shall be hot-dip galvanized to SANS 121.

No drilling, cutting, welding or machining shall be carried out after metal coating. Unavoidable damage shall be reported to the *Employer* in writing and repaired in accordance with 5.10.

Add the following new clause:

"PSHC-5.11 : Corrosion Protection

PSHC-5.11.1 : General Corrosion Protection

Corrosion protection of steel materials shall be as per the requirements of these specifications, the *Employer's* and Eskom (where applicable) standards and associated minimum SANS and other requirements. The protection of the specified steel materials shall make allowance for the harsh, coastal environment at the Site.

Any equipment not strictly complying with the above requirements shall be rejected. The *Contractor* shall furnish written confirmation that all equipment complies with the specifications. Should the *Contractor* fail to furnish such confirmation, the *Employer* reserves the right to reject the equipment.

PSHC-5.11.2 : Galvanic Corrosion Protection

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer*.

The table below provides a general indication/guide only, of which metals can be connected to each other without the need of special measures to ovoid interaction, and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The responsibility will remain with the *Contractor* to avoid bimetal/galvanic corrosion between different metal equipment.

Table 1 : Combinations Of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	StSt	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Copper	Not Permissible	Not Permissible	Permissible	Permissible	Not Permissible	Permissible
StSt	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

Where equipment has been exothermically welded together, 3 thick layers of bitumen shall be applied afterwards, unless otherwise specified or instructed.

5.7 PSP : Masonry

All masonry shall be in accordance with Specification No : 1924701-2-300-A-SP-0001 : Architectural.

6.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

Technical Specification Tippler 3 Bulk Power Supply -

HVAC

Document Number 1924701-2-300-B-SP-0002

Document Details

Ref (SA)	1924701-2-300-B-SP-0002
Date	13 April 2018
Prepared by	Johan Jooste
Reviewed by	Andrew Dally
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	13 April 2018	Issued for Construction	Johan Jooste	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

The buildings that will house the new bulk electrical supply infrastructure are to be equipped with cooling and ventilation systems to remove heat generated by the electrical equipment within these buildings and render the buildings safe for occupation. Owing to the large amounts of airborne dust present in the vicinity of the Site, cooling will not be achieved through natural or forced draft ventilation only but rather through the provision of chilled-water air conditioning systems. This specification includes the minimum technical requirements for the provision of these air conditioning systems.

1.2 Purpose

The purpose of this specification is to set out the minimum technical requirements for quality and workmanship for the design (where required), fabrication, supply, installation, construction, testing and commissioning of the following equipment/infrastructure:

- An air-cooled, closed loop, chilled water air conditioning system for Substation M, Substation N, and the 11 kV Switch House at the Main Intake Substation, complete with chillers, pumps, piping (chilled-water, make-up water and condensate), valves, tanks and accessories as specified in this document
- Galvanized sheet metal (GSM) ducting with all supports, lagging, grilles and dampers for the supply of conditioned air to the air conditioned rooms within the above-mentioned buildings to air handling units located within the building, and for the return of warm air from these rooms.
- GSM ducting with all supports, lagging, grilles and dampers for the supply of fresh air to all rooms within the building, and to pressurize un-air-conditioned spaces within each building to minimize the ingress of dust.
- A fresh air fan unit, equipped with a filtration system that is designed for handling large amounts of dust without requiring frequent maintenance (which would be needed for conventional filters to prevent excessive static pressure loss across the filter unit).
- Built-up chilled water air handling units for the transfer of heat from the return airstream to the chilled water system complete with the commensurate sound attenuation to attain the specified noise levels within the building.
- Fire dampers, that will be required to maintain the fire-rating of walls and floors that are intersected by ducting and compartmentalize the air conditioning system in the case of a fire, which will in turn assist with the operation of the building's automatic fire suppression system.
- Actuated louvered smoke vents for each of the emergency escape stairs that are provided in the above-mentioned buildings.
- The electrical and control infrastructure related to the above, as specified elsewhere in this document.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site Information.
- Drawings.
- Further technical specifications scheduled under Annexure K of the Works Information, as applicable.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
ACP	Air Conditioning (electrical / control) Panel
A.H.U.	Air Handling Unit
AIA	Authorized Inspection Authority
BAS	Building Automation System
BMS	Building Management System
GSM	Galvanized Sheet Metal
HEPA	High Efficiency Particulate Filters
HVAC	Heating Ventilation and Air Conditioning
NBR	National Building Regulations
NPSH	Nett Positive Suction Head
SABS	South Africa Bureau of Standards
SANS	South African National Standards
SG	Spheroidal Graphite
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
TDS	Total Dissolved Solids
TEFC	Totally Enclosed Fan Cooled
UL	Underwriters Laboratory

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to acceptance by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the accepted quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.
- National Building Regulations and Building Standards Act 103 of 1977

3.3 South African and International Standards

The *Contractor* shall ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request acceptance from the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include the following and all other standards and specifications as referenced therein.

Table 3 : South African Standards

Standard	Standard Title
SABS 23	Brazing alloys containing silver
SABS 0241	The design, fabrication and inspection of articles for hot-dip galvanizing
SANS 24	Soft solders
SANS 62-1	Steel pipes Part 1: Steel pipes of NB not exceeding 150 mm
SANS 62-2	Steel pipes Part 2: Pipes and pipe fittings of nominal bore not exceeding 150 mm, made from steel pipe
SANS 121	Hot-dip (galvanised) zinc coatings (other than on continuously zinc-coated sheet and wire)
SANS 193	Fire dampers
SANS 455	Covered electrodes for the manual arc welding of carbon and carbon manganese steels
SANS 460	Plain-ended solid drawn copper tubes for potable water
SANS 1067-2	Copper-based fittings for copper tubes Part 2: Capillary solder fittings
SANS 1091	National colour standards
SANS 1125	Room air conditioners and heat pumps
SANS 1186-1	Symbolic safety signs Part 1: Standard signs and general requirements
SANS 1200 H	Standardized specification for civil engineering construction Section H: Structural steelwork
SANS 1200 HC	Standardized specification for civil engineering construction Section H: Corrosion protection of structural steelwork
SANS 1238	Air conditioning ductwork
SANS 1453	Copper tubes for medical gas and vacuum services
SANS 1700	Fasteners – All parts
SANS 3575	Continuous hot-dip zinc-coated carbon steel sheet of commercial, lock forming and drawing qualities
SANS 10044	Welding: Parts I to VII
SANS 10064	The preparation of steel surfaces for coating
SANS 10103	The measurement and rating of environmental noise with respect to

Table 3 : South African Standards

Standard	Standard Title
	annoyance and to speech communication
SANS 10142	The wiring of premises Part 1: Low-voltage installations
SANS 10147	Refrigeration systems including plants associated with air-conditioning systems
SANS 10173	The installation, testing and balancing of air conditioning duct work
SANS 10238	Welding and thermal cutting processes – Health and safety
SANS 10400	The application of the National Building Regulations (various parts)
SANS 12944-4	Paints and varnishes – Corrosion protection of steel structures by protective paint system Part 4 – Types of surface and surface preparation
SANS 14713	The design, fabrication and inspection of articles for hot-dip galvanizing
SANS 50025	Hot rolled products of structural steel (various parts)

International standards shall include the following and all other standards and specifications as referenced therein.

Table 4 : International Standards

Code	Standard Title
API 5L	Specification for line pipe
ARI Standard 410	Forced-circulation air-cooling and air-heating coils
ASHRAE 52-76	American Society of Heating, Refrigeration and Air Conditioning Engineers Standard 52-76
ASTM A 126	Standard specification, for grey iron for valves, flanges, and pipe fittings
ASTM A 216 / A 216M	Standard specification for steel castings, carbon, suitable for fusion welding, for high temperature service
ASTM A 389 / A 389M	Standard specification for steel castings, alloy, specially heat-treated for pressure-containing parts, suitable for high - temperature service.
ASTM A 395 / A 395M	Standard specification for ferritic ductile iron pressure-retaining castings for use at elevated temperatures.
ASTM B 62	Standard specification for composition bronze or ounce metal castings
ASTM F 1369	Standard specification for heaters, convection, steam and hot water
ASTM F 1508	Standard specification for angle style, pressure relief valves for steam, gas and liquid services
BS 21	Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads
BS 449	Specification for the use of structural steel in building
BS 476	Fire tests on building materials and structures
BS 848 Part 1 & 3	Fans for general purposes: Performance testing
BS 970	Specification for wrought steels for mechanical and allied engineering purposes
BS 1334 (1969)	The use of thermal insulating materials for central heating and hot and cold water supply installations
BS 1486	Lubricating nipples

Table 4 : International Standards

Code	Standard Title
BS 1740	Specification for wrought steel pipe fittings
BS 1821	Specification for class I oxy-acetylene welding of ferritic steel pipework for carrying fluids
BS 1856	General requirements for the metal-arc welding of mild steel
BS 2633	Specification for Class I arc welding for ferritic steel pipework for carrying fluids
BS 2640	Specification for Class II oxy-acetylene welding of carbon steel pipework for carrying fluids
BS 3601-22	Specification for carbon steel pipes and tubes with specified room temperature properties for pressure purposes
BS 4504	Circular flanges for pipes, valves and fittings (PN designated) 3.1: Specification for steel flanges 3.3: Specification for copper alloy and composite flanges
BS 5000-99	Machines for miscellaneous applications
BS CP 3005 (1969)	Thermal insulation of pipework and equipment
IP44	International protection marking to SANS 60529 / IEC 60529
IP55	International protection marking to SANS 60529 / IEC 60529
ISO 1940	Mechanical vibration (various parts)
ISO 2372	Mechanical vibration of machines with operating speeds from 10 to 200 rev/s
ISO 8501-1	Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1
NFPA 90A	Standard for the installation of air conditioning and ventilating systems
SMACNA	Sheet Metal and Air Conditioning Contractors National Association (Standards)

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 5 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 DESIGN CONDITIONS

Where, in terms of this specification, air conditioning systems are installed, these systems shall be designed and commissioned (subject only to the limitations of their design), on the basis of the following climatic, temperature, humidity, and sound level data, unless specified differently in the technical schedules in Section 3 of the specification.

5.1 Design Criteria

5.1.1 Ambient Design Conditions

Summer	32.2ºC db	22.2ºC wb
Winter	5.0ºC db	

The above conditions are the mean average, maximum and minimum temperatures recorded in the area, which are normally not exceeded on more than ten days in a year.

5.1.2 Inside Controlled Conditions

Equipment Rooms (*)	Summer	30ºC db at ±35% Relative Humidity
	Winter	Heating is excluded

(*) : VSD rooms, switchgear rooms, electronics rooms and transformer rooms.

The temperature shall be controlled within a tolerance of ± 1.5ºC.

The relative humidity will not be positively controlled but will be indirectly controlled within the comfort range, as a result of the design and selection of the cooling plant.

5.2 Noise Levels

The air conditioning and ventilation installations shall be designed and configured to not exceed the rating levels of ambient noise for the relevant indoor dwelling spaces, based on the South African National Standard (SANS) 10103. Reference is made to the table below for design and maximum rating levels of ambient noise for indoor dwelling spaces as per SANS 10103. The *Contractor* shall ensure that the complete installation does not exceed the specified noise levels.

Table 6 : Noise Levels

Space	Design L Req. T, dBA	Maximum L Req. T, dBA
Circulation Space	50	70
HVAC plantrooms	50	70
Equipment Rooms	50	70

5.3 Measures to Reduce Noise and Vibration

Where attenuators are fixed into walls, canvas collars shall be placed on the noise sensitive side.

Where piping and ducting pass through walls, they shall be wrapped with high density (64 – 103 kg/m^3) preformed, resin-bonded glass wool of 25 mm thickness and then with thick builder's plastic. Grouting is then to be done hard-up to the plastic.

5.4 Outside Air Ventilation

All zones shall be supplied with mechanical ventilation systems, i.e. no natural ventilation.
The ventilation systems have been designed to provide a positive pressure of 50 Pa within each room with all doors closed. This is to be done by balancing the supply and return air flows in response to the normal 'leakage' from the pressurised space.

6.0 DRAWINGS AND SUBMITTALS

6.1 Employer's Drawings

The *works* shall be as illustrated on the drawings issued by the *Employer.* These drawings shall be read in conjunction with this specification and the Works Information.

Table 7 : *Employers* Drawings

Drawing Number	Title
Substation M	
1924701-2-510-M-GA-0029	Substation M HVAC General Arrangement Layout
1924701-2-510-M-SD-0005	Substation M Chilled Water Schematic
1924701-2-510-M-SE-0006	Substation M HVAC Section Layout (Sheet 1)
1924701-2-510-M-SE-0007	Substation M HVAC Section Layout (Sheet 2)
1924701-2-510-M-ST-0004	Substation M Standard Ducting Layout
1924701-2-510-M-ST-0005	Substation M Standard Piping Layout
Substation N	
1924701-2-510-M-GA-0031	Substation N HVAC General Arrangement Layout
1924701-2-510-M-SD-0007	Substation N Chilled Water Schematic
1924701-2-510-M-SE-0009	Substation N HVAC Section Layout (Sheet 1)
1924701-2-510-M-SE-0010	Substation N HVAC Section Layout (Sheet 2)
1924701-2-510-M-ST-0006	Substation N Standard Ducting Layout
1924701-2-510-M-ST-0007	Substation N Standard Piping Layout
Main Intake Substation : 11kV Switch Room	
1924701-2-510-M-GA-0026	Main Intake Substation HVAC General Arrangement Level 00
1924701-2-510-M-GA-0027	Main Intake Substation HVAC General Arrangement Level 01
1924701-2-510-M-GA-0028	Main Intake Substation HVAC General Arrangement Level 02
1924701-2-510-M-SD-0004	Main Intake Substation - Chilled Water Schematic
1924701-2-510-M-SE-0005	Main Intake Substation – HVAC Section Layout
1924701-2-510-M-ST-0008	Main Intake Substation - Standard Ducting Layout
1924701-2-510-M-ST-0009	Main Intake Substation - Standard Piping Layout

6.2 Working Drawings

The preparation and submission of working drawings and co-ordination drawings in respect of certain services will form part of the *works*.

Working drawings, drawn to a scale of not less than 1:50, shall be produced by the *Contractor* and submitted for acceptance to the *Employer*.

Such drawings shall be based on and co-ordinated with the latest available architectural, structural, roof truss and services drawings and dimensions, to be verified on Site prior to installation. The *Contractor* shall provide the following drawings:

6.2.1 Manufacturing and Installation Drawings

The manufacturing and installation drawings ("shop drawings") shall provide all details of the plant necessary for the manufacture and installation of the system in accordance with this specification.

6.2.2 Wiring Diagrams

The wiring diagrams shall provide details of all the electrical and communications wiring associated with the air conditioning and ventilation installations. The same drawing symbols and system shall be used as used in the *Employer*s drawings.

6.2.3 Record Drawings

On completion of the installation, but before the plant is handed over, the *Contractor* shall provide a complete set of drawings showing the completed installation, including wiring.

In addition to the drawings listed above, the *Contractor* shall provide all drawings necessary for the execution of the *works,* to be submitted to the *Employer* for acceptance.

Details and drawings of all major items of equipment made by the *Contractor* or his suppliers shall be submitted for acceptance by the *Employer*, even if a specific request for such drawings has not been made by the *Employer.*

All required drawings shall be submitted to an agreed programme to suit the construction of the plant.

All drawings shall be clearly numbered or marked with the equipment item numbers, area references and the like.

On completion of the installation, but before final handover, the *Contractor* shall provide an electronic copy and prints of drawings showing the services as fixed, to include, but not limited to, the following:

- Complete 1:50 scale layout of pipework inside plantrooms.
- Large scale (at least 1:50) details of plantrooms.
- Complete 1:50 scale drawings of the whole installation.
- Detailed drawings of all items of plant.
- Electrical and communication layouts and wiring diagrams.
- Details of any other items requested by the *Employer*.

The drawings shall be sufficient in detail to enable the *Employer*'s staff to maintain, dismantle, reassemble and adjust all parts of the *works*.

The layouts shall show the location of all manual and automatic valves, controls, control panels, outlets and the like.

A copy of the wiring diagram shall be mounted in the plantroom in a glass fronted frame. The diagrams shall be printed by a non-fading process.

6.3 Builder's Work

It is the responsibility of the *Contractor* to check the builder's *works* pertaining to the HVAC Installation as it is completed, to ensure that the *works* have been correctly carried out in accordance with the drawings. The *Contractor* shall identify any problem areas as soon as possible so that these can be rectified.

The *Contractor* shall carefully detail all areas where the air conditioning and ventilation installation pierces waterproofing. All necessary sleeves, caulking and flashing as required to make the installation waterproof shall be provided as part of this contract.

6.4 Acceptance of Drawings

The *Contractor* shall submit, for acceptance by the *Employer*, copies of all drawings prior to starting the *works*. Any *works* started (on or off Site) without the *Employer*s acceptance of drawings shall be at the *Contractor*s own risk.

The *Employer* may require from the *Contractor* further detailed drawings and/or calculations, which clarify features not adequately shown on the layout drawings. The request for additional details shall not be construed as extending the scope of this contract or altering the programme.

The *Contractor* shall submit two copies of each drawing to the *Employer* for acceptance.

The *Employer* will return to the *Contractor* within ten working days of their receipt by him, one copy of each drawing marked “ACCEPTED” or marked with any changes which are necessary.

The *Contractor* shall modify the details and drawings as required by the *Employer*. The nature and date of each modification and a distinguishing symbol shall be added and the drawings submitted again for acceptance.

Alterations to drawings by the *Employer* are not intended to change the scope of the *works,* unless explicitly stated as such. Should any alterations, in the opinion of the *Contractor*, change the scope of the *works*, the *Contractor* shall notify the *Employer* immediately on receipt of the altered drawings before any further drawings are compiled or fabrication is carried out. Claims for a change of scope after performance of the *works* will not be considered.

The acceptance of drawings by the *Employer* shall not relieve the *Contractor* of any responsibility in terms of the contract. The *Employer* will check the drawings for design only and acceptance of the drawings, schedules and catalogues shall not be construed as a complete check.

The *Contractor* shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him, whether such drawings or particulars have been accepted by the *Employer* or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the *Contractor*.

Five copies of the final manufacturing and installation drawings shall be issued to the *Employer* by the *Contractor* within ten days of receipt of acceptance. Further copies shall be provided as may be required by the *Employer,* either before or after final acceptance.

The *Contractor* shall provide at his own expense all copies of drawings by him in the execution of the *works* and shall also, at his own expense, supply to the *Employer* such drawings and copies thereof as are provided for in the specification.

6.5 Materials and Equipment Submittals

The *Contractor* shall submit to the *Employer,* for his acceptance, comprehensive manufacturer’s technical data (submittals) of major equipment and materials which he proposes to use.

Applicable model numbers, operation points, capacities and applicable options shall be highlighted or marked up in order to demonstrate compliance with the specification. Optional items that are not applicable shall be crossed out to avoid any ambiguities with regard to what is proposed.

The *Contractor* shall ensure that the technical data is submitted in good time to avoid the risk of delays. Prior to the placement of orders by the *Contractor*, the *Contractor* shall submit to the *Employer* for his acceptance a schedule of items of equipment and materials which he intends to submit, complete with the scheduled submittal and latest acceptance dates, in accordance with the agreed installation programme.

All material shall be new, of high quality and suitable for the conditions on Site. The *Contractor* shall ensure that the materials and equipment are adequately protected from adverse Site conditions, including, but not limited to, high dust content, accumulation of moisture and the corrosive, local environment. All materials and workmanship shall comply with the relevant SANS, BS or other listed standards.

The *Contractor* shall, when requested to do so, submit samples of equipment and material to the *Employer* for his acceptance prior to installation. Samples may be retained in the *Employer*’s possession until the *works* are completed, after which they will be returned. No payments will be made for such samples.

Locally manufactured equipment shall be used wherever possible and practical, in preference to imported equipment. The *Employer* does not commit himself to assisting the *Contractor* in obtaining import permits for imported equipment.

The *works* shall be designed to provide ease of inspections, cleaning and maintenance.

All artisans employed on Site shall be competent in terms of the relevant regulations and acts.

The *works* shall be executed to a high standard and subject to acceptance by the *Employer*. Should any workmanship, equipment or material not be accepted by the *Employer*, it shall be rectified at the cost of the *Contractor* and all rejected materials shall be removed from Site.

If, in the opinion of the *Employer*, any member of the *Contractor*'s staff is not competent to carry out the *works* to the required standard, then that person shall be removed from the project if so instructed by the *Employer.*

7.0 SPECIFICATIONS

7.1 General Information Regarding Equipment

This section of the specifications covers the technical information to be allowed for in the designs to be provided by the *Contracto*r for tender purposes.

The final pumping heads and fan resistance characteristics shall be determined, based on the final accepted major items of equipment. Estimated figures have been provided in these specifications for pricing purposes. The *Contractor* shall base the selection of fans and pumps on this data.

Should the final pumping head and fan resistance figures be different from the figures adopted in the designs used for tender purposes, price adjustments shall, if necessary, be made in accordance with the provisions of the contract.

7.2 Air Filters

7.2.1 Filter Types

Filters shall be of the type, size, quantity and efficiency as detailed in these specifications. The final filter selection shall be subject to acceptance by the *Employer*. The following requirements shall apply:

i. Protect filters installed close to exposed air inlets with weather louvers and a wire mesh screen.
ii. Use only dry media filters, unless specified otherwise.
iii. Select fan and systems for the expected final resistance, to ensure a supply air quantity in excess of 90% of design air quantity immediately prior to filter replacement.
iv. Provide one complete set of spare filters where washable filters are specified.
v. Hand the installation to the *Employer* with a clean set of filters.

7.2.2 Servicing of Filters

The following provisions shall be made for servicing of filters:

i. Allow sufficient space in front or behind filters, as applicable, to enable inspection and servicing.
ii. Fit properly sealed access doors to filter service areas.
iii. Where air filters of the washable type are specified, provide one suitable filter wash tank and stand, complete with a drying rack.
iv. The drying rack shall hold at least 20 filters at any one time.
v. Manufacture of the wash tank, stand and drying rack from galvanised steel shall be in accordance with SANS 121, SABS 0214 and SANS 3575.
vi. Connect the wash tank to main water supply and provide a suitable overflow and drain pipe to the nearest drain point.

7.2.3 Pressure Differential Gauges

The pressure differential gauges for filters shall comply with the following:

i. All filters and filter banks, including two-stage Hepa filters, shall be fitted with magnehelic pressure differential gauges.
ii. The gauges shall be clearly marked, with “filters clean” (green) and “filters dirty” (red) indicators of a permanent type.
iii. A separate gauge shall be fitted for each filter stage.
iv. Pressure differential switches of accepted type shall be fitted across a filter bank wherever specified.

7.2.4 General

Filter units shall be acceptable only if it can be shown, to the acceptance of the *Employer,* that they are standard products, produced by a reputable manufacturer that is regularly engaged in the fabrication of the particular type of air filter. Only filters tested by the South African Bureau of Standards to the ASHRAE Standard 52-76 will be acceptable. Testing and compliance shall cover the following properties:

i. Arrestance (gravi-metric).

ii. Efficiency (photometric).

iii. Dust holding capacity.

iv. Resistance against air velocity.

Imported products will be acceptance only if they are commonly used in South Africa and if they meet the above requirements.

Frames and filters shall be constructed in such a manner that the passage of unfiltered air is prevented. Gaskets shall be provided between filters and frames and filter frames unit casing.

Each filter bank shall be supplied with an identification label, stating the type of filters, quantity of filter elements, model numbers and all other information necessary for reordering filter material.

Filters shall be adequately protected against dirt during construction and shall not be operated until the system is thoroughly cleaned. Filters shall be put in regular operating condition before the fans to which they are connected are operated for any purpose.

An inclined manometer shall be made with copper tubing. The full gauge shall be connected to static pressure taps of accepted design, so that it will indicate correctly the resistance of airflow to the filter. Connections shall be installed on each filter bank. The scale reading of the inclined manometer shall be between 30 and 60 percent higher than the change-out pressure of the filters.

All filters, other than automatic types, shall be provided with pressure differential switches, which shall operate when the pressure drop across the filter reaches a value recommended by the manufacturer. The switch shall energize a pilot light on the main control board.

Filter dimensions shall be selected to suit the configuration of the air handling unit.

All filter accessories, including the filter holding frames and clips, shall be standard products of the filter manufacturer.

All metal parts shall be sufficiently protected against corrosion.

All metal parts shall be coated with baked enamel or equivalent paint.

7.2.5 Filter Efficiencies

The filters shall suit the particular applications as per the specification. Filter selection shall be based on the following table as per ASHRAE 52-76.

Table 8 : Filter Efficiencies

Old Standard	New Standard	ASHRAE Arrestance	ASHRAE Dust Spot Efficiency	DOP.0.3 Micron
EU1	G1	65%		
EU2	G2	65% - 80%		
EU3	G3	80% - 90%		
EU4	G4	90% - 95%		
EU5	F5		40% - 60%	
EU6	F6		60% - 80%	
EU7	F7		80% - 90%	
EU8	F8		90% - 95%	
EU9	F9		95% - 98%	
EU10	H10			90% - 95%
EU11	H11			95% - 99.5%
EU12	H12			99.5% - 99.97%
EU13	H13			99.99% - 99.995%
EU14	H14			99.999% - 99.9995%
EU15	U15 0.12 µ			99.9995%
EU16	U16 0.12 µ			99.99995%
EU17	U17 0.12 µ			99.999995%

Filters shall conform to the following minimum requirements:

Table 9 : Filters : Minimum Requirements

Filter Type	Primary Filters	Secondary Filters	Tertiary Filters. Depending on Requirements		
Arrestance	70%	>90%	>98%	0.3 µ to 1.0 µ	HEPA DOP 0.3 µ
Dust Spot Efficiency	20%	30-35%	90-95%	>95%	99,97%
Dust Holding Capacity (g/m^2)	300	1 500	1 500	1 500	2 000
Initial Nominal Face Velocity (m/s)	1,5	1,5	1.5	1.5	1,5
Initial Resistance (Pa)	60	60	60	60	250
Final Resistance (Pa)	250	250	250	250	500

7.2.6 Primary Filters

Primary filters shall comply with the following:

i. Panel filters shall be of the pleated type and not less than 50 mm thick.

ii. The filter shall be of the washable type.

iii. Synthetic media shall be used, which shall be bounded together with galvanised wire for reinforcing and bonded in the frame to ensure no air bypass.

iv. The frame shall be galvanised steel or of a distortion and corrosion free moulding.

v. Each filter shall be provided with a closed cell polypropylene seal.

7.2.7 Secondary Filters (Extended Surface Intermediate Efficiency Filters)

Secondary filters shall comply with the following:

i. Filter media shall be self-supporting, leak-free and stable under all air-flow conditions.

ii. Front frames shall be of aluminium, galvanised steel or reinforced high density hard polyurethane foam with a continuous seal as detailed in item 7.2.6.

iii. Filters shall be of the disposable type.

iv. Filter depths less than 100 mm are not acceptable.

v. Galvanised protection screens shall be fitted to match the air-flow arrangement.

7.2.8 High Efficiency and HEPA Air Filters

High efficiency and HEPA filters shall comply with the following:

i. Filter media shall be self-supporting, leak free and stable under all air flow conditions and shall be bonded in to a pressed and sealed particle board housing.

ii. Corrugated media separators shall be of aluminium or Kraft paper.

iii. Filters shall be of the disposable type.

iv. Filters shall be provided with silicone filled channel seals.

v. Always install high efficiency or HEPA filters after an arrangement of primary and secondary filters complying with the above requirements.

vi. Filter depths less than 300 mm are not acceptable.

vii. Effective filter media surface area shall exceed 50 m^2 per square metre nominal face area.

viii. Each filter shall be individually tested in the factory for leakage with DOP aerosol and supplied to Site in completely sealed protection containers.

ix. Filter efficiency shall be as stated in the specifications.

7.2.9 Filters Boxes (Holding frames)

Filter boxes and holding frames shall comply with the following:

i. Construction and installation of boxes shall be such that un-filtered air will under no circumstances by-pass the filters or filter banks.

ii. All boxes shall be sealed with silicone sealer at installation and filters shall be fitted with *Employer* accepted seals.

iii. Filter frames and retaining mechanisms shall be supplied and installed by the filter manufacturer.

iv. The filter to frame seal shall be a routed fluid seal. The sealing fluid shall be a silicon type, be highly viscous, non-solidifying and shall not support bacteria or bacterial growth. The sealing fluid shall be selected for the particular application.

v. The filter material shall be water repellent.

vi. The filter media enclosing frame shall be corrosion protected steel.

vii. The complete filter installation shall be leak tested by the filter manufacturer. The leak test shall be either a DOP or sodium flame test.

viii. The filter efficiency of each filter cell shall be tested and certified.

7.2.10 Spin Filters

Spin filter units shall comply with the following:

i. The filter's cyclonic action shall be achieved through the use of fixed vanes.

ii. The spin filter shall have a dust arrestance efficiency of 95 % or better for a minimum dust particle size of 15 micron.

iii. Inertial spin filters shall be of a self-cleaning design.

iv. Removal of dust particles from the filter unit shall be done by means of a dedicated purge fan. The fan shall be capable of discharging the purged air through a conventional filter box.

7.2.11 Grease Eliminators

Grease eliminators shall comply with the following:

i. Grease eliminators shall be 316 stainless steel "Filtaire S.A." panels or *Employer* accepted equivalent panels, configured in equal V-formation.

ii. The unit shall be made up of interlocking frames for the individual filter units, or bolted in a common assembly.

iii. The ends of the assembly shall be suitably blanked off.

iv. Each pair of filter units shall be provided with a readily removable drip tray.

v. Filters shall be fitted with suitable handles.

vi. The filter depth shall not be less than 50 mm.

7.2.12 Spare Media

One complete set of spare filter media shall be supplied for all the filters on the entire project.

Spare filter media shall be suitably packed and protected for storage. The packing shall withstand the normal handling procedures without damage to the filters.

7.3 Cooling and Heating Coils

7.3.1 General

Cooling and heating coils shall meet the following general requirements:

i. Coils shall be of the extended type, constructed with seamless copper tubes with either copper or aluminium fins bonded mechanically to the tubes.

ii. Only copper or stainless steel frames shall be used, to be constructed from 1.6 mm or thicker plate.

iii. Frames shall be flanged and bolted together so as to allow for easy removal without causing damage to coils, panels or drip trays.

iv. Only copper coil headers shall be used, with pipe connections only on one side.

v. Tubes shall be silver soldered or brazed to headers, unless the headers are sturdy enough to withstand, without undue distortion, any stresses due to rolling or expanding of the tubes.

vi. Coils shall be selected in accordance with ARI Standard 410 with economic pressure drops to suit the complete pipe and pumping system.

vii. Cooling coils shall be suitable for direct expansion air-to-refrigerant heat transfer or air-to-chilled water heat transfer as specified.

viii. Heating coils shall be either of the steam to air heat transfer type or hot water to air heat transfer type.

ix. Coils shall be designed and constructed for a test pressure of 1400 kPa or 1.5 times the system working pressure, whichever is the greatest.

x. Coil face velocity shall be low enough to ensure that no water is carried over in the air stream, generally not more than 2.5 m/s.

xi. Proper eliminators shall be fitted downstream of the coil where moisture carry-over may be a problem.

7.3.2 Direct Expansion Coils

Direct expansion coils shall comply with the following:

i. Direct expansion coils shall be circuited for the most economic balance between heat transfer, refrigerant pressure drop and proper oil return.

ii. The suction header shall be constructed to ensure complete oil drainage from the coil.

iii. Liquid and vapour distributors on multi-circuit coils shall ensure uniform refrigerant distribution between circuits.

7.3.3 Heating Coils

Steam or hot water heating coils shall be used, unless otherwise specified. The specification for heating coils shall be the same as for cooling coils, apart from the following:

i. Helical or plate fins may be used.

ii. The minimum fin spacing shall be 2 mm.

iii. The minimum material thickness of the fins shall be 0.16 mm.

iv. Steam heating coils shall be of the single pass type and shall have supply and return tapping for each section.

v. Tubes of steam heating coils shall be arranged so that expansion strains cannot occur and headers shall be welded steel, brass or copper.

7.3.4 Cooling Coils

Cooling coils shall comply with the following:

i. Cooling coils shall be of the extended surface type, constructed of copper tubing with a minimum outside diameter of 13 mm, with plate fins of aluminium, extending at right angles to the tubes.

ii. Fins shall be spaced not closer than 8 per 25 mm.

iii. Plate fins may be flat or formed and shall have a nominal thickness of not less than 0,008 times the outside diameter of tubes.

iv. Plate fins shall be provided with integral spacing collars at least 3 mm wide on full width of space between fins.

v. Tubes shall be tightly and permanently expanded into spacing collars.

vi. Plate fins may be flat or formed and shall have nominal thickness of not less than 0.11 mm.

vii. Plate fins shall be provided with integral spacing collars extending the full width of space between the fins.

viii. Tubes shall be tightly and permanently expanded into the spacing collars.

ix. Coils shall be of the serpentine type.

x. Coils fitted in air handling units with sprays, or into air handling units installed after a spray section of air washer, shall have copper tubes and copper fins.

7.3.5 Drip Pans

Drip pans shall comply with the following:

i. Drip pans shall be fitted under each cooling coil section.

ii. Drip pans above each other shall not be joined to each other.

iii. Drip pans shall be arranged so that no droplets are carried over the drip pan.

iv. The minimum distance by which drip pans can extend to the downstream side of any coil shall be 350 mm.

v. Drip pans shall be at least 50 mm deep at the coil and may reduce to a depth of 25 mm at the end away from the coil.

vi. Drain pans shall be provided to collect water condensing on the coil under all cooling/dehumidifying coils.

vii. Drain pans shall be fabricated from stainless steel only.

viii. The pan bottom shall slope from all sides towards the drain point.

ix. The pan shall be fitted with a drain connection 20 mm or larger, depending on coil size and application.

x. The drain connection shall be fitted with a manometric trap matching the fan pressure, but not less than 50 mm water depth.

xi. Coils shall be arranged so that all condensate water is collected with no air bypassing the coil.

xii. The drain shall be piped from the drip pan to the nearest building or plant room drain with 40 mm galvanised steel pipe or larger.

7.4 Field Assembled Air Handling Units and Plenums

Field assembled plants shall consist of plenum chambers, built to accommodate equipment such as dampers, filters, cooling and heating coils, heating elements, fans, drain pan and the like, all as specified and indicated on the drawings. The following requirements shall be met:

i. The unit shall be mounted a minimum of 300 mm above the finished floor.

ii. The panel finish shall be galvanised steel on the inside of the plenum and chromadek finish on the exterior.

iii. Panels for ventilating plants without heating or cooling can be of single-skin, suitably reinforced and un-insulated, if not exposed to any heat sources.

iv. The casings shall either be double-wall, factory-made 50 mm (minimum) panels with internal insulation, or as specified.

v. Panels shall be fastened to each other in an airtight and watertight manner, by means of an efficient and suitable locking arrangement and sealing compound.

vi. If necessary, structural reinforcement shall be provided to ensure the required rigidity.

vii. Junctions between the floor and side panels and the roof and side shall be rigid, strong, watertight and airtight.

viii. Casing panels shall be fabricated with galvanised sheet steel with a minimum thickness of 1 mm.

ix. Plenum casing panels shall be provided with glass-fibre insulation between the double walls.

x. Panel edges shall be fitted with insulation in such a manner that no un-insulated gaps will occur.

xi. The insulation shall have a minimum density of 48 kg/m^3 and a conductivity of 0,033 W/m$^\circ$C.

xii. The insulation shall not settle, tear loose or produce dust.

xiii. Polyurethane or polystyrene insulation may be used as an alternative to glass fibre.

xiv. All plenums shall be provided with bulkhead type light fittings, switchable from an externally mounted light switch.

xv. Floors shall be waterproof, cast with a fall to the drain points, and may be one of the following:

- Cement-sand topping with steel trowelled finish.
- Panels constructed as for walls (galvanised finish both sides) reinforced on top with 5 mm thick aluminium checker plating.
- As specified.

xvi. The entire plenum section shall be completely airtight and suitably reinforced/braced to withstand all possible pressure differentials across the walls and roof sections.

xvii. Detachable sections shall be provided for the removal or replacement of components such as fans, motors and the like.

xviii. Standard factory-fabricated modular central station air handling units will be considered as an alternative to field assembled units, provided that such units match the space and general requirements as set out above.

xix. Access doors shall be provided to electric heater banks, with safety micro switches so as to isolate all heater banks when the doors are opened.

xx. The following notice shall be painted on these access doors in clear red lettering at least 50 mm high: “DANGER – ELECTRICAL HEATERS”

xxi. Coils, heaters, dampers, and the like shall comply with the relevant sections of the specification.

xxii. Alternative factory-made plenum designs may be considered, subject to acceptance by the *Employer*.

xxiii. The positions of access doors are indicated on the drawings. Doors shall be of double wall construction with insulation, similar to that of the wall panels.

xxiv. Doors shall be factory-installed in panels provided with door openings and shall hinge on sturdy hinges.

xxv. Doors shall be supplied with two door handles, which can be operated from inside and from outside the plenum.

xxvi. Doors shall hinge against the system air pressure and shall be airtight.

xxvii. Access doors shall be a minimum of 600 mm wide, 1m high with bottom edge 500 mm above the floor, unless otherwise specified.

xxviii. Plenum casings shall be provided with removable sections with a width of 1.5 times coil width and full coil height plus clearance, to provide access to each coil.

xxix. Removable sections shall be provided for each coil on both sides of the plenum.

xxx. Pipes passing through the plenum panels shall be sealed with split-collar plates and rubber gaskets to obtain a watertight seal.

xxxi. Where pipes and conduits pass through plenums casings, the spaces between panels and pipes or conduits shall be sealed by means of rubber packing rings and steel flanges, which are bolted to the casing panel on both sides.

xxxii. Packing rings shall fit tightly around pipes or conduits and the flanges shall pull the packing rings tight against plenum casing panels.

xxxiii. The space between each pipe or conduit, and the inside of the holes in the panels, shall be filled with polyurethane foam insulation.

xxxiv. The unit shall be supplied complete with weatherproof switchboard, housing all starting gear, safeties and controls.

xxxv. The sump shall be manufactured in stainless steel and shall be of sufficient size to prevent loose droplets splashing onto the unit's floor.

7.5 Standard Specification for Factory Assembled Air Handling Units (including Chilled Water Fan Coil Units)

7.5.1 General

The air handling unit shall be rated in accordance with AIR Standard 230-74 and shall be a stock item, produced by a manufacturer that has been accepted by the *Employer*.

Each unit shall be supplied and installed complete, with all necessary chilled water, refrigeration, hot water and steam piping and control equipment, as well as all electrical wiring and control equipment.

7.5.2 Casing

The casing for factory-assembled air handling units shall comply with the following:

i. The casing of the unit shall be of heavy gauge steel reinforced and braced with steel angle framework.

ii. If the casing is sectionalized, the sections shall be factory assembled.

iii. An adequate number of removable panels shall be installed to provide free access to internal parts.

iv. When assembled the casing shall be leak proof.

v. The casing shall be insulated internally with neoprene covered or matt faced covered glass fibre insulation.

vi. The insulation shall be of adequate thickness and thermal resistivity to prevent condensation forming on any part of the casing.

vii. The insulation shall be enclosed within the double skin.

viii. The neoprene or matt facing covering the glass fibre shall be of adequate mechanical strength or prevent detachments of glass fibre particles or dust, even during prolonged usage.

ix. When the air handling unit is used exclusively for ventilation purposes, the installation of internal insulation is not necessary.

x. The casing shall either be chemically cleaned, phosphated and coated with a baked enamel finish, or the complete unit built up of parts that have been galvanised.

xi. All side panels shall be removable for ease of servicing. Where called for, collars for the supply and return ducting shall form part of the unit.

7.5.3 Drain Pan

The drain pan for factory-assembled air handling units shall comply with the following:

i. Drain pans shall be removable for cleaning purposes and shall be suitably insulated to prevent condensation on the outer surfaces.

ii. The drain pan shall project under the entire length and width of the cooling coil, including uninsulated portions of chilled water piping and valves, and shall consist of a single piece with no screws or joints.

iii. A drain pan capable of handling the condensate or spray water shall be installed in the casing.

iv. The drain pan shall, as a minimum, be large enough to cover the full coil section.

v. The drain pan shall be completely insulated with seamless cellular sprayed foam-in-place insulation with a minimum thickness of 10 mm.

vi. The drain pan shall have the facility to drain completely by means of the condensate removal line.

7.5.4 Fan and Drive

The fan and drive for factory-assembled air handling units shall comply with the following:

i. Fans shall be centrifugal type, statically and dynamically balanced and directly connected to the drive motor.

ii. The fan wheels and housing shall be of galvanised steel.

iii. The fan and drive unit shall comply with the details included elsewhere in the specifications.

iv. The fan shall be a double width, double inlet, centrifugal type.

v. The fan wheel shall be statically balanced before installation and dynamically balanced and tested after being installed in the casing.

vi. The fan shaft shall be designed to run well below its first critical speed.

vii. Fan bearings shall be silent running ball bearing type bearings.

viii. Fan bearings shall be selected for 200 000 hours average bearing life.

ix. Fan bearings shall be grease lubricated. The lubrication points shall be easily accessible.

x. Wherever bearings are situated inside the casing, an extended grease line to an easily accessible position shall be provided.

7.5.5 Fan Drive

The fan drive for factory-assembled air handling units shall comply with the following:

i. Fan motors shall be of the shaded pole or permanent split phase capacitor type with built-in thermal overload protection.

ii. The type of electric motor shall comply with the details noted elsewhere in the specification.

iii. The V-Belt drive shall comply with the requirements elsewhere in the specification.

iv. The V-belt guard shall fully enclose the V-belt drive.

v. The V-belt guard shall permit the monitoring of fan speed with a tachometer without the removal of the guard.

vi. The V-belt shall be easily adjustable.

7.5.6 Condensate Removal

Condensate removal for factory-assembled air handling units shall comply with the following:

i. A suitable drain pipe shall be installed from the unit to a suitable position.

ii. A suitable drain trap shall be installed between the drain pan and the drain pipe.

iii. The drain trap shall have a water seal with a sealing pressure of at least twice the static pressure as developed by the fan at the drain pan.

iv. The drain piping materials shall be as included in other parts of this specification.

7.5.7 Noise and Vibration

i. Fan Noise

Sound power levels (S.W.L.) in dB re 10-12 watt for the unit at the specified air quantity and static pressure shall be available in octave bands for:

- In duct calculations.
- Casing radiation noise calculations.
- Free discharge noise calculations.

ii. Vibration

Anti-vibration hangers or mountings shall be installed with the static deflectors as included in other parts of this specification.

All connections to the unit shall prevent short circuiting of the vibration isolation equipment.

The anti-vibration hangers and mountings shall comply with the details included in other parts of this specification.

No drumming or noise shall be emitted by any part of the air handling unit.

iii. Electrical Equipment

Electrical equipment shall comply with requirements included in other parts of this specification.

iv. Coils

Coils shall comply with requirements included in other parts of this specification.

7.5.8 Attachments

i. Air Dampers

Air dampers shall be positively locked to the shafts.

Damper rods shall rotate in brass bushings.

ii. Mixing box

The assembly shall be manufactured to the same standard and to specification as the fan casing.

iii. Electrical Heaters

Electrical heaters shall comply with the requirements included in other parts of this specification.

iv. Controls

Fan and unit on/off switch and controls shall be mounted on the unit or remote flush mounted as specified.

Fan control shall be as specified in the project specification.

Cooling/heating control shall be by means of a thermostat and shall be on/off or proportional as specified. The thermostat shall be either wall mounted within the controller or installed into the return air as per the specifications.

v. Filters

Washable filters shall be provided.

Filters shall be accessible for cleaning or replacing.

7.5.9 Chilled Water Room Fan/Coil Units

Chilled water type fan/coil units shall be installed as shown on the drawings and as described in the specification and shall comply with the following:

i. Fan/coil units shall be of the horizontal concealed ceiling-mounted type incorporating one or two direct – driven centrifugal supply air fans.

ii. Supply air fan/coil units motors shall be of the three-speed type, flexibly mounted within the units castings.

iii. Fan motor bearings shall be of the self-lubricating type requiring no maintenance.

iv. Cooling coils shall have aluminium fins rigidly bonded to copper tubing using a fin spacing of not less than 1.5 mm.

v. The cooling coils shall have manual air purge valves positioned in such a way as to facilitate chilled water system air bleeding.

vi. Corrosion proof and externally insulated condensate pans shall be installed under the cooling coils in such a way that the pans can be easily cleaned during regular maintenance service without removal of the entire fan/coil unit.

vii. Unit castings shall be constructed of galvanised or other accepted corrosive protection coating.

viii. Factory installed mounting lungs shall be fitted to the castings, preventing unnecessary drilling to the castings during Site installation.

ix. Fan/coil units shall be fitted with easily inter-changeable washable air filters of normal thickness 6 mm or alternatively easily removable screen filters may be fitted on hinged return air grilles as detailed in the drawings.

x. Where specified, fan/coil units shall be provided with electrical air heating elements to be installed on the discharge side of the supply air fans to, obviate the risk of heat radiation damage to the fan motor, the fan, and the cooling coil.

xi. Heater elements shall be of the black heat type and rated for 220 volt electrical supply.

xii. Heater elements shall be electrically interlocked to the supply air fans and overheat safety cut-out switches to ensure air flow in the heating position.

xiii. Heater elements shall be properly supported to prevent sagging throughout the life of the fan/coil units.

xiv. The fan coil unit shall be factory supplied with a suitable chilled water 2-way or 3-way bypass control valve, wall mounted room temperature controller and speed regulator.

xv. The chilled water control valve shall be positioned above a condensate drip tray.

xvi. Electrical and control system provisions are included in other parts of this specification.

xvii. A suitable terminal box and cover shall be fitted over the terminal strip with two 20 mm diameter holes suitable to accept the connection of sprigs.

xviii. Each fan coil unit shall be provided with 1.5 mm long flexible supply cable.

xix. Whereas the mains electrical supply to the fan coil units including local isolator switch is part of the general electrical subcontract *works*, the connection from the fan coil unit to mains isolator switch as well as all interconnecting wiring and conduit *works* between the thermostat, speed regulator, chilled water control valve and the fan coil unit is part of the air conditioning subcontract.

7.6 Condenser Units: Air Cooled Condensers

Air cooled condensers shall be complete, factory-assembled packaged units consisting of refrigerant condensing coils, framework, casing, fan/s and fan motor/s and all electrical equipment needed to make this a complete working unit. The following requirements shall be met:

i. Units shall be arranged for horizontal or vertical air flow, as indicated on the drawings.

ii. Units shall be fitted with ducted air discharge with centrifugal or axial flow fans.

iii. Wiring shall be terminated in a weather proof junction box mounted in an accessible position on the unit.

iv. The head pressure control shall be fitted with fan cycling and/or fan speed control as standard equipment.

v. Idle fans shall not be driven backwards by air short circuiting.

vi. Condenser casings shall be constructed of galvanised steel or stainless steel.

vii. All steel parts shall be protected against corrosion.

viii. Access panel doors shall be provided for repairs and maintenance.

ix. Condensing coils shall be of seamless copper tubing with copper or aluminium fins, as covered by other parts of the specification.

x. Inlet headers shall be designed for uniform gas distribution through all individual circuits.

xi. Units for outdoor use shall be suitably weather proofed.

xii. Fan blades shall be of aluminium or of steel, having a corrosion resistant coating, including fan shafts.

xiii. Air intake and discharge openings shall be screened to protect coils and fins.

xiv. Condensers shall be selected based on the design temperature criteria as specified.

xv. Interlocks shall be provided between the indoor and outdoor fans, such that the outdoor unit will only operate should the indoor unit require cooling or heating.

7.7 Pumps

Centrifugal water pump/motor sets shall be supplied and fitted where indicated on the drawings and the accompanying schedules. Pumps shall furthermore comply with the following:

i. Pumps shall be of the vertical split end suction type incorporating bronze impellers, stainless steel shafts and mechanical seals unless otherwise specified.

ii. Water pumps shall be centrifugal pumps with volute casings and shall have non-overloading characteristics. Pump casings may be horizontally or vertically split. The pump installation shall be complete with flanged inlet and outlet connections, matching flanges, removable drive coupling guard and fabricated steel base for pump and motor.

iii. Pumps shall be selected for the maximum possible efficiency at the required duty point and shall be free of vibration and silent in operation.

iv. Pumps shall be provided with adequate protection over inlet and outlet flanges before being delivered to Site. Protection covers shall be able to withstand normal handling during construction work.

v. Unless otherwise specified in the specifications, pump speed shall not exceed 1 500 r/min. No pump shall be operated at a speed exceeding the maximum recommended by the manufacturer.

vi. Calculate the total system resistance of the equipment proposed by the *Contractor* and verify that this is in accordance with the system resistance as shown on the drawings. The actual motor duties shall then be transferred onto the electrical distribution board drawings.

vii. Pump pressure and flow characteristics shall be selected to match the total system requirements under all control conditions.

viii. Ensure that the minimum NPSH as required by the pump manufacturer is maintained throughout the required operating pressure and flow range at the pumped fluid temperature.

ix. Pumps shall be suitable for the fluids and fluid temperatures which they handle and shall be selected accordingly.

x. Fit renewable casing wearing rings on all pumps with discharge diameters of 80mm and larger and with delivery pressures in excess of 175 kPa. Wearing rings shall be manufactured of bronze, chromium steel, nickel steel or an alloy suitable for the particular application.

xi. Impellers shall be manufactured of bronze and shall be statically and dynamically balanced. Impellers of pumps having 40mm diameter and larger discharge connections shall be fully enclosed and hydraulically balanced.

xii. Provide pumps with mechanical seals matching the duty, fluid and temperature requirements, which shall be aligned by the OEM/supplier of the pumps.

xiii. Pump casing design pressure shall match the total system working pressure or be 1.5 times the discharge pressure, whichever is the greater.

xiv. Pump casings shall be of close-grained cast iron.

xv. Suction and discharge connections shall be flanged with machined flanges corresponding to the pressure rating of the casing.

xvi. Bearings shall be grease lubricated ball and roller bearings selected for long duty life and capable of accommodating radial and axial loads.

xvii. Provide grease gun lubrication. The grease gun nipples shall be of an accepted type and shall comply with BS 1486 and be of the hexagonal “hook on” type 11 or 21.

xviii. Provide a stainless steel metal drip tray with drain connection underneath each pump. Drain connections shall be piped to the nearest drain or gully.

xix. Pumps with stuffing box type shaft seals will only be considered if:

- The shaft is fitted with a replaceable stainless steel wearing sleeve.
- A lantern ring is fitted.
- A minimum of 4 standard packing rings can be fitted.
- Bronze thrust bushes are provided.

xx. Protect pump drives by a securely mounted sheet metal guard.

xxi. Provide manual vent valves at high points on the pump casings for applications with temperatures above boiling point. The vent shall be piped to a safe drain point.

xxii. Provide drain plugs at low points on the pump casings.

xxiii. Provide each pump with a cast iron or fabricated steel bed-plate of ample size to hold both pump and motor in correct alignment. Pump and motor shall be accurately aligned when running at normal temperature. The impeller shall be removable without dismantling the motor or pipe work. Dowel pins shall be fitted to base plates after alignment.

xxiv. No more than one pump and motor shall be mounted on one common bed-plate. The bed-plate of each pump shall be separately mounted on anti-vibration machine base mountings.

xxv. Pumps of a design different from that specified above, offered as integral parts of factory made equipment, will also be considered.

xxvi. The efficiency of each pump as selected shall not be less than 70% and not more than 10% below the peak of the efficiency curve for the impeller as furnished.

xxvii. The supplier shall ensure that the NPSH of the selected pump is suitable for each pump application.

xxviii. The supplier shall ensure that the motor supplied is adequate for the full pump characteristic and not only for the duty specified.

xxix. Pumps shall be connected through flexible couplings of rubber tyre type (“FENNERFLEX” or accepted equivalent), to electric motors operating at a speed not exceeding 1440 rpm. Pumps and motors shall be mounted on robust channel steel bases and the pump body is to be fitted with a galvanised steel (minimum thickness 1.6mm) drip tray with discharge pipe to waste.

xxx. The pump/motor set is to be supplied and installed complete with easily removable, robust coupling guard.

xxxi. The pump motor shall be sized for not less than 1.3 times the pump shaft power requirement.

xxxii. The pump set is to be mounted on a concrete inertia base of minimum thickness 200mm.

xxxiii. Correctly sized anti-vibration spring mounts on height-saving brackets are to be mounted underneath the inertia base and over a concrete sub-base of minimum height 100mm.

xxxiv. In the case that the offered chiller equipment has a higher capacity (i.e. chilled condenser water flow) than specified, the *Contractor* shall ensure, at no extra cost to the *Employer*, that the offered pump flow rates match the increased flow requirements of the offered chiller/compressor.

xxxv. The selection of the model and size of the motor/pump set shall make allowances for a 10% increase in pump pressure, i.e. the pump duty shall not be selected on the outer pump curve or the maximum impeller diameter.

xxxvi. The capacities of the pumps offered shall exceed the minimum flow requirements specified in the schedules.

xxxvii. Should alternative refrigeration equipment be offered with flow rate capacities greater than the scheduled requirements, the larger pumps shall be selected and these shall be deemed to have been allowed for in the tender price.

xxxviii. Pump/motor sets with motor powers in excess of 1.5kw shall have flexible pipe connection at both the suction and discharge pipe connections.

7.8 Refrigerant Circuits

Refrigerant tubing shall be in accordance with SANS 1453: Copper Tubes for Medical Gas and Vacuum Services, with preferred sizes in accordance with SANS 460 Class 2, and shall be de-oxidised and dehydrated. The following requirements shall be met:

i. Fittings shall be copper based capillary solder fittings in accordance with SANS 1067. Only silver solder shall be used on joints (SANS Alloy Number S20). Silver solders shall be in accordance with SANS 24.

ii. Pipe sizing shall be as specified. Pipe size selections shall however be such as to produce moderately low velocities whilst ensuring that:

- Proper oil return to the compressor is maintained and lubricating oil being trapped in the system is minimized.
- Practical lines without excessive pressure drops and with proper feed to evaporators.
- Prevent liquid refrigerant from entering the compressor during operation and at shutdown.

iii. All plant room piping shall be cleaned and painted with a heat-resistant clear lacquer.

iv. Support piping (unless otherwise indicated on the drawings) shall be as follows:

Table 10 : Support Piping

Pipe Size Mm	Max. Distance Between Supports meter
10 (and smaller)	0.6
10 – 18	1.0
22	1.5
28 – 35	2.0
42	2.5
54	2.75
67	3.0

v. All refrigerant pipe fixing saddles shall be of copper. Whenever copper piping is in contact with metal surfaces other than copper, felt inserts shall be installed between the dissimilar metal surfaces.

vi. Refrigerant piping shall be arranged so that normal inspection and servicing of the compressor and other equipment is not hindered.

vii. Locations where copper tubing will be exposed to mechanical damage shall be avoided.

viii. Flexible metal vibration absorbers shall be fitted at compressor discharge and suction connections.

ix. Absorbers shall be installed at right angles to the direction of the vibration.

x. Hangers and supports shall be design to prevent transmission of vibration to the building at locations where piping penetrates through walls.

xi. A hot gas muffler shall be installed as close to the compressor as possible to prevent oil trapping.

xii. Flash gas at the expansion valve shall be prevented.

xiii. On systems with large pressure drops, due to line friction or static head, liquid line sub-cooling shall be accomplished by the use of either liquid-suction heat exchangers, or sub-cooling sections in evaporative, air or water cooled condensers.

xiv. Receivers shall be provided in the liquid line between the condensing and sub-cooling coils.

xv. Coils shall be provided with more than one inlet.

xvi. Coils in which the individual circuits are not evenly loaded, due to surface or air quantity variations, shall be provided with separate expansion valves.

xvii. For evaporative or air cooled condensers, each compressor shall be equipped with a circuit with a receiver with safety valve, isolating valves and purge cock, capable of holding the full volume of refrigerant in that circuit.

xviii. Receivers shall be shaded from the sun.

xix. Receivers with pressure/volume rating, qualifying as pressure vessels in terms of the regulations of the Machinery and Occupational Health and Safety Act, shall comply with all requirements of the act and regulations and shall be fitted with safety valves, purge cock, isolating valves, manufacturer's plates and the like, as required by the regulations.

xx. For water-cooled condensers, where the condensers are not of sufficient capacity to hold the full refrigerant charge, a receiver shall be installed in each circuit to hold the balance of refrigerant.

xxi. The liquid piping from the condenser to the receiver shall allow free drainage of the liquid.

xxii. The condenser to receiver piping shall be as short as possible and shall be pitched towards the receiver with a minimum slope of 50 mm per metre.

xxiii. Oil separators shall be used in systems where it is impossible to prevent substantial absorption of refrigerant in the crankcase oil during normal operation or during shut-down periods.

xxiv. Oil separators shall be separated to prevent them from acting as a refrigerant condenser. Drainage of condensed refrigerant into the crankcase shall be prevented.

xxv. A high quality refrigerant drier shall be provided in the liquid line on all systems.

xxvi. Driers shall be installed with a three-valve bypass for servicing and to allow partial flow on open compressor systems in order to reduce pressure drop.

xxvii. All the refrigerant shall flow through the drier on hermetic compressor systems.

xxviii. A reliable moisture indicator shall be provided for positive indication when the drier cartridge should be replaced.

xxix. A high quality strainer shall be provided on all systems in the liquid line.

xxx. A suction strainer shall be provided, unless the compressor is equipped with a built-in suction strainer.

xxxi. Combined filter-driers are also acceptable.

xxxii. Strainers shall be adequately sized to assure adequate foreign material storage capacity, without causing excessive pressure drop.

xxxiii. Sight glasses shall be installed and shall be of the double port seal cap type, installed in a vertical section of the liquid line after the receiver or condenser (if no receiver is used), to check the refrigerant charge, and before the expansion valve, to check the state of the refrigerant.

xxxiv. Moisture indicators, installed directly in the liquid line and serving the dual purpose of liquid line sight glass and moisture indicator, are also acceptable.

xxxv. A refrigerant charging connection shall be provided between the receiver or shell and tube condenser and the refrigerant drier, in the liquid line.

xxxvi. Before charging the system with refrigerant the circuit shall be tested as specified.

xxxvii. Solenoid valves shall have opening stems to continue operation of the system in case of solenoid coil failure.

xxxviii. All pipes, vessels and the like, operating below ambient dew point, shall be insulated and a vapour barrier shall be provided.

xxxix. All equipment shall be of one type, installed under one order and shall be of the same manufacturer and South African supplier.

xl. Pressure and temperature ratings of valves and other pipeline components shall be suitable for the system into which they are installed and shall be selected according to the ratings given by the manufacturer.

7.9 Fire Dampers

Combination fire/smoke control dampers complying with SANS 193 and NFPA 90A are required in the positions indicated on the drawings. The dampers shall be UL or SABS marked with proven low leakage in the closed position and shall meet the following further requirements:

i. Dampers shall be actuated by fusible link, electrical solenoid or pneumatic means, as specified on the drawing.

ii. Fire dampers shall be flanged both sides and access panels shall be provided in the ducting at each fire damper on the upstream side.

iii. Each fire damper shall be clearly marked as per Clause 4 of SANS 193.

iv. Fire dampers shall have at least a 2 hour resistance rating when tested in accordance with SANS 193.

v. The open or closed status of the damper shall be clearly indicated outside the casing for inspection purposes.

vi. Dampers shall be sized so that the nominal free air area when in the open position is not less than the connected duct free air area.

vii. Dampers shall be installed to form part of a continuous barrier to the passage of fire when in a closed position.

viii. Sheet metal sleeves shall be provided for housing the fire dampers where a fire damper is mounted in a wall.

ix. Where a fire damper cannot be fitted immediately adjacent to the fire wall, the section of ducting between the damper and wall shall be at least the same metal thickness and fire rating as the damper casing.

x. Dampers shall be self-supporting, to provide for the case of duct destruction due to heat.

xi. Care shall be exercised that the frame is set so that the closing device is accessible.

xii. Suitable hand openings shall be provided, with tightly fitted covers to make dampers accessible for inspection and maintenance.

xiii. Retaining angles shall be installed on four sides of the fire damper sleeve and on each side of the wall.

xiv. Angles shall be fastened to the sleeves only, and not to the wall.

xv. Retaining angles shall lap the masonry by a minimum of 35 mm around the entire opening.

xvi. Kitchen canopies shall be provided with a fire extinguishing system.

xvii. The recommended minimum angle sizes are as follows:

Largest Dimension of Fire Damper	*Angles*
0mm to 1 200 mm	38 x 38 x 3,2 mm
1 200mm to 1 800 mm	44 x 44 x 3,2 mm
Over 1 800 mm	51 x 51 x 4.8 mm

xvii. Clearance shall be provided between the sleeve and the masonry opening on the top and at the sides of the fire damper, to allow for expansion. A gap of 1 mm for each 100 mm of sleeve width or depth shall be allowed, but the gap shall not exceed 15 mm.

7.10 Air Outlets and Dampers

7.10.1 Grilles

Supply and return air grilles shall be provided as indicated on the drawings and shall meet the following requirements:

i. Each grille shall be selected in accordance with the manufacturer's recommendation, to be capable of passing the specified air quantity without creating excessive resistance, noise or local draughts.

ii. Grilles shall be manufactured of stamped, extruded or rolled aluminium or steel sections, finished as specified and mounted in a neat frame.

iii. Supply air grilles shall be provided with double deflection aerofoil vanes, adjustable from the front of the grille.

iv. Vanes shall be spaced at not more than 20 mm centres.

v. Exhaust and return air grilles in the same installation shall be similar in general appearance and construction to the supply air grilles but with a single set of fixed vanes.

vi. Supply air grilles shall be provided with opposed blade volume control dampers adjustable from the front of the grille.

vii. Return air grilles shall be provided with opposed blade dampers for volume control. Grilles shall be furnished in a natural anodised finish to be accepted by the *Employer*. Dampers shall be adjustable from the front of the grille.

viii. Grilles shall in all cases be selected with free air passage areas not less than that indicated on the drawings.

7.10.2 Weather Louvres

Weather Louvres shall be manufactured of stainless steel, as specified and shall comply with the following:

i. Weather louvres shall be constructed with drip edges to the blades and rigid frames to enable fixing and installation.

ii. Weather louvres shall be finished as natural anodised, powder coated or painted as specified.

iii. Weather louvres shall be watertight, even with nominal air velocity up to 3.0 m/s.

iv. Weather louvres shall be fitted with 12 mm opening size stainless steel expanded metal or wire mesh screen.

v. Top and bottom blades shall be fitted flush with the frame and smooth without grooves, channels or recess where dirt or water could collect.

7.10.3 Ceiling Diffusers

Ceiling diffusers shall be manufactured of steel or aluminium and shall be finished in high quality white baked enamel or epoxy coated in a colour matching the ceilings, to be accepted by the *Employer*. The following further requirements shall be met:

i. Ceiling diffusers throughout the building project shall be of similar appearance.

ii. The *Contractor* shall, prior to placing orders for ceiling diffusers, submit a sample unit to the *Employer*, in the colour format required by the *Employer*.

iii. Diffusers shall be square, round or rectangular with face plates matching the ceiling grid as specified.

iv. Each diffuser shall be selected in accordance with the manufacturer's recommendations, to be capable of passing the specified air quantity without creating excessive resistance, noise or local draughts.

v. Each diffuser shall be provided with an opposed blade volume control damper, or alternatively an adjustable disk type throttling mechanism.

vi. Dampers shall be selected and installed so as not to disturb the supply air distribution pattern or induction ratio of the diffuser.

vii. Diffuser cores shall be removable for cleaning and access purposes.

7.10.4 Variable Volume Outlets

Variable volume outlets with controls and re-heaters shall be provided where indicated on the drawings and shall comply with the following:

i. Only well-catalogued and proven products will be considered.

ii. Minimum air volume shall be factory set and Site checked for each outlet.

iii. Outlets shall be selected and installed to ensure that no dumping or coning of supply air streams occurs, particularly at low air flow rates.

iv. Variable volume control shall be achieved with pneumatic or electric drives as specified. Low noise levels during operation is essential.

v. Re-heaters shall be protected against overheat and shall be switched with an adequately rated and reliable micro-switch.

vi. Easy access to all parts possibly requiring servicing, removal or setting shall be provided.

7.10.5 Dampers

Dampers for positive volume control purposes shall be manual or electric actuator driven as specified and shall be provided where indicated on the drawings. The following further requirements shall be met:

i. Damper blades, links and damper frames shall be of rigid construction galvanised steel, as per SANS 1238, and shall be of the opposed blade type.

ii. Manually adjusted dampers shall be provided with adjusting levers in accessible positions, with provision for positive locking in any position from fully open to fully closed.

iii. Dampers shall be of the link or gear type as specified.

iv. Damper blade shaft bearings shall be brass.

7.10.6 Non Return Outlet Louvers

Non return outlet louvers shall be installed where indicated on the drawings.

7.10.7 Door Grilles

Door grilles shall be supplied where shown on the drawings. Such door grilles shall be delivered in good time for fitting in the relevant doors/frames.

Door grilles shall of the “no vision” type, incorporating flanges on both sides of the door and horizontal blades of the vee type, spaced in order to limit air friction loss.

Door grilles shall be finished in natural anodised finish, as accepted by the *Employer.*

7.10.8 Floor Grilles

Floor grilles shall be supplied where shown on the drawings. They shall be manufactured from heavy section extruded Type 50S anodising grade aluminium. Grille cores should be easily removable and all grilles shall be fitted with opposed blade dampers.

7.11 Fans

7.11.1 General

The combination fan and silencer selection shall comply with the specified noise levels. The requirements under this section applies to fans which are not an integral part of cooling towers, air handling units or similar equipment, designed as standard units by the manufacturer. Fan duties are specified in the equipment schedules. The following further requirements shall be met.

i. Where no pressure requirements are indicated, the fan static pressure requirements shall be estimated from the system lay-out drawings and equipment.

ii. The design resistance of the total fan system shall be finally checked when all information on the selected system elements is available.

iii. Fans shall be selected to operate at or as near to maximum efficiency as possible.

iv. Flexible connections shall be fitted between fan inlet/discharge and ducting or equipment as appropriate.

v. Matching flanges shall be supplied with all fans.

vi. Fans shall be fitted with the manufacturer's nameplates, permanently fixed to the casing in a prominent position clearly indicting the manufacturer, model number, maximum operating speed, maximum power absorbed, size and serial number.

vii. Fan in/outlets, which are not connected to ducting or equipment with removable screens, shall be protected.

viii. Indicating arrows shall be provided on the fan casing, indicating direction of rotation and direction of air flow.

ix. Fans for special applications, such as corrosive gases, explosive atmospheres and the like shall be selected for the particular medium.

x. Fans for proprietary and package units, although not specifically covered in this specification, shall however comply with the general requirements of this specification.

xi. All fans shall be mounted on anti-vibration mountings or supported from anti-vibration hangers. All anti-vibration mountings shall be subject to acceptance by the *Employer*.

xii. Bearings shall be ball or roller type and quiet in operation.

xiii. Bearings shall be sized to have a long life (not less than 100 000 hours) at the loads imposed by the application.

xiv. Belt guards shall be arranged to permit lubrication and use of speed counters with the guard in position.

xv. Belt guards shall have adequate ventilation for belt cooling.

xvi. Fans shall be painted in the factory with one primer coat and two coats of high gloss corrosion resistant paint.

xvii. The *Contractor* shall provide and connect the electrical supply wiring with a local isolator near each fan, wired to the fan via an interlocking ON/OFF switch where necessary and as indicated in the technical schedules.

xviii. For 380 volt 3 phase fans, the *Contractor* shall provide a 3 phase local isolator, wired up to a 380 volt 3 phase supply, with interlocking starter contactor with suitable overload protection.

xix. The *Contracto*r shall wire and connect from the isolator to the fan**.**

7.11.2 Centrifugal Fans

Centrifugal fans shall be of the forward or backward curved, multi-vane type with single or double inlet and arrangement as specified in the equipment schedules. The following further requirements shall be met:

i. Fan performance shall be based on tests carried out in accordance with BS 848 : Part 1 or Part 3 (as applicable) as amended.

ii. The fan casing shall be of the volute type, manufactured from sheet steel with lock forming or continuously welded seams, suitably reinforced and adequately supported by means of a steel superstructure.

iii. Fans with a wheel diameter above 1000 mm shall be provided with access doors fitted to the fan casing.

iv. Fan wheel and shaft assembly shall be statically and dynamically balanced to ISO 1940 within grade G6.3.

v. Fan drives shall be by means of standard V-belt and grooved pulley configuration or direct drive.

vi. Fans and motors shall be rigidly bolted to a common prefabricated steel frame with the motor mounted on slide rails for normal belt drive adjustment or replacement. The complete frame shall be mounted on anti-vibration mountings.

vii. Larger fans shall be manufactured in sections with split casings to permit installation through available openings in new and existing buildings.

viii. Shaft bearings shall be grease lubricated, self-aligning ball or roller bearings, in accordance with the fan manufacturer's standard practice.

ix. For bearings located in the air stream, precaution shall be taken to prevent loss of lubricant.

x. Shafts shall be fully machined steel shafting conforming to BS 970.

xi. A drain socket with plug shall be provided at the lowest point in the fan casing (except if discharge is at lowest point).

xii. Fans used in variable volume applications shall have stable characteristics throughout the operating range to suit the particular application.

xiii. All fans shall be tested in the factory and checked for vibration to ISO 2372.

xiv. Bearings shall be checked using a shock impulse meter. All measurements and observations made during this test run shall be recorded and made available to the *Employer* on request.

xv. Fan motors in the air stream in draw-through applications with spray coolers or sprayed coils shall be TEFC and protected to IP44 or better.

xvi. Shafts for variable inlet vane control shall be supported by pre-lubricated sealed bearings.

xvii. Both sets of variable inlet vanes on double inlet fans shall be controlled simultaneously and equally.

7.11.3 Axial Flow Fans

Axial flow fans shall be of the aerofoil type with non-overloading characteristic. Peak power requirements shall occur within the normal operating pressure range and motor rating. The following further requirements shall be met:

i. Axial fans shall be selected for the highest possible efficiency with the lowest possible blade tip speed.

ii. All fans shall be of the adjustable pitch impeller type.

iii. The complete fan unit shall be statically and dynamically balanced in accordance with ISO 1940 within Grade G6.3.

iv. Fan performance shall be based on tests carried out in accordance with BS 848 : Part 1.

v. Fan casings shall be manufactured from reinforced mild steel with pre-drilled flanges at both ends. Casing access panels shall be provided wherever specified in the equipment schedules.

vi. Fan motors shall be totally enclosed squirrel cage induction type with protection to IP55, unless for a special application as set out in the equipment schedules.

vii. Motor connections shall be in an external weatherproof terminal box forming part of the casing, except for flameproof and special applications, which are specified in the equipment schedules

viii. Lubrication points shall be extended to the outside of the casing and inspection doors of ample size shall be provided in the casing.

ix. In the case of aerofoil bladed fans, fan impellers shall be manufactured from aluminium or rigid PVC and shall be fitted in machined hubs featuring individual blade angle adjustment.

x. Fans mounted in ducts shall be provided with access panels for inspection and shall be easily removable for maintenance purposes.

xi. Vibration isolation equipment to axial fans shall be provided in accordance with the specification.

xii. Axial flow fans, where not mounted in ducting, shall be protected with suitable wire-guards**.**

7.11.4 Roof Extract Fans

Roof extract units shall be of the vertical jet or mushroom type, unless prior acceptance for an alternative type has been given by the *Employer*. The following further requirements shall be met:

i. Fans shall be installed in accordance with the manufacturer's recommendations.

ii. Outlet cowls and shutters shall be the standard product of the fan unit manufacturer.

iii. Outlet grilles shall protect the fan from birds.

iv. Single phase fan motors shall be provided only where specified in the equipment schedules.

v. Flow and rotation direction arrows on fan casings shall be easily visible from the plant room or from the access to the fan.

vi. Where specified, units shall be suitable for upstand and curb mounting, complete with weather skirting and flashing as required.

7.11.5 Propeller Fans

Propeller fans shall be suitable for mounting with or without mounting plate (diaphragm) as specified in the equipment schedules. The following further requirements shall be met:

i. Wall cowls, wire guards, diaphragm plates and louvre shutters shall be standard products supplied with the fans.

ii. Mounting plates (diaphragm), where required, shall be of pressed steel or fibreglass reinforced polyester with integral bell mount orifice.

iii. Impellers shall be of heavy gauge contoured pressed steel blades or reinforced polypropylene or fibreglass reinforced polyester, ultra-violet stabilised, mounted on cast aluminium or steel hubs.

iv. Fan motors shall be totally enclosed, three-phase squirrel cage induction type with protection to IP44, unless otherwise specified in the equipment schedules.

v. Fans shall be resiliently mounted.

vi. Balancing and testing shall be as set out as for axial flow fans.

vii. Motor and impeller protection screens shall be fitted, as applicable.

viii. Where applicable, fans on exterior walls shall be fitted with weather proof louvre shutters and, where specified, with wall cowls.

ix. Fans shall be manufactured from corrosion resistant material, chemically treated and painted in a high gloss enamel.

7.11.6 Window/Wall Extract Fans

Window / wall type fans shall be fitted with automatic shutters and with finger protection guards.

Speed control shall be provided if specified and motors shall be fitted with thermal overload protection.

Where remote control is specified, the wiring between the fan, control point and power supply point shall be flush mounted with conduit and draw boxes.

7.12 Ductwork

7.12.1 Sheet Metal Ductwork

Air ducts shall be constructed according to “Low Velocity Duct Construction Standards” and “High Velocity Duct Construction Standards” (SMACNA) or SANS 1238 as amended. Ductwork shall be installed as indicated on the drawings. All duct dimensions, (including internally insulated ducts), refer to the clear internal cross-sectional area. The following further requirements shall be met:

i. Where changes in duct sizes as indicated are necessitated on Site, duct sizes shall be determined using equivalent diameters (hydraulic diameter) and not cross-sectional area.

ii. Construction shall be sturdy and ducts shall be airtight and shall not drum or vibrate when the internal static pressure varies.

iii. Ducts shall be constructed so that airflow is even, without excessive static pressure drop.

iv. Ducts shall be thermally insulated in accordance with the specifications.

v. Internal or external insulation shall be applied according to the requirements as shown on the drawings.

vi. Aspect rations in excess of 4:1 shall be avoided in rectangular ductwork.

vii. Internal duct dimensions of less than 200 mm in rectangular ducting are not acceptable in low and medium velocity ductwork.

viii. Adjustable opposed blade dampers, sound attenuators, duct splitters and turning vanes shall be provided wherever shown on the drawings.

ix. Unless otherwise specified ductwork shall be manufactured of galvanised sheet steel using thicknesses as recommended by SMACNA.

x. Ductwork shall be painted, as specified.

xi. All ducts passing through concrete or brick walls shall be isolated from the walls by means of a high density glass fibre collar at least 20 mm thick, to prevent transmission of vibration to the building structure.

xii. All openings where ducts pass through plant room walls shall be sealed by means of polysulphide mastic.

xiii. Flexible joints exposed to weather shall be provided with protecting galvanised sheet steel cover strips.

xiv. Flexible connections shall be made of fireproof fabric-reinforced air-tight material, attached both sides with *Employer* accepted galvanised steel collars or frames.

xv. Overhead hangers for horizontal ducts shall be of the “Trapeze“ type (SMACNA page 45).

xvi. Vertical ducts shall be supported in accordance with SMACNA page 43, Fig B.

xvii. Ductwork connected to equipment such as cooling towers, evaporative condensers, plenum chambers and the like, shall be provided with flanged removable sections to allow for removal of debris and access to eliminators.

7.12.2 Low Velocity Ducts

This section refers to ducts with velocity up to and including 10 m/s and static pressure up to and including 500 Pa. Reference shall be made to “Low Velocity Duct Construction Standards” (SMACNA) for all constructional requirements. Applicable alternative methods and further requirements are as specified below.

i. Galvanised sheet steel shall be used with thickness as recommended in SMACNA (“Table 1, Page 11). Either cross-breaking or beading is acceptable.

ii. Longitudinal seams shall be of the “Pittsburgh Lock” or “Acme Lock” type. Transverse joints shall be as follows (SMACNA – Table 1, Page 11).

Table 11 : Ducts

Dimensions of Longest Side of Duct	Traverse Joints		Reinforcing Angle
	Long Side	Short Side	
Up to 450 mm	B	A	SMACNA – P 11
475 – 750 mm	E	A	SMACNA – P 11
775 – 1 500 mm	L	L	SMACNA - P 11
1 525 mm and larger	M	M	SMACNA – P 11

iii. Reinforcing angle irons shall be galvanised. Rivets, screws, bolts and other fastening equipment shall be completely corrosion proof.

iv. Elbows shall be in accordance with SMACNA Page 61. Standard radius elbows shall generally be used. Short radius elbow pieces shall be used where shown on the drawings.

v. Square elbows with galvanised turning vanes shall be in accordance with SMACNA Fig. A, Page 53.

7.12.3 High Velocity, Medium Pressure Ducts

Reference shall be made to "High Velocity Duct Construction Standards" (SMACNA) for all constructional requirements. This part of the specifications applies to ducts with velocities higher than 10 m/s and a static pressure between 500 Pa and 1 500 Pa. The following further requirements shall apply:

i. Galvanised sheet metal shall be used with thicknesses as recommended in SMACNA Fig 3-1, Pages 14 and 15. Construction shall be in accordance with (1), (2), (4) and (12) of Fig 3-1.

ii. Standard radius elbows shall generally be used. Short radius elbow pieces shall be used where shown on the drawings.

iii. Short radius elbows shall be provided with splitters and square elbows with double thickness type turning vanes (SMACNA pages 42, 43 and 44).

iv. Flexible ducts shall be of the spiral wire reinforced glass fabric type (SMACNA) page 63).

v. Overhead hangers for horizontal ducts shall be of the "Trapeze" type (SMACNA page 56). Support vertical ducts shall be as indicated in SMACNA page 57.

7.12.4 High Velocity, High Pressure Ducts

This part of the specification refers to ducts with velocities above 10 m/s and static pressure above 1 500 Pa. Reference is made to "High Velocity Duct Construction Standards" (SMACNA) for all constructional requirements. Applicable alternative methods and further requirements are as specified below.

i. Galvanised sheet steel used for construction shall be in accordance with SMACNA Fig 3-2 Pages 16 and 17, Tables (1), (2), (4) and (11).

ii. Standard radius elbows shall generally be used. Short radius elbow pieces shall be used where shown on the drawings.

iii. Short radius elbows shall be provided with splitters and square elbows with double thickness type turning vanes. (SMACNA) Pages 42, 43 and 44.

iv. Flexible ducts shall be of the spiral wire reinforced glass fabric type (SMACNA Page 63).

v. Overhead hangers for horizontal ducts shall be of the "Trapeze" type (SMACNA Page 56). Vertical ducts shall be supported as indicated in SMACNA Page 57.

7.12.5 Flexible Ductwork

Where indicated on the drawings, ductwork shall be connected to mixing boxes and integrally mounted ceiling diffusers by means of flexible ducting. The following requirements shall be met:

i. Flexible ducts shall be either of the flexible aluminium foil metal type or of the spiral reinforced fabric type, in accordance with SMACNA Page 106.

ii. All flexible ducts shall be insulated externally.

iii. Flexible ducting shall comply with local fire codes, NFPA Bulletin 90A and SANS 10400 fire resistance requirements.

iv. Flexible ducts connected to diffusers or mixing boxes shall, unless otherwise shown or accepted, not exceed 1.2m in length nor have more than the equivalent of one 90° bend.

v. Bends shall be of the maximum possible radius without flattening or distorting the flexible ducting.

vi. Flexible ducting shall be supported with sufficient and correct brackets that will ensure that the shape of the duct is maintained.

7.12.6 Duct Access Doors

Access doors shall be of the insulated hinged type as shown in SMACNA Fig. B, Page 17 (“Low Velocity Duct Construction Standards”).

Access doors shall be of sizes as shown on the project drawing**.**

7.12.7 PVC Ductwork

PVC Ductwork, where specified on the drawings, shall be of unplasticized polyvinyl chloride (uPVC), manufactured and installed in accordance with SMACNA – “The Thermoplastic Duct Construction Manual”. The following further requirements shall apply:

i. The class of ducting shall be as specified.

ii. Provision shall be made for expansion and contraction of the ductwork.

iii. Flexible connections shall be made of plasticized polyvinyl chloride (PVC).

iv. Duct joints shall be welded flanges or male/female socket type welded around.

v. All welded joints and seams shall be tested by high frequency spark test at 40 kV.

7.12.8 Manual Air Dampers for Volume Control

Each branch duct leading to a single air outlet shall be provided with a damper, unless the outlet diffuser is of the variable volume type. The following requirements shall apply:

i. Each branch duct leading to a group of air outlets shall be provided with a damper at the point where the branch leaves the main air duct. Splitters may be used in lieu of dampers where the estimated pressure drop does not exceed 30 Pa.

ii. Dampers and splitters shall be installed so that they can be adjusted at any time after the completion of the *works*.

iii. Access panels shall be provided where the adjusting mechanism is concealed by suspended ceilings, furring or the like.

iv. Front and back bars or vanes of directional grilles shall not be used for adjustment of air quantities.

v. Butterfly dampers shall be of the balanced type with opposed blades and shall be constructed in accordance with SMACNA Pages 64,65,66 and 67 (“Low Velocity Duct Construction Standards”).

vi. Dampers shall not be used to create artificial resistance in the system in order to reduce fan air flow capacity.

vii. Reduction of air flow shall be accomplished by reduced fan speed or by changing the fan blade angle.

7.12.9 Testing

Unless otherwise specified, the total ductwork installation shall be tested for leakage, as per SANS 10173.

Leakage rates shall not exceed 5% of the required air flow quantity in any section of ductwork, or exceed the SANS permissible leakage, whichever is the smaller.

7.12.10 Duct Installations

Ductwork shall be installed in accordance with the drawings. The drawings are diagrammatic insofar as construction details are concerned, but they are drawn to scale and give the exact, required duct positions. All final dimensions shall however be checked on Site before preparation of manufacturing drawings and the fabrication of ducting.

Where beams, stanchions or other obstructions interfere with the straight running of ducts, suitable offsets shall be provided or changes made in the section of the particular duct. All drawings of any particular building shall be checked by the *Contractor* to determine the number of such offsets or changes in section and the positions in which they will be required. The tendered rates shall make allowance for such offsets.

7.12.11 General

Unless specified otherwise, type 316 stainless steel shall be used for stainless steel ducting.

All exhaust air ducting for moisture-producing equipment, such as cooling towers, or where air is drawn in through or over water, shall have sealed longitudinal and cross joints and shall be painted on the inside with corrosion protection paint to the satisfaction of the *Employer*. Corrosion protection shall provide a minimum protection life of five years.

Black mild steel with a minimum thickness of 1.6 mm shall be used for grease- contaminated exhaust systems. All joints shall be welded.

7.12.12 Duct Hangers

Duct hangers shall not protrude below the lowest part of the shelf angles and shall be as follows**:**

Table 12 : Duct Hangars

Longest Duct Dimensions (mm)	Round Hangers (mm)	Galvanized Strap Hangers (mm)	Shelf Angles	Maximum Spacing (mm)
Up to 760	6	25 x 1.6	25 x 25 x 3	3.0
761-1000	10	25 x 1.6	38 x 38 x 3	3.0
1001-1200	10	25 x 1.6	50 x 50 x 3	2.4
2101 – 2400	10	25 x 1.6	50 x 50 x 6	2.4
2401 and over	12	25 x 1.6	50 x 50 x 6	2.4

7.13 Insulation

7.13.1 General

All surfaces shall be cleaned and treated before insulation and a base coat shall be provided prior to insulation. Steel surfaces shall be prepared and painted in accordance these specifications. The following further requirements shall be met:

i. All pressure tests shall be conducted in the presence of the *Employer* prior to insulation.

ii. All thermal insulation *works* shall only be executed by suitably qualified and experienced *Contractors*, to be accepted by the *Employer*.

iii. Only adhesives sealants and coatings, which are compatible with the insulation material, shall be used.

iv. Only insulation materials, which do not produce toxic fumes when burning, shall be used.

v. Certified test reports, issued by independent institutions, shall be submitted, covering the following information:

- Thermal conductivity of insulating materials at operating temperature.
- Surface spread of flame of insulating materials, adhesives and other finishes.
- Permeance of vapour barrier systems (chilled water systems).
- Sound absorption co-efficient of insulation materials (internal insulated ducts).

vi. The surface spread of flame of insulation cladding shall be in accordance with BS 476 Class I.

vii. Only insulation, adhesives and finishes which are resistant to rotting, mould, fungus growth, decay and attack by vermin shall be used.

viii. Upon conclusion of the pressure tests and before the application of insulation sections, all piping shall be thoroughly de-greased and painted with a high quality anti-corrosive paint.

ix. The *works* shall be executed in a workmanlike manner and the final surface shall be of a neat, smooth and symmetrical finish.

x. Thermal insulation of equipment shall comply with BS CP 3005, provisions of BS 1334 and BS 476 or the latest versions / amendments as applicable.

xi. Oil, grease, rust, scale and dirt shall be removed from surfaces by means of a suitable cleaning agent before the application of insulation.

xii. No equipment shall be insulated until tested and accepted.

xiii. Pipes shall be painted with bitumastic paint before application of insulation.

xiv. The permeability of insulation cladding around chilled water pipes shall not be more than 1.

xv. The thickness of insulation cladding will be checked by the *Employer* after completion of insulation *works*. If any thicknesses are less than that recommended by the manufacturer, the *Contract*or will be requested to apply one extra cover coat over the whole installation at his own expense.

xvi. Continuity of the vapour barrier shall be ensured.

7.13.2 Insulation of Chilled Water Pipes

i. Chilled Water Pipes

All supply and return pipes shall be insulated with preformed sections of insulation with a heat transmission co-efficient not higher than 0.035 watts per square metre per degree C. The following further requirements shall be met:

i. The insulation thickness shall not be less than 25 mm over any pipe or fitting.

ii. The insulation thicknesses are shown on the drawings.

iii. Insulation on pipes larger than 125 mm in diameter shall not be less than 40 mm.

iv. The preformed sections of insulation shall be provided with a factory applied canvas finish.

v. During installation the *Contracto*r shall ensure that the canvas finishes overlap each other by at least 25 mm on all joints.

vi. A vapour-proof protective cladding equivalent to "FOSTER SEALFAS coating 30-36", "DECADEX fire check" or accepted equivalent, shall be brush-applied over the canvas covering. The applications shall be as follows:

- FOSTER 30-36 – 2 coats each at 1.6m² per litre.
- DECADEX FIRE CHECK – 2 coats each at $1m^2$ per litre.

vii. Circumferential joints to the insulation shall receive one application of 'FOSTER FOAMSEAL 30-45" or accepted equivalent, to the full thickness of the insulation during erection to obviate lateral migration of moisture vapour along the pipe when in service.

viii. All points where pipe supports are used, or where the vapour barrier is broken due to cut-outs in the insulation, shall be sealed with "FOSTER FOAMSEAL 30-45" or accepted equivalent, during erection.

ix. Circumferential and longitudinal laps to the canvas shall be adhered with "FOSTER SEALFAS coating 30-36'1 or accepted equivalent before application of final coats.

x. Bends, valves, flanges and fittings shall be insulated and covered as described for pipes.

xi. Exposed pipe insulation inside the central chiller plant room and all insulated piping in the basement areas, riser shafts and outside the building (weather exposed) shall be insulated with the relevant thickness as stated above and shall be provided with applied shop-strand glass fibre mat. The vapour barrier in this instance shall be formed by applying two brush coats of epoxy resin to suit the colour specification.

xii. All flanges, valves, non-return valves and other devices in this pipework requiring servicing shall have easily removable jackets.

ii. Pipes in Plant Rooms

All supply and return pipes in plant rooms shall be insulated with sectional resin bonded glass fibre insulation with a density of at least $96kg/m^3$ and with the following thicknesses.

Pipes up to 125 mm diameter	:	25 mm
Pipes bigger than 125 mm diameter	:	40mm

The following further requirements shall be met:

i. Glass fibre insulation with a factory applied canvas finish shall be used.

ii. A vapour barrier, using only coatings and cloth accepted by the *Employer,* shall be used. The vapour barrier shall have a permeance not exceeding 0.30 perms.

iii. All circumferential joints shall be sealed to the insulation with an accepted sealant to the full thickness of the insulation during erection, to prevent lateral migration of moisture vapour along the pipe when in service.

iv. All points where pipe supports are used or where the vapour barrier is broken due to cut-outs in the insulation shall be sealed with an accepted sealant.

v. All circumferential and longitudinal laps of the canvas shall be sealed.

vi. Straight runs of pipe with a 0.5 mm thick galvanised sheet metal cladding over the insulation material shall be provided.

vii. Bends with "lobster back" bends shall be cladded with a 0.5 mm thick galvanised sheet metal.

viii. The sheet metal covering shall be cut to the size of the pipe support.

ix. Cladding shall be secured by galvanised steel bands or pop rivets every 500 mm. Self-tapping screws shall not be used.

x. Sheet metal cladding shall be installed with seams in the "20 minutes past the hour" position. Where possible, the cladding shall be installed with the seams in non-visible positions.

iii. Pipes outside Plant Rooms

Pipes and fittings outside plant rooms do not require sheet metal cladding. The insulation shall be covered with shop-stand glass fibre mat as above.

7.13.3 Insulation of Hot Water Pipes

Pipe insulation for hot water piping shall be provided with applied canvas finish. Bends, valves, flanges and fittings shall be insulated as stated above for chilled water piping**.**

i. Pipes in Plant Rooms

All supply and return pipes shall be insulated with plain resin bonded glass fibre insulation with a density of at least 96 kg/m^3 and with the following thicknesses.

Pipes up to 125 mm diameter : 25 mm
Pipes bigger than 125 mm diameter : 40 mm

The insulation shall be clad as described above.

ii. Pipes outside Plant Rooms

All supply and return pipes outside plant rooms shall be insulated as described for pipes in plant rooms. Glass fibre insulation with a factory applied canvas covering shall be used. A protective coating shall be applied over the canvas.

7.13.4 Thermal Storage & Other Vessels and Heat Exchangers

Insulation shall consist of a 100 mm thick layer of glass fibre with a density of at least 96 kg/m^3. The following further requirements shall be met:

i. The insulation shall be covered with a 0.5 mm thick sheet metal covering.

ii. Dished ends shall be clad with triangular segments, to ensure a neat installation

iii. Internal supports shall be fitted to prevent compression of the glass fibre material.

iv. All manholes and inspection welded seams with easily removable sections.

v. Neat sheet metal trims shall be fitted around pipes connected to the equipment, which shall be bolted or screwed to the sheet metal cladding.

7.13.5 Insulation of Air Ducts

i. Ducts - General

Hanger pins for the fastening of external insulation shall comply with the requirements as specified in "Duct Liner Application Standard" (SMACNA) where applicable. The following further requirements shall be met:

i. Hanger pins shall preferably be of the electric stud weld type. Welding time shall be sufficient to ensure a firm adhesion.

ii. Fresh air and exhaust air ducts shall not be insulated, unless specifically specified.

iii. For inside and protected applications, all ducting conveying cooled or heated air and all ducting returning air from conditioned spaces shall be externally insulated using 25 mm nominal thickness fibreglass blanketing of 24 kg/m^3 density with factory applied aluminium foil external coating.

iv. The insulation shall be affixed over its full area with adhesive suitable for bonding between fibreglass blanketing and galvanised sheet metal and shall be mechanically secured at maximum intervals of 400 mm in any one direction by means of spot welded pins with securing washers or heads of diameter not less than 30 mm.

v. Projecting pins shall be turned over for safety.

vi. Joints in the insulation shall be covered with 100 mm wide adhesive backed aluminium foil to ensure continuous insulation and a vapour barrier.

vii. For all outside and weather exposed ducting (all ducting which conveys cooled or heated air) to and from conditioned spaces shall be externally insulated using 50 mm nominal thickness fibreglass blanketing of 24 kg/m^3 density, covered with a fibreglass layer for protection and finished with a waterproof barrier.

ii. Internal Air Duct Insulation

All air conditioning supply and return air ducts shall be internally insulated with 25 mm thick insulation to the latest edition of the relevant SANS Specification, unless otherwise specified. The following further requirements shall be met:

i. Insulation material shall be resin bonded, mineral or glass fibre with a protective synthetic membrane specifically designed for internal duct insulation.

ii. All leading and trailing edges of insulation shall be fitted with metal nosing piece to keep the insulation in place. This nosing piece shall cover the insulation for a minimum distance of 30 mm over the entire perimeter.

iii. In addition to the welded pins, positioned as described in the latest edition of the relevant SANS specification, the insulating material shall be glued to the sheet metal, ensuring a 100% area adhesion.

iv. The minimum insulation material density shall be 24 kg/m^3.

v. Any damage to the insulation or membrane shall be repaired to the satisfaction of the *Employer*.

iii. External Duct Insulation

Air conditioning supply and return air ducts shall be externally insulated with insulation of at least 25 mm thickness where external insulation is specified. The following further requirements shall be met:

i. Insulation material shall be resin-bonded mineral or glass fibre, with a protective aluminium facing specifically designed for external duct insulation.

ii. Insulation shall be installed in a neat and workmanlike manner.

iii. Insulation shall be adhered to the duct surface by means of “FOSTER SAFETEE DUCTFAS ADHESIVE 81-99” or accepted equivalent.

iv. The *Contracto*r shall ensure a 100% area-bonding between the duct and insulation.

v. The insulation on the sides and bottom of the duct shall be pinned with mechanical fasteners as described for internally insulated ducts.

vi. All joints shall be taped with an aluminium adhesive tape accepted by the *Employer*. The minimum insulation material density shall be 24kg/m³.

vii. The continuity of the vapour barrier shall be insured.

iv. Special Requirements

The air conditioning supply and return air ducts shall be externally lagged, as described in further parts of these specifications.

v. Ducts in Plant Rooms or Visible Air Conditioned Areas

The following requirements shall be met:

i. Ducts shall be externally insulated with resin bonded glass fibre of 25 mm thickness and with a density of 24 kg/m^3.

ii. The insulation shall be accurately cut so that the edges at all joints closely abut each other.

iii. Insulation shall be bonded to the duct surface using an accepted glue.

iv. Inverted and side insulation shall be additionally supported by the use of hanger pins.

v. Where insulation is cut to provide for duct hangers, supports or other projections through the insulation, the insulation shall be sealed for the full thickness and shall be brush-coated with one application of an accepted coating.

vi. Ducts outside Plant Rooms or in Concealed Non Air conditioned areas

Ducts shall be externally insulated with resin bonded glass fibre of 50 mm thickness and density of 24 kg/m^3 and covered with a factory-applied aluminium foil facing.

Insulation shall be adhered to the duct surface by means of an accepted adhesive. All protrusions and cuts through the insulation shall be sealed for the full insulation thickness.

Duct hangers shall not be covered with insulation and shall be removed one by one when applying external insulation.

7.13.6 Metal Cladding of Pipes

All chilled and hot water pipes in plant rooms shall be provided with a 0.5 mm thick galvanised sheet metal cladding over the insulation material. The cladding shall be installed after the vapour-proofing has been accepted by the *Employer*. The following further requirements shall be met:

i. Care shall be taken not to damage the vapour barrier.

ii. Cladding shall be secured by stainless steel bands every 500 mm. Self-tapping screws shall not be used.

iii. The sheet metal covering shall be cut at pipe supports or hangers.

iv. No dents or any damage to sheet metal covering will be accepted at the final inspection.

7.13.7 Valves and Fittings

Valves and fittings shall be insulated with resin-bonded mineral, wool or glass fibre with a minimum density of 96 kg/m. The following further requirements shall be met:

i. Plaster of at least 13 mm thick shall be applied over a steel mesh covering the insulation. The plaster shall be of the asbestos hard setting compound type, trowelled to a neat, smooth and symmetrical finish.

ii. The insulation of valves and fittings shall fit neatly to the rest of the pipe insulation.

iii. Care shall be taken that all valves and fittings can be operated without damaging the insulation.

iv. The end plates of strainers shall be insulated with suitable closed cell foam rubber to prevent any dripping.

7.14 Water Treatment

7.14.1 General

i. The water treatment company shall have a fully equipped laboratory to assist in fault finding and field systems division to maintain the equipment installed.

ii. The *Contractor* shall provide water treatment for all cooling towers, open and closed circuit type as well as evaporative condensers.

iii. The *Contractor* shall provide water treatment and water quality control to match the specific application and local Site and water conditions.

iv. The *Contractor* shall provide water treatment for evaporative cooling units only where specified in the Project Specification.

v. The tendered rates shall include for the supply, delivery and installation of all necessary equipment, including labour, fittings and electrical wiring and connections to render the installation operative.

vi. All the required chemicals shall be supplied, delivered and applied both initially and subsequently during the maintenance period. Additional dosing for adjustments shall be for the supplier's account.

vii. The chemicals which are used shall not contain chromates. The effluents from any of the above systems shall meet with municipal by-law regulation of zinc, copper, aluminium, sodium, tin and other toxic metals. The pH shall be between 2,5 – 11,5 or any stricter values laid down in local by-laws.

viii. The *Contractor* shall ensure that effluent discharges from a treatment circuit do not violate any national laws or any local authority by-laws. The onus for determining the applicable regulations vests with the *Contractor*.

ix. Dosing quantities and periods shall be determined by the equipment supplier.

7.14.2 Test Kit

A test kit for testing the quality of the water complete with instructions how to operate the test kit shall be supplied to the *Employer*.

7.14.3 Service Visits

i. The *Contractor* shall, in conjunction with his supplier, maintain the equipment, draw samples of the system water and chemically analyse this water on Site on a monthly basis, for the full duration of the defects liability period. The results, together with the make-up quantities and chemicals used, shall be recorded and these reports shall be sent to the *Employer* immediately upon completion of the tests.

7.14.4 Water Treatment of Chilled and Hot Water Systems

i. Cleaning of Pipes

The piping systems shall be flushed according to the following schedule before being filled with treated water and to the satisfaction of the *Employer*.

i. For the removal of metal deposits : A 5% solution of Clorodine No. 2 shall be circulated through the systems with all balancing valves open. The circulation shall be continuous for a period of at least eight hours. The system shall then be drained.

ii. For the neutralizing of acids and dissolving of grease : The systems shall then be filled with a 5% solution of Soda ash and circulated for a period of not less than two hours. The system shall then be drained.

iii. Rinse : The systems shall then be filled with tap water and circulated for a period of not less than one hour. The system shall then be drained.

iv. Filter cleaning : After each operation as described above, all the filters shall be cleaned out and be replaced. After the final rinse the filters shall be cleaned out and then, after an inspection by the *Employer,* the system shall either be declared clean or the complete pipe cleaning procedure shall be repeated.

ii. Dosing Pot

i. A 5 litre dosing pot, complete with valves, shall be installed for each system, according to the installation instructions of the manufacturer.

ii. Rust prevention : An initial dose of Organol 3075 or accepted equivalent shall be added to the water system in the prescribed quantities as indicated by the manufacturer of the water treatment chemicals.

iii. The *Contractor* shall allow in his tender price for the initial dose and subsequent conditioning doses for a period of one year after handing over to the *Employer,* as recommend by the manufacturer.

iv. Biocide : Biocide B or accepted equivalent shall be added to the water system in the prescribed quantities as indicated by the manufacturer.

v. The *Contractor* shall allow in his tender price for the initial dose and subsequent doses for a period of one year after handing over to the *Employer* as indicated by the manufacturer.

iii. Water Softener

i. The *Contractor* shall install water softeners in the make-up lines to evaporative condensers and cooling towers where required by the local conditions.

ii. Where capacities are not specified, the softener shall have sufficient capacity to ensure that the make-up demand is met under all operating conditions and that the softener will be capable of operating for at least 48 hours without regeneration.

iii. The softener shall function automatically and shall be of the base exchange type, manufactured from corrosion resistant materials.

iv. The softener and dosing plant (where specified) shall be of the same manufacture and provided by the same local supplier.

v. The softener shall be installed complete with a flow recording meter, control wiring, and the like and a bypass valve arrangement.

vi. Each water softener shall be equipped with a time control mechanism to automatically control the time lapse between regeneration cycles for any period between 24 hours and 7 days. Alternatively the regeneration cycle may be controlled volumetrically by means of a meter in the soft water outlet pipeline.

vii. The brine tank shall hold at least one week's brine for summer conditions and shall be manufactured from PVC, Polypropylene or similar material.

viii. The salt level shall not be more than two thirds of the tank volume.

ix. Drainage pipe work shall be taken to the nearest drain pipe.

x. The *Contractor* shall install the softener to match the existing Site water pressure. If the water pressure is too high, an accepted pressure reducing valve shall be installed. If the water pressure is too low, a booster pump of sufficient capacity shall be installed.

iv. Water Dosing Plant

i. Unless otherwise specified, cooling tower/condenser water circuits shall be provided with automatic dosing plant including bleed control.

ii. The functions of such equipment shall be:

- Conductivity control.
- Water stabilisation chemical dosing.
- Microbiological control chemical dosing.

iii. Where capacities are not specified the dosing plant shall have sufficient capacity for the application and local water quality.

iv. Each evaporative condenser or cooling tower circuit shall be provided with its own independent dosing plant and bleed control.

v. The dosing system shall be complete with all necessary chemicals, controls, valves and appliances.

vi. The system shall comprise of an automatic bleed-off valve controlled by an electronic measuring cell from the water conductivity and automatic measuring type dosing pump/s. The electronic measuring cell shall continually measure the water conductivity and control the bleed-off valve and dosing pump/s accordingly.

vii. The pre-set values of the water conductivity shall be adjustable. The TDS shall be controlled in the range of 600-800mg/b.

viii. The water treatment shall ensure that:

- Scale forming and corrosion are prevented.
- Algae and microbiological growth is controlled.
- Sediment is controlled with low water consumption.

ix. Chemicals shall comply with the local health authority regulations and shall be compatible with all materials forming part of the piping system.

x. Accepted dilution tanks shall be provided as reservoirs for the metering pumps.

xi. Sufficient chemicals and salt shall be provided for three months use at first hand over.

xii. When the plant is in effective operation, water samples shall be drawn after the softener and from the condenser sump. The samples shall be analysed by a recognised laboratory suitably equipped and the report submitted to the *Employer*.

xiii. The *Contractor*, in conjunction with his supplier, shall carry out service calls with water analysis and recognised corrosion tests out every three months during the defects liability period. Reports shall be sent to the *Employer*. The tests shall include, but not necessarily be limited to, the following:

- pH
- TDS
- Turbidity

xiv. Isolating valves shall be provided to allow all components of the water treatment plant to be removed for maintenance without affecting the operation of the cooling plant.

xv. The water treatment plant shall be electrically interconnected with the recirculating water pump so that it cannot operate unless the pump is running.

xvi. Chemicals shall be readily available from a recognised local supplier.

xvii. Chemicals shall be selected so as not to interact with or neutralise each other.

xviii. Concentration of chemicals in pipe system shall be in accordance with suppliers' recommendations.

v. Closed Water Systems

i. The closed water treatment function shall maintain the design heat transfer by keeping the system clean and free from attack sludge deposits, insulating deposits and microbiological growth. This shall be achieved by a once-off barom-nitrite based treatment, providing 1000 to 1500 ppm of nitrite in the system.

ii. Apart from the actual dosing, the system shall have a 20mm PVC corrosion test rig.

iii. This unit shall come complete with mild steel and copper coupons. These coupons shall be numbered and accurately weighed prior to installation. After 6 months the coupons shall be removed, cleared and re-weighed. The resultant weight loss shall be calculated and a full report submitted to the *Employer*.

iv. The installation of the coupon racks shall be by the *Employer* accepted water treatment specialist subcontractor, appointed by the *Contractor*.

v. The closed water system shall be in compliance with the capacities and operating conditions as indicated in the table below.

Table 13 : Capacity and Operating Parameters : Closed Water System

Substation M : Main Plant	
Circulation rate	CW: 13.2 litre/s
System volume	1 810 litre
Water temperature	CW: 6.0 / 11,5°C
Substation N : Main Plant	
Circulation rate	CW: 16.6 litre/s
System volume	2850 litre
Water temperature	CW: 6.0 / 11,5°C
Main Intake Substation 11 kV Switch House : Main Plant	
Circulation rate	CW: 8.5 litre/s and 4.6 litre/s
System volume	975 litre
Water temperature	CW: 6.0 / 11,5°C

E

vi. *Note*

i. In order to monitor the chilled water programme effectiveness, corrosion rates shall be monitored and reported on every month, as described under Subclause 17.14.4 iv : Item xiii.

ii. Corrosion monitoring equipment and the costs of the water analysis shall be included in the tendered rates.

iii. Regular on-Site analysis of water stabilisation process, microbiological contamination and closed water system shall be carried out on a monthly basis for the duration of the defects liability period. Written reports shall be submitted to the *Employer*.

iv. The *Contractor*, in conjunction with his appointed water treatment specialist subcontractor, shall be responsible for all chemicals required during the defects liability period.

v. Where dosing tanks/drums are required these shall be mounted on a suitable galvanised stand.

7.15 Chillers

7.15.1 Reciprocating Compressor Water Chillers

i. Reciprocating compressors shall be of the open, semi-hermetic or hermetic type.

ii. Compressors in the larger cooling capacity ranges shall be equipped with positive lubrication systems.

iii. Compressors shall be operated within the selection and speed ranges recommended by the manufacturer. Compressor/motor units shall operate at a maximum speed of 1440 RPM.

iv. Provision shall be made to prevent excessive accumulation of liquid refrigerant in crank-cases during off-cycles. Larger units shall be factory-fitted with crank-case heaters as a standard.

v. Compressors having nominal cooling capacities of 35 kW and larger, shall be equipped with built-in capacity controlled steps (depending on number of cylinders) of unloading cylinders. Compressors with nominal cooling capacity exceeding 7kW shall start unloaded.

vi. Open type compressors shall be directly coupled to the drive motor by means of flexible couplings. Motor and compressor assemblies shall be statically and dynamically balanced and shall be free from vibration at all operating conditions.

vii. Compressor and motor shall be mounted on a single robust bed-plate of fabricated steel construction.

viii. Multiple compressors connected to the same refrigerant circuit shall have the piping arranged to return oil equally to all compressors and balance lines shall be installed to equalise pressure differences between compressors.

ix. The compressors shall all operate at the same suction pressure.

x. Operating and safety controls shall be provided for each unit in a control panel forming an integral part of the unit, or in a separate control panels/switchboard, as specified.

xi. The following controls and instruments shall be provided, as a minimum:

- Suction and discharge pressure gauges with isolating valves.
- Oil pressure gauge and low oil pressure safety switch on compressors with positive pressure oil freed.
- High and low refrigerant pressure safety switches.
- Positive action timer controlled circuit for pump-down and to prevent short-cycling.
- Sight glass indicating oil level in crank-house.

xii. Units 7 kW and larger shall be fitted with a suction strainer and an oil filter with replaceable element and safety by-pass.

xiii. The *Contractor* shall provide the initial charge of oil and refrigerant.

xiv. The *Contractor* shall fit initial motor-over-temperature protection to hermetically and semi-hermetically sealed units together with over-current protection.

xv. Serviceable compressors shall be equipped with shut-off valves on the suction and discharge sides.

xvi. Compressors and components of 40kg and heavier shall be fitted with lifting lugs.

xvii. The compressor manufacturer/supplier shall have adequate local back-up support and shall carry sufficient stock of the complete line of spare parts that may be subject to replacement.

xviii. Each water chiller shall be supplied and installed complete with one or more compressor and motor units, water cooler (evaporator) condensers, expansion valves, refrigerant piping circuits, controls, control panel and starter panels.

xix. The water chiller shall be a complete packaged unit, with all components mounted on a sturdy steel framework with cladding, panels and the like, to match the application.

xx. The condenser shall be air cooled or water cooled, as specified.

xxi. Water cooled condenser(s) shall be of steel and tube design with seamless copper tubes, integrally finned, expanded into steel tube sheets and incorporating a safety relief valve.

xxii. Condenser(s) shall be in full compliance with all local government factory/machine regulations.

xxiii. Both ends of the condenser bundle shall be removable for tube cleaning.

xxiv. Tubes shall be accessible from either side of the shell for tube replacement and cleaning purposes. Each tube shall be individually replaceable.

xxv. Internal baffling shall be corrosion proof.

xxvi. Condenser end caps shall be fitted with sacrificial anodes.

xxvii. Chillers smaller than 30 kW cooling capacity may be provided with copper to copper, tube-in-tube evaporators.

xxviii. Water-side working pressure for the water cooler and condenser (where water cooled) shall be not less than 1000 kPa and shall be suitable for the specified operating conditions.

xxix. Evaporators shall be factory insulated.

xxx. Step control shall be provided, matching the compressor/cylinder configuration.

xxxi. Each evaporator unit shall be provided with a chilled water low temperature safety switch which is manually re-set.

xxxii. The evaporator-condenser shells shall be of carbon steel plate.

xxxiii. Evaporators and condensers shall be designed, tested and stamped in accordance with ASME Code for refrigerant side working pressure of 21 bar.

xxxiv. The insulation of all low-temperature surfaces shall be covered with 19mm Armaflex 11 or equal K=.28, including the evaporator, water boxes, economiser lines and items to prevent formation of condensation.

xxxv. The carbon steel tube sheets shall be drilled, reamed and grooved to accommodate the tubes.

xxxvi. The evaporator and condenser tubes shall be individually replaceable, externally finned, internally enhanced seamless copper with glands at all tube sheets. The evaporator tubes shall be 25mm diameter and the condenser tubes shall be 19mm diameter. The tubes shall be mechanically expanded into tube sheets. The condenser tubes shall be mechanically fastened to tube supports. The condenser baffle shall prevent direct impingement of compressor discharge gas upon the tubes.

xxxvii. All tube pass arrangements shall be available at 21 bar waterside working pressure with right or left hand face flanged connections. Waterside shall be hydrostatically tested at 1.5 times design working pressure, but not less than 21 bar.

xxxviii. The compressor control shall be interlocked with a flow-switch in the chilled water and condenser circuit (with delay timer) to prevent the unit operating with no water flow.

xxxix. Multiple compressor and refrigerant circuit units shall be provided with automatic controls for lead/lag switching and operating time balancing of compressor running hours.

xl. Units shall be selected with fouling factors as specified in the specifications.

7.15.2 Centrifugal Compressor Water Chillers

i. Centrifugal compressor chillers shall be of the packaged type, complete with built-up water cooler and condenser, centrifugal compressor, capacity control system, lubrication system, purge system, all interconnecting piping, controls and all other auxiliaries required for the proper and safe operation of the unit.

ii. Rotor assemblies shall be statically and dynamically balanced and free from vibration at all operating conditions, also during acceleration from rest and deceleration from operating speed to rest.

iii. The operating speed shall be well below the first critical speed.

iv. Centrifugal water chillers shall be of the standard, factory assembled, packaged type.

v. Units shall be equipped with a forced lubrication system complete with oil pump, reservoir, oil heater, oil cooler, filter, level indicator and the like, which shall provide positive lubrication of all moving parts under all operating conditions, including start-up and shut-down operations.

vi. Each unit shall be provided with a control panel or cabinet containing the main switch, circuit breakers, refrigerant pressure gauges, high and low pressure and low temperature cut-out safety switches, a differential oil pressure safety switch and all other accessories required for the proper and safe operation of the unit.

vii. Units operating above atmospheric pressure shall be provided with a separate compressor operated transfer unit and storage tank to permit removal and isolation of the full refrigerant charge, allowing internal inspection of the evaporator, condenser and compressor.

viii. The transfer unit shall be complete with all necessary controls for manual operation, including all piping and valves.

ix. The unit shall comply with all special control requirements of the chiller supplier. The *Contractor* shall select and install all control equipment and fittings which do not form part of the factory assembled unit, according to the instructions of the manufacturer.

x. The water cooler (evaporator) shall generally be of the shell and tube type, as specified for the reciprocating compressor water chillers.

xi. Condensers shall be of the water cooled shell and tube type, as specified for the reciprocating compressor water chillers.

xii. Evaporators shall be provided with charging connections, relief devices and sufficient eliminator area to prevent liquid refrigerant carry-over.

xiii. The *Contractor* shall provide the following minimum operating and safety controls on the control panel or cabinet supplied with each unit:

- Microcomputer control system.
- Suction and discharge refrigerant pressure monitors.
- Oil pressure monitors.
- Oil temperature monitors.
- Low chilled water temperature safety switch.
- Low oil pressure safety switch.
- Low- and high refrigerant pressure safety switches.
- Bearing high-temperature safety switch.
- Motor winding high-temperature safety switch.
- Necessary relays and time delays, including motor overload protection.
- Amp read-outs.

xiv. Units shall be selected with fouling factors as per the specifications.

xv. The *Contractor* shall provide the initial charge of oil and refrigerant.

xvi. The water chiller shall be a complete packaged unit with all components mounted on a sturdy steel framework with cladding, panels and the like, to match the application.

xvii. Compressor control shall be interlocked with a flow switch (with delay timer) in the chilled water circuit to prevent the unit operating with no water flow.

xviii. Mechanical means shall be provided to prevent loss of efficiency and impeller damage due to liquid carry-over.

xix. When more than one chiller is connected in series or parallel, a lead-lag switch shall be provided for sequence starting of the chillers.

xx. The commissioning of chillers shall be performed only by the factory representatives of the machine and only after the supplier has satisfied himself about the state of the electrical and water systems.

xxi. After the supplier has commissioned the chiller (s) and has satisfied himself concerning the correct adjustment of all control and protection systems, the *Employer* shall be notified to witness a demonstration of the operation of all above mentioned systems.

7.15.3 Screw Compressor Water Chillers

i. Screw compressor chillers shall be of the serviceable hermetic compressor, direct drive packaged type, complete with screw compressor, water cooler, condenser, capacity control, lubrication system, all interconnecting piping, control panel and all other auxiliaries required for the proper and safe operation of the unit.

ii. Motor and rotor assemblies shall be statically and dynamically balanced and shall be free from vibration at all operating conditions.

iii. Capacity control shall be by means of a hydraulic slide valve on a continuous basis or equally accepted system.

iv. Bearing elements shall be pressure lubricated.

v. Oil circulation system shall be complete with separator, compressor oil injection, oil filter, solenoid valves, flow switch, oil cooler and the like.

vi. The water cooler (evaporator) shall be of the shell and tube type as specified for the reciprocating compressor water chillers.

vii. The condenser shall be air-cooled or water-cooled shell and tube condenser, as specified for the reciprocating compressor water chillers (refer Clause 7.15.1 above).

viii. The water chiller shall be a complete packaged unit with all components mounted on a sturdy steel framework with cladding, panels and the like, to match the application.

ix. Each evaporator shall be provided with a low temperature safety switch with manual re-set.

x. Compressor control shall be interlocked with a flow switch in the chilled water circuit (with delay timer) to prevent the unit operating with no water flow.

xi. Units shall be selected with fouling factors as per the specifications.

xii. Each unit shall be provided with a control panel or cabinet containing the main switch, circuit breakers, refrigerant pressure gauges, high and low pressure and low temperature cut-out safety switches, low oil pressure safety switch and all other accessories required for the proper and safe operation of the unit.

xiii. Operating and safety controls shall be provided on the control panel or cabinet supplied with each unit, as well as minimum instrumentation as for centrifugal chillers.

xiv. The *Contractor* shall provide initial charge of oil and refrigerant.

xv. The compressor motor shall be semi hermetic, direct drive, with a maximum of 2800 r.p.m. motor with capacity control slide valve, integral single-stage economiser with no moving parts, oil sump heater and differential refrigerant pressure oil pump.

xvi. The motor shall be liquid refrigerant cooled, hermetically sealed, squirrel cage induction type.

xvii. The refrigeration circuit shall comprise of multiple orifice control system, with no moving parts, to maintain proper refrigerant flow.

7.15.4 Air Cooled Chiller

i. The above sections for reciprocating and screw water chillers shall be applicable to an air cooled chiller as well.

ii. Should a chiller be located in a high ambient environment, a high ambient kit shall be provided, suitable for operation up to 52° C.

iii. The condenser coil shall comprise of copper tubes and aluminium fins and treated using a Heresite protective coating or accepted equivalent.

iv. Condenser fans shall sized to operate at the external air resistance as noted in the technical details.

v. Condenser coils shall have an integral sub-cooler and intermediate liquid receiver acting as a liquid seal. Sub-cooling shall be at least 6%.

vi. Condenser coils shall be manufactured of aluminium fins mechanically bonded to seamless copper tube.

vii. Condenser fans shall be directly driven and be selected for a low noise level.

viii. Fans shall have aerofoil shaped blades and be fitted with aerodynamically designed casings.

ix. Fan motors shall be of the totally enclosed, fan-cooled type, suitable for the electrical supply as noted in the schedules appended hereto.

x. Fan guards shall be fitted on all fans.

xi. The complete unit shall be weatherproof and finished with a protective coating to suit the environment in which the unit is located.

7.15.5 General

i. Commissioning

The chillers shall be fully commissioned by the manufacturer.

ii. Spares and Services

A complete range of spares for the chillers offered shall be kept at the supplier's store within 150km of the chiller installation. The *Contractor* shall verify this before placement of any orders.

iii. Noise Level

Complete sound power curves for the chillers shall be submitted and verified prior to placement of any orders.

iv. Guarantee and Maintenance

The defects liability period shall be 12 months after commissioning and handover. The guarantee shall make allowances for all materials and labour that will be required to keep the chillers in good running condition for this duration.

The *Contractor* shall appoint a person qualified to perform the maintenance function during the defects liability period, to the satisfaction of the *Employer*. This person shall visit the Site on a monthly basis and record all the required data in a logbook provided by the *Contractor* and kept by the *Employer.*

iv. Motor/Compressor Units

One or more semi-hermetic reciprocating or screw motor compressor units shall be provided for each single chiller unit. The compressor (s) shall have replaceable cylinder liners and externally activated cylinder unloaders, ensuring at least 3 steps of unloading per compressor.

Motor/compressor units shall be suitable for continuous operation at the specified electrical supply. Screw type compressors shall be fitted with capacity control slide valve, integral single or multistage economiser without moving parts and oil pressure pump.

Motor/compressor units shall be protected by motor winding thermostatic sensors, by high/low refrigerant pressure switches and by differential type oil safety switches.

Motor/compressor units shall be fitted with valved refrigeration pressure gauges, indicating condensing pressure, evaporating pressure and oil pressure. These gauges shall be of the glycerine filled type.

7.15.6 Additional Requirements

i. The chiller unit (or each motor compressor unit) shall be mounted on spring mountings with a deflection range of approximately 50mm over concrete sub-bases with a minimum height of 150mm.

ii. The chiller unit shall be factory pressure tested and supplied with the operating charge of the specified refrigerant and oil.

iii. The chilled water unit shall be factory supplied with a chilled water temperatures control system.

iv. The evaporator and condenser pipe connections shall be flanged.

v. Each motor/compressor unit shall be fitted with its own “hours run” meter and ammeter (100mm x 100mm minimum face).

vi. Design evaporating temperatures at rated conditions shall not be less than 1.5°C and design condensing temperatures at rated conditions shall not exceed 41°C, unless stated otherwise in the capacity schedules.

vii. In the event that the standard instrumentation provided with a standard, factory-built water chilling unit does not meet the instrumentation requirement as described in this specification, the *Contractor* shall arrange for the necessary additional instrumentation to be installed, which shall be at no extra cost to the *Employer* and without jeopardising the equipment warrantee.

viii. The exposed surfaces of the machine are to be painted with quality and durable primer-finisher prior to shipment.

7.15.7 Control/Electric Panel(s)

i. Each chiller unit shall come complete, with factory supplied and pre-wired control/electric panel(s), including, as a minimum, reduced voltage compressor motor starter(s) with thermal overload protection, safeties and control circuitry.

ii. The motor/compressor units shall have individual motor power feeds from the relevant switchboard to each motor starter, with at least one ammeter (100mm x 100mm minimum face) per compressor motor. This ammeter may be fitted either on the chiller panel or on the relevant switchboard.

iii. The control panel shall be a factory mounted, micro-processor based type, complete with automatic shutdown protection and manual reset provided for low evaporator refrigerant temperature and pressure, high condenser refrigerant pressure, high compressor discharge temperature, high motor temperature, motor current overload phase reversal and low oil flow. Automatic shutdown protection, with manual reset when condition is corrected, shall be provided for low line voltage, loss off chilled water flow and loss of condenser water-flow.

iv. The unit control module is to be automatically activated in the event of low evaporator refrigerant temperature, high condenser refrigerant pressure, motor current overload and shall prevent the motor current from exceeding the setpoint current limit.

v. A solid-state chilled water temperature sensor shall be included for control purposes. A four-position selection switch shall be provided to allow the machine to unload, hold or to allow automatic operation.

vi. A menu-driven display is to be provided, to indicate the operating code, the last diagnostic code, chilled water set point, current limit set point and entering and leaving chilled and condenser water temperatures.

vii. 35 diagnostic checks shall be made available and displayed whenever a problem is detected.

viii. Control panel mounted gauges shall display suction and discharge refrigerant pressure and include shut-off valves.

ix. Each chiller shall have ammeter and voltmeter sets (three each) mounted on the starter door, together with hour-run meters.

x. All control and starter panels shall be weatherproofed.

7.15.8 Alternatives

The *Contractor* may propose alternative makes and products to those indicated in the specifications and these will be considered by the *Employer*, provided that the alternative product is of an equal or better standard than the product already accepted by the *Employer*. The *Contracto*r will be required to provide evidence to this effect, to the satisfaction of the *Employer*. Acceptance of such alternatives will be at the sole discretion of the *Employer*.

7.16 Pipe Installations

7.16.1 General

i. Pipe sizes and positions are as shown on the project drawings. Valves, strainers, and the like shall be suitable for the system. Valves, strainers, pressure gauges and other fittings shall be of a manufacturer accepted by the *Employer*.

ii. Pipes, strainers and other fittings up to 50 mm may be screwed or flanged.

iii. Valves, strainers and other fittings larger than 50 mm shall be flanged.

iv. Thread shall be in accordance with BS 21 and flanges to ASA standard or BS 4504, unless otherwise specified.

v. Pipes larger than 50mm diameter connected to equipment or fittings, or where specifically indicated, shall be flanged to ASA Standards or BS 4504.

vi. All other piping with a diameter larger than 50 mm shall be welded, except where galvanised pipes are used.

vii. Galvanised piping shall be screwed when smaller than 50 mm and flanged above 50 mm.

viii. Pressure and temperature ratings of valves and other pipeline equipment shall be suitable for the system into which they are installed and shall be selected according to ratings given by the manufacturer.

ix. Matched flanges shall correspond in construction and dimensions to flanges on the equipment. Matched flanges shall be provided with the correct bolts, nuts and packing rings.

x. All piping shall be thoroughly cleaned before connecting.

xi. All equipment piping and fitting items, installed as part of the *works,* shall be of one type only and shall be supplied from the same, well-established South African supplier/manufacturer. Changes in the type and makes of piping and fittings may only be made upon the *Employer's* written acceptance.

xii. Welding to galvanised piping or fittings is not permitted. Where welding for whatever purpose is unavoidable, the complete section shall be hot dip galvanised after manufacture. Cold galvanising is not acceptable.

xiii. Full radius bends and sweep fittings shall be used wherever possible. Elbows may only be used under exceptional conditions and only with the acceptance of the *Employer*.

xiv. Where it is necessary to reduce pipes in size, only reducing sockets shall be used. Bushes are not permitted.

xv. Eccentric fittings in horizontal runs of piping shall be used where there is only a slight fall.

xvi. Where pipes pass through walls and the like, the *Contractor* shall provide sleeves that will not foul against any piping due to expansion and contraction of the piping.

xvii. All pipelines shall be provided with 15 mm drain cocks at all low points in the system, so that the pipe work can be drained of liquid without dismantling.

xviii. Provision shall be made for one in every twenty welded joints to be cut out for inspection and testing and for making good afterwards. All welds on the installation shall be X-rayed and examined by an authorized inspection authority (AIA), at the *Contractor's* expense. Should any of the test welds prove unsatisfactory, the welds shall be re-done and re-tested. The *Contractor* shall submit written test and inspection reports by the inspection authority before the installation is accepted.

xix. Wherever possible, horizontal pipes with a slope of at least 1 in 500 shall be installed to allow venting of air to the expansion tank. All pipes shall be fitted in such a manner as to prevent the formation of air locks and air pockets. High points shall be provided with automatic air vent valves or air bottles. Air vents or bottles shall be designed for at least 1.5 times the working pressure of the system.

xx. Piping in plant rooms shall be arranged so that normal inspection and servicing of equipment is not obstructed.

xxi. Pipes that are not dimensioned on the drawings shall be sized in accordance with the following criteria:

- The velocity shall not exceed 2.5 m/s.
- The friction rate shall not exceed 60 kPa per 100 m length.

xxii. The pressure drop through all circuits shall be approximately the same. If this cannot be achieved by pipe sizing alone, due to excessive resultant velocities, throttling or balancing type valves shall be provided where required.

xxiii. Pipe supports and the positions of anchors shall allow for movement due to either pipe expansion and contraction or expansion joints within the building structure, as applicable.

xxiv. Pipe expansion joints, where required, shall be of the bellows type, manufactured from stainless steel, or may be of the Viking Johnson pipe coupling or accepted equivalent, capable of accommodating moderate expansion.

xxv. Pipe expansion joints shall be rated at not less than 1.5 times the maximum working pressure in the system. Expansion joints in hot water piping shall be suitable for water temperatures of up to 120°C.

xxvi. Pipework, pipe fittings, valves and associated fittings for chilled water, hot water, and condenser water services shall be supplied and installed in accordance with the drawings.

xxvii. Chilled water piping shall be black medium tubing, conforming to SABS 62-1971. Screwed joints may be used for piping of diameter up to and including 50 mm diameter. All piping in excess of this diameter shall be joined by welding, using flanges where stated below.

xxviii. Pipes of diameter in excess of 150 mm shall be constructed of seamless black steel in accordance with SABS 62-1971 with welded joints only.

xxix. All black pipe fittings shall conform to BS 1740.

xxx. All condenser water piping shall be hot dip galvanised after fabrication. No welding or cutting of such piping will be permitted after the completion of hot dip galvanising.

xxxi. Welding of pipework shall be carried out only by qualified welders. The *Employer* reserves the right to cut out welds for examination, on the basis that:

- The weld is re-executed free of charge by the *Contractor* should any defects be noted.
- Should the cut-out be assessed to be free of defects, the *Contractor* will be reasonably compensated for such a cut-out and repair.

xxxii. Connections to air handling units, pumps, chillers and other major equipment shall be flanged in the case of piping of diameter 65mm and over and shall be joined using cone face unions in the case of piping of diameter less than 65mm, to enable sections of the air conditioning system to be removed and replaced.

xxxiii. Flange gaskets shall be of the “full face” type.

xxxiv. In all piping installations due allowance shall be made for the thermal expansion and contraction of the piping material.

xxxv. All bends or elbows used in the installation shall be of medium radius type. Short radius elbows will not be permitted.

xxxvi. The chilled water system shall be supplied with an expansion tank (manufactured as described in Clause 4.3.30), complete with ball valve, quick-fill and drain connections.

xxxvii. Automatic air release valves shall be fitted at the top of the riser pipe stacks, and in any other positions in the chilled water systems where necessary to prevent airlocks and to facilitate commissioning of the pumping systems.

7.16.2 Steel Pipes for Water Up To 65°C

i. Pipes shall comply with BS 1387 and SANS 719 specifications and shall be of medium black steel. Wall thickness for pipes above 150mm diameter shall be suitable for the pressure and temperature of the water.

ii. Fittings shall be of malleable steel or malleable iron and shall conform to BSS 1740. Flanges shall be of cast iron or steel to BS 4504. Flange packing shall be of the reinforced rubber type.

iii. Piping shall be supported or suspended and shall be isolated from the building structure.

7.16.3 Steel Pipes for Hot Water 65°C And Over

i. Pipes shall comply with BS 1387 and SANS 719 specifications and shall be of heavy black steel. Fittings and flanges shall be as specified.

ii. Flanges shall be provided with suitable metal packings.

iii. Pipe hangers shall be of the spring, roller, chain or rod type. The maximum spacing of hangers and the minimum diameter of hanger rods shall be as follows:

Table 14 : Spacing of Pipe Hangers

Nominal Pipe Size (mm)	Maximum Span (m)	Minimum Rod Diameter (mm)
25	2.2	10
40	2.8	10
50	3.1	10
80	3.6	14
90	3.6	14
100	4.3	16
125	4.3	16
150	4.3	20
200	4.7	22
250	4.7	22
300	4.7	22

7.16.4 Steel Condenser Water Piping, Drain Pipes and Soft Water Pipes

i. Pipes shall be of medium or heavy black steel piping to BS 1387 or SANS 719 specifications, hot-dip galvanised with a minimum coating of 300 g/m^2.

ii. Fittings shall be of heavy galvanised malleable steel or malleable iron with galvanising as above, and shall be manufactured to BS 1740. Flanges shall be of cast iron or steel to BS 4504 or ASA standards and shall be galvanised. Flange packing shall be of a material accepted by the *Employer*.

iii. Drain pipes shall have a fall with a gradient of 1:50.

iv. All drain pipes shall be provided with cleaning eyes at each change in pipe direction.

v. Condensate drain piping shall be supplied and fitted where shown on the drawings.

vi. Domestic grade copper piping may be used for such drain piping, with elbows and fittings of the compression or solder type.

7.16.5 Hangers and Supports

i. Spring hanger mountings for vibration damping shall be used in all plant rooms.

ii. Spring hanger mountings shall be selected in accordance with the supplier's recommendations. The springs shall not be fully compressed during any stage of operation.

iii. Spring hanger mountings shall be provided with acoustical neoprene washers.

iv. Hangers shall be spaced so that the pipe mass is distributed evenly over all the hangers.

v. Hangers shall be constructed to allow for the expansion and contraction of pipes, except where an anchor point is used.

vi. Pipe hangers shall be adjustable in height to set the pipe gradient.

vii. Pipe hangers shall be designed to prevent pipe movement on starting and stopping of pumps.

viii. Before manufacture or installation full details of the anchors, supports, expansion loops, guides and load calculations shall be submitted to the *Employer* for acceptance. A written statement from the manufacturer, that the work has been reviewed and certified by the manufacturer, shall also be provided to the *Employer*.

ix. The materials for hanger rods, hangers, clamps and all other support devices shall be compatible with the supported pipe and supporting structure.

x. Horizontal and vertical pipe guides shall be installed where required.

xi. All flexibly supported piping shall be sway-braced without interfering with the proper thermal movement of the piping.

xii. Anchors and guides for all horizontal and vertical piping (for proper control of thermal movement) shall be installed. These shall be designed to prevent undue strain on branches, to provide proper performance of expansion joints and expansion loops and to avoid overloading of hangers and supports.

xiii. The maximum horizontal support spacing and hanger rod diameters for steel chilled water, condenser water, hot water, compressed air and vacuum pipes shall be as follows .

Table 15 : Maximum Horizontal Support and Hanger Spacings

Normal Pipe Size (mm)	Hanger Rod ø (mm)	Span (m)
12-32	10	2.5
40-65	10	3.0
80-100	12	3.5
125-150	16	4.0
200-300	22	5.0
350-500	25	6.0

xiv. The maximum horizontal spacing for steam and condensate pipes are as follows:

Table 16 : Maximum Horizontal Spacing for Steam and Condensate Pipes

Nominal Pipe Size		Span (m)	
Gradient	**1:120**	**1:240**	**1:480**
20	2.5		
25	3.5		
32	4.5	3.0	1.5
40	5.5	4.0	2.0
50	6.0	5.0	3.5
65	7.0	5.5	4.5
80	8.0	6.5	5.0
100	9.5	7.5	6.0
125	11.0	8.5	7.0
150	12.0	10.0	7.5

Table 16 : Maximum Horizontal Spacing for Steam and Condensate Pipes

Nominal Pipe Size		Span (m)	
200		11.5	9.0
250		13.0	10.0

xv. The maximum horizontal support spacing for condensate (from AC units) pipes shall be as follows:

Table 17 : Maximum Horizontal Spacing for Condensate Pipes

Nominal Pipe Size (mm)	Span (m)
12-20	1.0
25-40	2.0
50 and over	2.5

xvi. Hangers shall be provided at a maximum spacing of 1 metre from each elbow or pipe fitting.

xvii. Hanger rod dimensions for steam and condensate piping shall be not less than that stated in the specifications.

7.16.6 Piping Installation

i. Pipe work shall be installed in accordance with the service drawings.

ii. The tender drawings are schematic and do not purport to show exact positions of pipes or specific details of construction of the latter. All final dimensions shall be checked on Site before preparation of manufacturing drawings and the fabrication of piping.

iii. Suitable offsets shall be provided, or alternatively changes shall be made in the section of the particular pipe where beams, stanchions or other obstructions interfere with the straight running of pipes.

iv. Sufficient off-sets shall be allowed or, alternatively, expansion bellows shall be provided in piping installations to allow for expansion and contraction.

v. The *Contractor* shall study all the drawings of the particular building in order to determine the number of such offsets or changes in section and the positions in which they will be required.

7.16.7 Valves for Water, Air or Gas up to 65°C and 1000 kPa Working Pressure

i. Valve materials shall be selected for the particular application.

ii. Saunder's type valves are acceptable.

iii. Gate valves up to 50 mm ø shall consist of bronze valve bodies with screwed bonnets and screwed alloy stems and solid tapered wedge type discs of bronze.

iv. Gate valves of 65 mm ø and over shall have cast iron valve bodies with flanged ends. Bonnets and yokes shall be bolted. Rising brass or bronze stems with outside screw and yolk shall be utilized. Wedge discs shall be solid cast seat rings on body and disc. Trim shall be bronze.

v. Gate valves shall only be used as isolating or shut off valves.

vi. Gate valves shall be provided with back-seating on stems to facilitate repacking under pressure.

vii. Globe and angle valves up to 50mm ø shall have bronze bodies with screwed bonnets and screwed ends. Stems shall be rising copper alloy with inside screw. Trim shall be bronze.

viii. Bronze seat rings and replaceable composition or bronze discs shall be with compressed air of liquid oxygen.

ix. Globe and angle valves over 65 mm ø shall have cast iron bodies with flanged ends, bolted bonnets and yokes, rising bronze stems with outside screw and yoke, replaceable bronze seals, replaceable discs and bronze trim.

x. Globe valves shall be used for throttling or balancing purposes.

xi. Butterfly valves of a diameter over 50mm shall have cast iron bodies with suitable rubber lining inside and flanged ends, or water type fitting between flanges. Lever operation is acceptable but gearbox operation shall be provided above 500mm size or with a pressure above 350kPa. Both lever and gearbox operation shall have position indication and locking mechanism.

xii. Butterfly valves shall be used for throttling or balancing purposes.

xiii. Diaphragm valves up to 50 mm ø shall have screwed ends and above 65 mm flanged ends. Cast iron bodies are acceptable.

xiv. Diaphragm valves shall only be used as shut-off valves, unless stated otherwise in the specifications.

xv. Check valves for water or non-pulsating air or gas shall have cast iron or cast steel bodies with screwed ends up to 50mm and flanged ends for valves with a diameter of 65 mm and over.

xvi. Working parts of check valves are to be spring loaded, completely guided or swing-flap operation and fabricated of stainless steel or bronze with elastic seats.

xvii. Check valves shall be of the non-slam type for horizontal or vertical installation.

xviii. Check valves with stainless steel perforated cone and resilient conical diaphragm are also acceptable if flange mounted in a short, straight, removable flanged type section or bobbin for easy removal of the valve.

xix. Diaphragms shall be suitable for the system fluid characteristics.

xx. Float valves up to 40 mm ø shall have bronze valve bodies and working parts, screwed connections and shall be suitable to open against the system pressure.

xxi. Float valves of a diameter of more than 50 mm shall have cast iron bodies with flanged ends and bronze seat rings.

xxii. Plug cocks up to 50mm shall have bronze bodies and plugs, screwed ends with gland and square heads.

xxiii. Plug cocks of a diameter of 65 mm and over shall have cast iron bodies and bronze plugs, flanged ends with square heads.

xxiv. Plug cocks shall be used for balancing purposes.

7.16.8 Valves for Hot Water, Steam, Air or Gas from 65°C and 1000 kPa and Over

i. Valve materials shall be selected for the characteristics of the fluid and the system that the valve is to be used in.

ii. Gate valves up to 50mm shall have bronze valve bodies with union bonnets and screwed ends, rising copper alloy stems with inside screw, nickel alloy or solid bronze wedge discs and bronze or stainless steel seats.

iii. Only stainless steel seats shall be used with steam.

iv. Gate valves of 65 mm ø and over shall have SG cast iron or cast steel valve bodies with flanged ends, bolted bonnets and yokes, rising stainless steel or bronze stems with outside screw and yoke, solid SG cast or cast steel wedge discs with replaceable stainless steel or bronze seats on discs and bodies.

v. Gate valves used for steam application of above 700 kPa pressure shall have stainless steel trim.

vi. Gate valves shall be provided with back seating on stems to facilitate repacking under pressure.

vii. Gate valves shall be used as isolating or shut-off valves only.

viii. Globe and angle valves up to 50mm ø shall have bronze, SG cast iron, forged or cast steel bodies with screwed ends and union bonnets, rising stems of copper alloy, replaceable bronze or stainless steel discs and body seats. Only stainless steel seats shall be used with steam.

ix. Globe and angle valves of 65 mm ø and over shall have SG cast iron or cast steel bodies with flanged ends, rising stems of stainless steel or bronze with outside screw and yoke, bolted bonnet and yoke, stainless steel or bronze trim, replaceable stainless steel or bronze discs and seats.

x. Stainless steel trim shall be used for steam application above 700 kPa.

xi. Globe and angle valves shall be provided with back seating on stems to facilitate repacking under pressure.

xii. Globe valves shall be used for throttling or balancing purposes.

xiii. Check valves up to 50 mm ø shall have forged steel or bronze valve bodies and screwed ends.

xiv. Check valves with a diameter of 65mm and over shall have cast steel valve bodies with flanged ends. Working parts shall be spring loaded and completely guided and shall be of stainless steel. Elastic seats, suitable for the temperature and application, shall be provided. Valves shall be installed horizontally or vertically with flow upwards. Valves may also be of the double swing flap with spring loading on the swing plates. Springs and swing plates shall be of stainless steel.

xv. Check valves shall be of the non-slam type.

xvi. The stainless steel cone and diaphragm type non-return valves are not acceptable.

xvii. Check valves for pulsating compressed air shall be of the “Belliss and Morcom” manufacture or accepted equivalent.

xviii. Check valves for condensate up to 50 mm shall have bronze bodies with screwed ends and be of the swing type with bronze discs.

xix. Check valves for condensate of 65 mm ø and over shall have cast iron bodies with flanged ends, replaceable bronze or stainless steel disc and replaceable bronze or stainless steel body seats.

7.16.9 Calibrated Balancing Valves

i. Calibrated balancing valves shall be of the plug cock type with bronze or cast iron valve bodies, bronze disc, internal seals, screwed ends, up to 60 mm and flanged ends for 65 mm ø and over.

ii. Calibrated balancing valves shall be of the globe type with bronze or cast iron valve bodies with screwed ends-up to 50mm and flanged ends for 65 mm ø sizes and over.

iii. Valves shall be provided with screwed take-off connections to which a pressure differential gauge can be coupled and provided with check valves in the take-offs.

iv. A valve position indicator shall form integral part of the valves.

v. Valves shall be suitable for a working pressure of 1000kPa and a working temperature of 90°C unless otherwise specified.

vi. A removable polyurethane cover shall be provided for each valve.

vii. Portable differential pressure gauges shall be supplied with the above valves, complete with all necessary tubing, shut off and ventcocks and carrying cases. At least one differential pressure gauge shall be supplied for each project and one additional gauge for every 20 valves after the first 30 valves.

viii. Graphs and charts showing the flow quantities against valve openings and pressure differential across the valves shall be supplied for each portable pressure differential gauge.

ix. The pressure gauges shall be calibrated to the latest SI units.

x. On completion of the installation, the portable differential pressure gauges and charts shall be handed over to the *Employer*.

xi. The *Contractor* shall supply and fit, where shown on the drawings, valves to regulate and measure the total fluid flow to each item of equipment. Valves shall be "TOUR AGENTUR" or accepted equivalent.

7.16.10 Pressure Reducing Valves

i. Pressure reducing valves up to 32mm ø for steam, air or water shall have bronze bodies with screwed ends, stainless steel working parts and built-in stainless steel strainers. Valves shall be direct-acting and shall be suitable for the system fluid characteristics, pressure and temperature.

ii. Pressure reducing valves of 40mm ø and over for steam, air or water shall have cast steel or malleable iron valve bodies with flanged ends, stainless steel working parts and built-on strainers.

iii. Valves shall be pilot operated.

iv. Pressure reducing valves shall be selected in accordance with the manufacturer's recommendations for inlet pressures and shall be designed to give a constant downstream pressure with varying upstream pressure.

7.16.11 Safety Relief Valves

i. Safety relief valves for compressed air shall be according to BS 1123.

ii. Safety relief-valves shall be of the spring loaded type with side outlet and screwed connections. Valve bodies shall be of bronze or cast iron and working parts and trim of bronze.

iii. The outlet of safety relief valves shall be piped to a safe position on the outside of the building.

iv. Safety relief valves for hot water and steam shall be in compliance with BS 759.

7.16.12 Air Vents

i. Air vents for steam shall be of the automatic balanced pressure type, with bronze or brass bodies with screwed ends, stainless steel liquid filled bellows and stainless steel working parts.

ii. Air vents for steam shall be selected to the manufacturer's recommendations regarding working steam pressure, temperature and the like.

iii. Outlets from air vents for steam shall be piped to the nearest safe drain point.

iv. Air vents for water shall be automatic and shall have bodies of cast iron with screwed ends, floats, float mechanisms and all working parts of stainless steel.

v. Air vents for water shall be selected in accordance with the manufacturer's recommendation regarding working water temperatures and pressures.

vi. Outlets from air vents for water shall be piped to the nearest drain points.

vii. Vent pipes of 50mm ø shall be installed at all high points in the systems or as shown on the drawings. Vent pipes shall be provided with 15mm ø globe valves in a position readily accessible at the top of the 50mm ø pipe.

viii. Vent pipes shall be taken up to 200 mm above the highest point in the system and then bent and taken down to a position 200 mm above the finished floor level.

ix. The globe valve in the vent pipe shall be installed at a position 2000 mm above finished floor level and permanently connected to the nearest drain by means of rigid steel piping.

x. Air bottles with vent pipes shall be installed at the highest points in the system or as shown on the drawings.

7.16.13 Strainers

i. Strainers shall be of the angle or Y-type. Strainers up to 50 mm shall have screwed ends and strainers of 65 mm ø and above shall have flanged ends.

ii. Strainers for cold water up to 65° C and 1000 kPa and over shall have bronze bodies and bronze screens.

iii. Strainers for steam or hot water over 65° C shall have cast steel bodies and stainless steel screens.

iv. Bronze screens will be acceptable in lieu of stainless steel screens.

v. Screens shall be perforated as follows:

Table 18 : Screen Perforations

Strainer Size (mm)	Perforation Size (mm)
10-50	1.0
65-150	1.5
200 and over	2.0

vi. Strainers shall be provided with a 50mm blow-down pipe and cock on the cap piped to the nearest drain point. Flexible piping shall be used.

vii. The effective free area of each strainer, in terms of perforations, shall be not less than three times the cross sectional area of the inlet.

viii. Strainers shall be installed on the inlet side of all hot water, chilled water and condenser water pumps.

7.16.14 Gauges

i. Pressure gauges for water or air shall be of the Bourdon type and glycerine filled.

ii. Pressure gauges for steam services shall be of the turbine movement type.

iii. Pressure gauge dials shall have a diameter of at least 100 mm.

iv. A gauge cock and siphon tube shall be provided with each gauge.

v. Gauges shall be calibrated to the latest SI units to a minimum reading of 50% higher, but not more than 75% higher, than the system working pressure.

vi. A red line shall be provided on the dial at the maximum system pressure.

vii. Pressure gauges shall be of the heavy duty type with adjustable zero point.

viii. Vacuum gauges shall be as specified for pressure gauges for air.

7.16.15 Flow Meters

i. Flow meters shall be of the stainless steel orifice plate type, fitting between flanges.

ii. Corner pressure tapping shall be used.

iii. Flange tapping shall be used.

iv. D, D/2 pipe tapping shall not be permitted.

v. The complete flow meter, including flanges, shall be supplied by a reputable manufacturer.

vi. The screwed take-off connections shall have built-in check valves.

vii. Flow meters shall be suitable for the system working pressure and a temperature of 120° C, unless otherwise specified.

viii. A differential pressure gauge, complete with tubes, shut-off cocks, air vents and a carrying case, shall be supplied for the flow meters. Graphs or charts on which the flow quantities are plotted against pressure differential across the flow meter shall be supplied.

ix. The differential pressure gauge shall be matched to the orifice plates and shall give a direct fluid quantity reading.

x. Orifice plates permanently connected to direct reading differential pressure gauges, as described above, shall be fitted in each condenser water circuit and chilled water supply line to each chiller and the main chilled water supply and return pipes to the chiller plant room.

7.16.16 Thermometers, Thermometer Pockets and Thermostat Pockets

i. One thermometer shall be installed on the inlet side and one thermometer on the outlet side of each piece of heat exchange equipment.

ii. Thermometers shall be of the replaceable glass type of straight or angle pattern with bronze casings and calibrated in degrees C.

iii. Scale length shall be at least 170 mm and calibration shall be suitable for the system temperature range.

iv. Loose thermometer and thermostat wells shall be provided.

v. Thermometer and thermostat wells shall be manufactured of brass with a wall thickness of not less 1.5 mm around the thermometer or thermostat bulb.

vi. Thermometer and thermostat wells shall project at least 50 mm into the pipe.

vii. Thermometer and thermostat wells shall project a distance into the pipe equal to at least two thirds of the pipe diameter.

viii. Wells shall have dust excluding caps with gaskets and chains.

ix. Pipes smaller than 65 mm ø shall be enlarged at the points where the wells are installed to (accommodate the wells).

x. Wells shall be oil filled and be installed vertical or at an angle of at least 45° to the horizontal, so as to retain oil.

xi. The position of each thermostat shall be such that they can be read easily by a person standing on the floor with normal room illumination.

7.16.17 Expansion of Pipes

i. Proper provision for the expansion and contraction in all parts of the piping systems shall be made.

ii. Where pipe loops or changes in direction of piping cannot be employed to absorb the expansion and contraction, expansion joints shall be provided.

iii. Guides shall be provided on both sides of all expansion joints and loops and in additional locations as recommended by the expansion joint manufacturer.

iv. Expansion joints, connecting piping, anchors and guides shall conform to the manufacturers' recommendations.

7.16.18 Connections to Vibrating Equipment

i. Stainless steel bellows type flexible connectors shall be used for equipment connections to vibrating equipment or where shown on the *Employer's* drawings.

ii. All flexible connectors shall have flanged joints and be designed for 1000 kPa for one and a half times system working pressure, whichever is the higher value.

iii. Only connections manufactured and supplied by a reputable manufacturer, who is well represented in South Africa, shall be accepted.

iv. Rubber isolated tension members shall be provided to prevent excessive elongation.

7.16.19 Sleeves and Plates

Sleeves shall be provided where piping runs through walls, flooring or ceilings. Sleeves shall be of 1.2mm thick galvanised steel sheet, large enough to leave not less than 6mm clear around the pipe and insulation.

Sleeves through flooring shall be of adequate length to pass through the entire floor construction, including floor finishes. Wall, ceiling and floor sleeves shall be provided with plates on both sides of the wall, ceiling or floor. Plates shall be designed so as to leave the pipe free from expansion and contraction.

7.16.20 Testing of Pipe Installations

i. All pipe fittings shall be tested hydrostatically up to a pressure of 1000 kPa or 1.5 times the maximum system pressure, whichever is the higher value.

ii. Tests shall be carried out before the application of insulation.

iii. Water systems shall be filled with water and air vented at least 24 hours before the test.

iv. The test pressure shall be maintained for a period of at least 2 hours after the pump has been disconnected.

v. Leaks in screwed joints shall be corrected by re-making the joints.

vi. Leaks in welded joints shall be cut out and re-welded.

vii. Test instruments shall be tested for accuracy in a laboratory accepted by the *Employer* or by the manufacturers. Test certificates showing the degree of accuracy shall be furnished to the *Employer* on request.

viii. All instruments, equipment and labour required for the tests shall be supplied by the *Contractor.*

ix. Testing of parts of the system will be permissible. The *Employer* may however instruct the *Contractor* to conduct a single test for the total system. No additional payments will be made for such a test.

x. Piping systems shall be pressure tested with the fluid it was designed for.

xi. Vacuum systems shall be tested with nitrogen at a pressure of 1000 kPa or at a pressure of 3 kPa (absolute) at the sole discretion of the *Employer*.

xii. All piping circuits shall be tested to a pressure of at least 1.5 times working pressure at any point in the system. Such tests shall be witnessed by the *Employer.* The *Contractor* shall provide reasonable notice to the *Employer* for attendance of such tests.

7.16.21 Witnessing of Tests

i. The Contractor shall notify the *Employer* in writing at least seven working days prior to the test.

ii. The *Employer* will certify acceptance of all tests. Such certification will not waive the *Contractor's* responsibilities or liabilities in any way.

7.16.22 Construction Materials

Construction and materials of valves shall comply with the following specifications.

Bronze valves	:	BS 1400 LG 2-C, or ASTM B62-63
Cast iron valves	:	BS 1452 GR 14, or ASTM A126-61T
SG Cast-iron valves	:	BS 2789-1961, or ASTM A445-63T
Cast steel valves	:	BS 1504-161A, or ASTM A216

7.16.23 Flushing/Draining

i. Upon the completion of all pressure tests throughout the buildings, and prior to the commencement of commissioning of pumping systems, the entire system shall be drained and flushed to ensure the removal of waste jointing material, accumulated dirt, and sundry construction materials.

ii. Methods of cleaning and flushing the piping reticulation shall be as described under Section 14 of these specifications.

7.17 Steel Fabrication and Welding

7.17.1 Steel Fabrication and Baseplates

The manufacture of all fabricated items of plant shall generally be in accordance with SANS 1200-H. The following further requirements shall apply:

i. The fabrication and manufacture of the plant and equipment shall be completed in the manufacturer's workshops before delivery to Site. No fabrication of completed units shall take place on Site.

ii. Site *works* shall be confined to minor alterations and adjustments, as are necessary during erection.

iii. If major alterations are required, the affected items of plant shall be returned to the manufacturer's workshops for modifications or replacement and shall be tested and checked before re-delivery to Site.

iv. Drive baseplates shall be robustly constructed and adequately stiffened to prevent twisting and distortion. The ratio of the base length to its height shall not be more than 10:1.

v. Fabricated baseplates shall be of all-welded construction and formed of rolled mild steel plates and sections.

vi. Surfaces shall be free from recesses and cavities wherever possible, to prevent the accumulation of dirt and/or waste material.

vii. Where driving units are directly coupled to the driven component, all mounting surfaces shall be accurately machined to ensure correct alignment.

viii. After final shop assembly and testing, the individual items of plant shall be accurately dowelled in position on the baseplate to prevent any misalignment during installation and connection of ducting.

7.17.2 Structural Steelwork

The structural steel used in this contract shall be in accordance with SANS 50025.

i. General purpose bolts and nuts shall be in accordance with SANS 1700.

ii. Plain metal washers shall be in accordance with the relevant section of SANS 1700.

iii. High strength friction grips bolted joints shall conform to SANS 10094.

iv. Torque wrenches or impact tools, where used, shall be recalibrated before each shift.

v. All fabrication and erection procedures shall be in accordance with SANS 1200-H as amended.

vi. Before commencing the fixing of the steelwork the *Contractor* shall check the seating for line level and bolt setting.

vii. Any errors which cannot be accommodated by the steelwork shall be reported to the *Employer*.

7.17.3 Welding

Welding shall be carried out in accordance with the current edition of SANS 10044 Parts I to VII where applicable. Health and safety standards for welding and cutting shall be in accordance with SANS 10238. The following further requirements shall be met:

i. Welders shall be in possession of a valid, accepted competence certificate as required by the Occupational Health and Safety Act, Act 85 of 1993, e.g. for welding on pressure vessels.

ii. All oxy-acetylene welding and testing shall be in accordance with BS 1821 or BS 2640, as applicable, for oxy-acetylene welds in mild steel pipe lines up to 1670 kPa and/or temperatures up to 218 ° C.

iii. Metal arc welding and testing shall be in accordance with BS 1856 or BS 2633, as applicable.

iv. All electrodes shall conform to SANS 455. Filler metal electrodes shall be of a type certified to be suitable for use with the base material being used and shall be kept in a dry condition.

v. The *Contractor* shall submit, for acceptance by the *Employer*, welding procedures for each pipe size, wall thickness and material type that is to be welded, in accordance with the standardized specifications as listed above.

vi. Before any welding is undertaken, each welder shall be qualified for the particular weld procedure. This shall include production, inspection and approval by a properly registered and authorized inspection authority (AIA), to be appointed by the *Contractor*, of a sample weld on a representative pipe size, having the same physical and chemical properties as that to be used for the *works*.

vii. Only welders that have been qualified for the weld procedure shall be permitted to undertake welding on Site.

viii. The test welds shall be executed in the presence of a representative of the *Employer*. Samples of the test welds shall, after stress relieving or normalizing, be cut out and submitted for further metallurgical testing by the AIA.

ix. Further testing of field joints by radiographic or other means of inspection shall be undertaken as directed by the *Employer.* These inspections shall all be conducted by the AIA.

x. Any joints that are found to fail shall be repaired in accordance with an approved weld repair procedure, or shall be cut out and re-placed, at the *Contractor's* expense.

xi. The costs attached to the appointment and services provided by the AIA shall be included in the tendered rates.

xii. The joints in the weld run, where welding has been recommenced, shall be as smooth as possible and shall show no pronounced hump or crater in the weld surface.

xiii. The profile of the weld shall be uniform, of approximately equal leg-length and free from overlap at the toe of the weld.

xiv. Unless otherwise specified, the surface shall be either flat or slightly convex in the case of fillet welds, and with a reinforcement of not more than 3 mm in the case of butt welds.

xv. The weld face shall be uniform in appearance through its length.

xvi. On completion each weld shall be coated with one coat of red lead paint.

7.18 Painting

7.18.1 General

The following requirements shall apply to all paintwork required for the HVAC installations:

i. The *Contractor* shall develop and submit for acceptance by the *Employer* coating, coating repair and test procedures for the each of the substrates, products and applications, as required.

ii. Paint shall not be applied over any surface containing traces of grit, grease, oil, loose mill scale, corrosion products and the like.

iii. All metal surfaces to which paint is applied shall be completely dry and devoid of any signs of moisture.

iv. Paint surfaces which are to be overcoated shall be hard dry before overcoating, unless the specification states otherwise.

v. All traces of soluble salts and corrosive air-borne contaminants shall be thoroughly washed from the surface prior to painting. Surfaces shall be dried and painted immediately after washing and cleaning.

vi. Unless otherwise stated, no paint shall be applied within 50 mm of areas which are to be welded.

vii. Welds and adjacent parent metal shall be de-slagged, inspected and all splatter shall be removed prior to painting.

viii. The weld area shall be wire brushed and all contaminants shall be removed prior to painting. The weld area shall then be flushed with fresh water and allowed to dry. In the case of rust formation, the weld area shall be wire brushed again.

ix. Surfaces which are to rest on concrete or other floors shall receive the full coating prior to erection.

x. Areas where the paint coating has been damaged during transportation, erection or by any means whatever, shall be repaired in accordance with an accepted coating repair procedure.

xi. Rust spots shall be removed by means of a wire brush or emery paper and the surrounding, competent coating shall be feathered for a distance of 20 mm beyond the damaged area.

xii. Spot priming shall cover all previously applied coating layers and shall overlap the competent coating area by 20 mm.

xiii. Where the shop coat has been allowed to age for a few months before painting, it shall be lightly sanded or rubbed with steel wool or scrubbed with Polycell sugar soap solution, using a bristle brush. The surface shall then be rinsed with potable water.

xiv. Mating or contact surfaces shall be brought together by ensuring that the two surfaces brought into contact with each other are prepared and primed in accordance with the specification.

xv. Areas which will be inaccessible after erection shall receive the full coating before erection or assembly.

xvi. Unless otherwise specified, steel embedded within concrete shall not be painted, except to within 50 mm below the concrete / air interface.

xvii. All sharp edges and cut ends shall be filed smooth and shall then receive the specified dry film thickness of paint.

xviii. When blast-cleaning, a satisfactory blast profile (i.e. anchor pattern) shall be achieved. If the abrasive used for blast cleaning is sand, it shall be free of clay and chlorides. Alternatively an accepted grit shall be used.

xix. The *Contractor* shall ensure that the final finishing coat fully covers the previous coat.

xx. The *Contractor* shall ensure that only thinners recommended by manufacturers of a particular paint are used.

xxi. The *Contractor* shall ensure that primed steelwork, piping and the like, which is to be delivered to Site, is stacked on bearers and is clear of the ground.

xxii. Wherever possible, channels, angles and the like shall be stacked so that water cannot collect on the steel.

xxiii. Surfaces which are to be friction-bolted shall be prepared in accordance with the specification (i.e. wire brushed) but shall receive no paint coating.

xxiv. The painted dry film thickness shall be measured using a non-destructive thickness gauge, such as "Mikrotest" or accepted equivalent.

xxv. All mixing of paints shall be done using either a flat-sided paddle or by means of a mechanical mixer.

xxvi. Where the coating components are to be mixed in a specified ratio, provision shall be made on Site for an accurate method of volume measurement.

xxvii. All air used for abrasive blast-cleaning or for spraying shall be free from all traces of oil, water and other contaminants.

xxviii. The paint manufacturer's instructions shall be strictly adhered to.

7.18.2 Painting of Chequer Plate or Egg-Crate Flooring and Supporting Frames

This paint specification is referred to as Class "C" painting. Chequer plate and egg-crate flooring shall not be delivered to Site with a bituminous coating. The following further requirements shall be apply:

i. The finishing coat shall consist of three coats of "HYSHEEN EPOXY TAR (SAR 681-BROWN, SAR 682-BLACK)" to SABS 801-1973, Type II, or accepted equivalent.

ii. The dry film thickness shall be 70-80 micrometers per coat.

iii. Overcoats shall be applied within a minimum of 16 hrs and a maximum of 48 hrs.

7.18.3 Steelworks

All steelwork which is not galvanised, chrome plated or otherwise protected against corrosion shall be given a coat of protective paint at the manufacturers' premises. The *Contractor* shall ensure that this coating is properly protected prior to final coating on Site.

i. Surface Preparation

All surfaces shall be thoroughly degreased with "AQUASOLV DEGREASER" (Code AR) or accepted equivalent and then rinsed with fresh water and allowed to dry.

The surfaces shall then be wire brushed to remove loose rust and loose mill scale to a St 3 finish to SANS 10064 or ISO 8501-1.

ii. Shopcoat

One coat "ENAMELCOAT PRIMER" (U 53) or accepted equivalent shall be applied to a dry film thickness of 30-40 micrometers.

iii. Site Painting

One coat of "MERIT UNIVERSAL UNDERCOAT" (UC1) or accepted equivalent shall be applied to a dry film thickness of 30-40 micrometers.

iv. Finishing

One coat of" UNIVERSAL HIGH GLOSS" colour or accepted equivalent shall be applied, to a dry film thickness of 30-40 micrometers.

7.18.4 Motors, Gear-Boxes, Pumps and Other Equipment

i. Surface Preparation

The surfaces to be painted shall be abrasive blast cleaned to Grade Sa 2 ½ of SANS 10064 or ISO 8501-1.

ii. Priming

One coat of "EPIMIDE EPOXY PRIMER ZINC/CHROMATE IRON OXIDE (EPD 41)" or accepted equivalent shall be applied to form a uniform coat and to fill all porosities in the castings.

iii. Undercoat

One coat of "EPIDUCT CHEMICAL RESISTANT EPOXY ENAMEL" (EPD 700/699 series) or accepted equivalent, tinted to a shade just lighter than the finishing colour with "UNIVERSAL STAINERS" (X 14-20), or accepted equivalent, shall be applied.

iv. Finishing

One coat of "EPIDUCT CHEMICAL RESISTANT EPOXY ENAMEL" (EPD 700/699 series) or accepted equivalent in the specified colour shall be applied.

The blast profile for this system shall be between 25 and 40 micrometers.

If overcoating the primer after two weeks, the surface shall be abraded with 220-350 grit waterproof paper to provide a matt finish and rinsed with fresh water.

7.18.5 Above Ground Piping (Other than Steam Piping)

Piping which is not galvanized is to be protected as follows after installation.

i. Surface Preparation

The surfaces shall be wire brushed to remove loose rust and loose mill scale to an St 3 finish to SANS 10064 or ISO 8501-1.

ii. Priming

Priming shall consist of one coat of "ENAMELCOAT PRIMER" (UC 53) or accepted equivalent with a film thickness of 30-40 micrometres.

iii. Undercoat

The undercoat shall consist of one coat of "MERIT UNIVERSAL UNDERCOAT" (UCI) or accepted equivalent, applied to a dry film thickness of 30-40 micrometers.

iv. Finishing

Finishing shall consist of one coat of "UNIVERSAL HIGH GLOSS ENAMEL" (G) or accepted equivalent in the specified colour, applied with a dry film thickness of 30-40 micrometers.

The total dry film thickness for the coating system shall not be less than 90 micrometers.

7.18.6 Underground Piping or in Trenches : (Other than Steam Piping).

Piping which is not galvanized and is installed underground or in trenches shall be painted with bitumastic paint, whether the pipe is insulated or not.

7.18.7 Galvanised Iron

i. Surface Preparation (General)

All grease and other deposits shall be removed from all surfaces with galvanised iron cleaner (Code G.I.C.). The surface shall then be rinsed with clean water to give a water break-free surface.

All surfaces shall be thoroughly cleaned and dry prior to the application of any coating materials. Should this not be achieved, the cleaning process shall be repeated.

ii. Galvanised Cladding Inside Buildings

Priming shall consist of one coat "CALCIUM PLUMBATE PRIMER" or accepted equivalent to a dry film thickness of 25 – 35 micrometers.

The intermediate coat shall consist of one coat "UNIVERSAL UNDERCOAT" (UC 1) or accepted equivalent to a dry film thickness of 25 – 35 micrometers.

The total dry film thickness shall not be less than 75 micrometers.

iii. Galvanised Cladding Exposed to Atmosphere

Priming shall consist of one coat "CALCIUM PLUMBATE PRIMER" or accepted equivalent to a dry film thickness of 25 – 35 micrometers**.**

Intermediate coat and finishing shall consist of two coats of "IRONGUARD MIO MICACEOUS IRON ORE ROOF PAINT" or accepted equivalent to a dry film thickness of 50 - 70 micrometers.

The total dry film thickness shall not be less than 75 micrometers.

iv. Galvanised Cladding Moist Conditions

Priming shall consist of one coat of "CHEMICOTE HIGH BUILD CHEMICAL RESISTANT PRIMER" (CHC 1) or accepted equivalent to a dry film thickness of 60 – 80 micrometers.

Intermediate coat shall consist of one coat of "CHEMCOTE HIGH BUILD CHEMICAL RESISTANT INTERMEDIATE COAT" (CHC 101) or accepted equivalent to a dry film thickness of 60 – 80 micrometers.

v. All Galvanised Pipes

Finishing shall consist of one coat "CHEMCOAT ENAMEL" (CHC 3000) or accepted equivalent to 25 – 35 micrometers.

The total dry film thickness shall not be less than 145 micrometers.

7.19 Corrosion Protection

All surfaces shall be protected using either of the following methods:

7.19.1 General Corrosion Protection

Corrosion protection of steel materials shall be as per the requirements of these specifications, the *Employer's* standards and associated minimum SANS requirements. The protection of the specified steel materials shall make allowance for the harsh, coastal environment at the Site.

Any equipment not strictly complying with the above requirements shall be rejected. The *Contractor* shall furnish written confirmation that all equipment complies with the specifications. Should the *Contractor* fail to furnish such confirmation, the *Employer* reserves the right to reject the equipment.

7.19.2 Galvanic Corrosion Protection

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer*.

The table below provides a general indication of which metals can be connected to each other without the need of special measures to ovoid interaction, and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The below is intended as a guide only. The responsibility will remain with the *Contractor* to avoid bimetal/galvanic corrosion between different metal equipment.

Table 1: Combinations of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	StSt	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Copper	Not Permissible	Not Permissible	Permissible	Permissible	Not Permissible	Permissible
StSt	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

Where equipment has been exothermically welded together, 3 thick layers of bitumen shall be applied afterwards, unless otherwise specified by the *Employer*.

7.19.3 Galvanising

All hot dip galvanising shall be carried out in accordance with SANS 121 and SANS 3575, as applicable.

Component design, fabrication and inspection of articles for hot-dip galvanising shall be done in accordance with SANS 14713.

The *Employer* may require an inspection of all steel components before galvanising and may reject or request remedial treatment of any materials, including welds, which are assessed to be unsuitable.

7.19.4 Painting

All steelwork and pipework shall be prepared and painted prior to insulation, as per the following SANS standards:

- The preparation of steel surfaces for coating: SANS 10064 and SANS 12944-4.
- Corrosion protection of structural steelwork: SANS 1200 HC.
- National colour standards: SANS 1091.
- Paint support structures and brackets black, unless specified otherwise in the specifications.

7.20 Notices & Signage

The *Contractor* shall supply and install all notices and warning signs that are required in accordance with SANS 1186-1.

Markings on equipment which makes up a refrigerating system shall be according to SANS 10147, if no other specification or guideline applies.

All valves, including control valves, shall be marked with the manufacturer's brand name, pressure and temperature ratings, material of body, disc, stem and seat, identification numbers, size and fluid recommendation.

7.21 Sound Attenuators

7.21.1 General

Sound attenuators shall generally be manufactured, selected and supplied by the fan manufacturer. The following requirements shall be met:

i. Sound attenuators shall be factory-made units, of a make to be accepted by the *Employer,* and shall consist of a casing, internal baffles and sound absorbing lining material.

ii. Sound attenuators shall be suitable for the system working pressure, velocity and for an air temperature up to 80°C.

iii. Casings shall be constructed of galvanised sheet metal, of which the minimum thickness is in accordance with requirements covered elsewhere in the specification.

iv. The sound-absorbing lining material shall be odourless, non-flammable, rot proof and shall not tear loose as a result of the airstream flowing over it.

v. Sound attenuators shall be provided complete with mating flanges.

vi. Duct-mounted sound attenuators shall be of the rectangular or circular type, to achieve the noise criteria ratings stated in the specification.

vii. Sound attenuators of the rectangular type shall be flanged, heavy metal duct sections containing built-in silencer baffles. Baffles shall be installed in order to achieve the required attenuation rate.

viii. Sound attenuators of the circular type shall be supplied and installed complete with flanges and shall comprise of a heavy gauge circular duct section with internal sound absorption lining, complete with centre pod (if pod is required to achieve sound attenuation rate stated in the specifications).

ix. Sound-absorbent material shall be manufactured from non-flammable, odourless, rat proof, fire resistant, non-combustible, damp-resistant material, edged with galvanised sheet steel and covered with fireproof erosion resistant material. The finished product shall not tear loose as a result of the airstream flowing over it.

x. Sound attenuators shall be factory-manufactured by recognised and accepted specialist manufacturers. Acceptable manufacturers include TROX, HOWDEN AIR, WOODS and AIR MOVEMENT SUPPLIES.

xi. The attenuators shall be selected to have a maximum air pressure drop of 50 Pa.

xii. The *Contractor* shall take note of the attenuator properties included in the technical schedules.

7.21.2 Air conditioning applications

In the case of normal air conditioning applications, sound attenuator panels shall be covered with perforated metal sheet.

Sound attenuators shall be provided complete with mating flanges. The size of the flanges shall be at least the same as are specified for ducting of the same duty and dimensions.

7.21.3 Special Applications

In the case of corrosive airflow applications, the sound attenuator materials shall be suitable for the application.

7.21.4 Note

Should fibre glass be used as a sound absorbent material, the exposed internal lining shall be protected with “MALINEX” or accepted equivalent and perforated metal sheet**.**

7.22 Chilled Water Expansion Tanks

7.22.1 Construction

i. Hermetically sealed expansion tanks shall be provided.

ii. Expansion tank shall be of a bladder, or diaphragm type.

iii. The tanks shall be made of steel and shall be of a welded or other accepted construction.

iv. All steel used shall be primed and painted to the manufacturer's specification.

v. The complete construction shall be leak-proofed.

vi. If required an inspection/access opening shall be provided in the tank for maintenance purposes. The cover for this opening shall close tight against the internal pressure.

vii. A feed and expansion/charging connection shall be fitted to each tank.

7.22.2 Installation

i. The tanks shall be elevated above the structural floor by means of a steel frame or shall be fixed to the structure. All necessary fixing equipment shall be provided for the installation.

ii. In un-pressurised systems, the expansion tanks shall be installed above the highest point of the piping systems served. Steelwork stands shall be supplied and installed if necessary.

7.22.3 Controls and Alarm

i. The water level shall be controlled by means of a high or low pressure float valve as required.

ii. The float valves shall travel from fully open to fully closed positions, with a maximum of 50 mm movement of the ball.

iii. Copper floats shall be fitted to the float valves.

iv. The water level shall be controlled by means of level switches of an accepted make, if the tank is fed by a pump or pumps.

v. Audible and visual high and low level alarms shall be installed.

7.23 Chilled Water Buffer Tank

7.23.1 General

i. Where shown on the drawings, the *Contractor* shall supply and install an insulated thermal hot water storage tank of the volume, temperature and pressure ratings as specified in the technical schedules. The tank shall be factory built by a specialist manufacturer.

ii. The tank shall be manufactured to the latest applicable OHS Act, National Building Regulations and applicable SABS standards, as appropriate for the size and application of the tanks and in accordance with ASME VIII.

iii. The tank shall be cylindrical with domed ends on top and bottom. The tank shell shall have a minimum wall thickness of 8mm when manufactured of steel in accordance with specification BS-1501-151-43A. The wall thickness of the domed ends shall be in accordance with BS-1501-151-430A. The tank shall be fitted with a manhole with a minimum diameter of 450mm with cover in accordance with BS-4360-43A.

iv. The tank shall be supported by a minimum of four support legs or round skirting. The welding manufacturing shall be in accordance with ASME VIII. The tank shall be supplied with suitable, factory-fitted hoisting lugs.

v. Welding joints shall be staggered to avoid concentrations of welding joints which could create hot spots. Weld sockets shall be in accordance with ASA B16-11 and shall be long enough to extend at least 50mm outside the tank, to penetrate the tank insulation up to the cladding surface.

vi. The test pressure, working pressure and operating temperatures shall be as indicated in the relevant standards and as shown in the technical schedules.

7.23.2 Fittings, Controls, Safeties and Instruments

i. The tank shall be manufactured with sufficient sockets to accommodate the connections for the controls and safeties and other devices, as stipulated in the technical schedules including, but not limited to:

- 1 No cold water inlet as shown on the CW schematic drawing.
- 1 No cold water outlet as shown on the CW schematic drawing.
- 1 No 40 mm ø drain valve.
- 1 No 50 mm ø air vent on the top of the tank.
- 1 No vacuum breaker.
- 2 No pressure relief valves as specified in the technical schedules, with suitable copper blow-off discharge piping to the nearest drain.
- 1 No 20 mm ø socket to accommodate a 100mm ø glycerine-filled pressure gauge with stainless steel casing.
- 3 No 25 mm ø dial type(100 mm) thermometers.
- 1 No socket for radiation loss heater as detailed in the technical schedules.

ii. Steel tanks which are to be internally copon coated shall have weld-flanged connections in lieu of threaded sockets for instruments, safeties and pipe connections. Threaded sockets are not acceptable.

iii. The tanks shall be factory fitted with suitable hoisting lugs.

7.23.3 External Finish (Steel tanks only)

After completion of the tank manufacturing, and prior to applying tank insulation, the external surface shall be cleaned to remove grease and dirt and wire brushed and scraped to remove all rust and scale before applying two coats of suitable red oxide type priming paint.

7.23.4 Tank Insulation

i. The tank shall be insulated using 50 mm fibreglass blankets affixed to the tank with pin straps, spikes or other accepted means to prevent sagging of the fibreglass insulation.

ii. The fibreglass insulation shall be covered with removable galvanised sheet metal or aluminium cladding, as detailed in the technical schedules. The insulation and cladding may be applied on Site after the tank has been placed in its final position, to prevent damages to the insulation. The manhole and other items requiring access for servicing shall have easily removable aluminium jackets.

7.23.5 Fixtures and Fittings

i. The tank shall be supplied with all necessary control and safety devices, instrumentation (pressure gauges and thermometers), valves and other devices in accordance with the technical schedules. The tank shall meet the specified pressure and temperature requirements.

7.23.6 Test Procedures

The following pressure and temperature ratings shall be strictly adhered to:

i. Tank to be factory pressure tested with water at the rated test pressures prior to sandblasting and copon coating. A certificate shall be issued to the *Employer* for acceptance. The *Employer* shall be notified of the date of such test at least seven days prior to testing, to enable him to witness the test at his discretion.

ii. After the tank has been installed and piping connected, the tank shall be filled with water and pressure tested on Site up to the rated test pressures, with the tank pressure relief valve plugged off.

iii. A pressure relief valve, downstream from the pressure reducing valve of the mains water supply, shall be provided to ensure that the mains water pressure at the tank never exceeds 300 kPa upon failure of the pressure reducing valve.

iv. This relief valve shall be tested on Site by increasing the pressure in the building mains pressure reducing valve to above 250 kPa as part of the commissioning procedures.

v. The tank shall be fitted with at least two pressure relief valves, each adequately sized to allow sufficient steam, generated by the electric heater elements, to blow off. The tank shall be isolated and pressure tested to ensure that the pressure relief valve opens as soon as the tank pressure reaches the rated relief pressures.

vi. As part of the commissioning procedures the *Contractor* shall submit a signed test report to the *Employer* for review and acceptance, as documentary evidence that all tests have been carried out in accordance with the requirements and to the acceptance of the *Employer*.

vii. Acceptance of the design drawings, technical submittal data, test results and plant operation does not relieve the *Contractor* and the tank manufacturers and suppliers of their responsibility with respect to compliance of the system and its components with all local applicable regulations, laws and by-laws.

7.24 Standard Equipment

7.24.1 General Equipment Protection

i. All equipment shall be adequately protected against weather and damage on Site.

7.24.2 General Machinery Protection

i. All high-speed couplings, projecting shaft ends and hazardous moving parts of machinery within normal reach shall be protected by a guard, manufactured from mild steel plate with a thickness of no less than 1.6 mm.

ii. The coupling guards shall be neatly formed and securely fixed in position.

iii. All belt or rope drives within normal reach shall be adequately protected by a belt guard.

iv. The belt or rope guard shall be manufactured from wire mesh or open-type expanded metal, securely braced and stiffened with light rolled steel sections that are bolted in position.

v. All chain drives shall be fitted with sheet steel chain cases and lubrication facilities, to the chain manufacturers' recommendations. All joints shall be dust tight and arranged for convenient installation and dismantling.

vi. Each chain case shall be fitted with a hinged inspection door, drain hole and plug.

vii. All guards shall be finished in a colour as specified by the *Employer* specifications (available upon request).

7.25 Control Systems: General

The control systems serving the air conditioning system shall be supplied and installed by an accepted specialist subcontractor.

The central control systems shall be of the electronic type. A centrally mounted controller unit shall be incorporated in each adjustment and indication sub-system, with remote sensors, actuators and ancillary components. The controls shall be electronically programmable PLC's or Remote Input/Output Device (RIO). A local HMI unit shall also be provided on the central control system to display alarms, events and the like.

Centrally-mounted control equipment, such as controllers, step-controllers, switches, relays, indication instruments integral to the control system and accessories, shall be mounted in separate panels adjacent to the power switchboards. Reference shall be made to further applicable specifications and drawings, respectively listed under Annexure K and L of the Works Information.

The equipment components for the total automated control system shall, unless otherwise specified for certain items of equipment, be manufactured by one, single manufacturer and shall meet the following requirements:

- The control system shall be accessible via a laptop or similar portable device and serial and/or hot-wired cable from all sub-system centrally mounted controller units throughout the building for commissioning and service purposes.
- The control system and all sub-system centrally-mounted controller units shall be internally protected against power surges and damage or memory/software loss due to power failures.

The controls shall be configured so that the plant operator will have direct communications to all HVAC equipment.

7.25.1 Fire Interlock

Given the large amounts of heat generated by the electrical equipment within the buildings, a complete shut-down of all air conditioning systems due to localized overheating or fire within a single room is undesirable, as air conditioning will still be required at other rooms and sections of the substation.

Should a fire be detected in a room within the substation building, the fire dampers serving that room shall close to isolate the room. The dampers shall be configured to re-open after an 'all clear' signal is received from the fire detection/suppression system.

The complete air conditioning shall be configured to shut down only if a fire is severe enough to cause all power to the building to be cut off.

All fire dampers shall be individually addressable to allow only the fire dampers that serve a room in which a fire is detected to be closed.

The design, supply and installation of the local fire relays, including the associated control philosophy, installations and wiring for the fire damper operations, shall be done by a specialist subcontractor, to be appointed by the *Contractor,* subject to acceptance by the *Employer*.

7.25.2 Chiller Plant Control

The chiller sequencing software shall control the start-up and stopping of the system water pumps and chillers based upon the system load. When the chilled water system is enabled the chiller system control will:

- Start the lead/swing chilled water pump and prove flow through the evaporator.
- Start the lead/swing chiller after chilled water flow is proven.
- Modulate the speed, and hence the flow of the chilled water pump.

The chiller sequencing software shall initiate start-up of a further chiller whenever the supply temperature begins to rise. When the chilled water supply temperature exceeds the system setpoint

plus deadband for an operator-specified length of time, the chiller sequencing software shall initiate the start of the next chiller in the sequence. The following further functionalities shall be provided:

- Lag chillers shall start in a similar manner to the lead chiller start sequence.
- The chiller sequencing software will unload operating chillers prior to starting a lag chiller.
- The BAS shall control each chiller's setpoint to equalise the chiller loading and meet system demands as the system load varies.

Prior to the start-up of another chiller, all operating chillers shall be unloaded to a pre-set percentage current draw to prevent flow disturbances, caused by the starting of another pump, from affecting the chiller operation. Following confirmation of the additional chiller operation, all chillers shall be allowed to reload.

Upon sensing a chiller failure, the chiller sequencing software shall lockout that chiller and pump and immediately initiate the start of the next chiller in the rotation sequence. The BAS shall automatically send the fault alarm to the plant operator via the port SCADA system.

Provision shall be made for automatic rotation of the chiller operation to equalize chiller run time. Rotation shall be initiated based on an operator-entered day interval, by the cycling of a binary point or by comparing run hours. The method of sequence shall be operator selectable.

Provision shall be made for chillers to be forced into a new rotation sequence by cycling chillers at the time of initiation. Alternatively, chiller cycling caused by normal system load fluctuations shall cause the chillers to change rotation sequence, therefore eliminating unnecessarily chiller cycling. The chiller sequencing software shall provide a user-adjustable loading time at system start-up to prevent the unnecessary operation of chillers and limit the system electrical demand during chilled water loop pulldown.

As part of the demand limiting scheme for the buildings, the chiller sequencing software shall be able to monitor and reduce peak power demand through the limiting of chiller system capacity.

7.25.3 Controls System Description

i. Chilled Water Pump(s) Control

The pump control and the modulation of its speed via the VSD shall be performed by maintaining a pressure differential at a selected point in the system. The control point shall be selected to minimise over pressurising the system and to ensure adequate flow at all the critical loads.

ii. Chiller Plant Control Description

The control panel(s) shall be located as indicated in the applicable specifications and drawings, respectively included under Annexure K and L of the Works Information, unless otherwise instructed by the *Employer*. The system shall have a plant manual/off/auto control switch, allowing the system to be started manually or shut down if required by the operator.

When the plant control selector switch is in the "Auto" position, operation of the air conditioning system shall be triggered by a time clock.

The chilled water system shall consist of two chillers (see drawings for details) with associated pumps. Provision shall be made for each chiller to be switched and monitored by the control system. Each chiller shall have its own built in electronic controller to maintain and control a set chilled water leaving temperature.

Both pumps shall be variable speed controlled by a frequency inverter on an output from the pressure controller in the vertical chilled water riser.

The chilled water system shall be circuited with a combination of 3-way and 2-way chilled water control valves to allow for the flow of chilled water throughout the piping systems and minimising dead water at the end of the pipe run.

Upon receiving the start signal the lead variable volume chilled water pump shall start.

The control shall slowly accelerate the chilled water pump to full speed or an advised percentage of full speed. The input from one of the water pressure sensors shall determine whether sufficient pressure is being achieved on the index leg of the system, to ensure that adequate water flow is being reached to the furthest valve, and to modulate the speed of the pump accordingly.

iii. Chilled Water Temperature Control

The control system shall start the first chilled water pump (as selected automatically from the sequencing schedule or manually by the operator). On confirmation of running status, the selected lead chiller in the operating sequence shall start and control its own chilled water leaving temperature. The chillers shall maintain a chilled water leaving temperature of 7ºC.

The control sequence shall be configured to select the first chiller in the operating sequence and obtain an ambient temperature input, while allowing only one chiller to run for a period of 15 minutes (operator adjustable value). This shall enable the chilled water loop to cool down while low load and ambient conditions prevail and allow for a more accurate assessment of the building load requirements.

On an increase of temperature differential between the chilled water supply and return temperatures, and after a pre-determined period of settling down, the control system shall start the next chiller.

Operator adjustable timer delays, such as run timers, delay on/off timers and anti-recycle timers between the chiller loading steps, shall be provided.

If any of the chillers are in, or indicate a fault status/alarm during the loading sequence, the control shall automatically bypass that machine in a pre-set sequence and select the next chilled water pump/chiller.

Two temperature sensors, located in the return and supply lines, shall also be monitored. The sensor readings shall be provided as an input to the system, as necessary.

During the operation of the air conditioning system, the differential pressure will influence the pressure available to the two-way valves. This shall be maintained below the cut-off pressure of the valves.

iv. Fresh Air Unit

On receipt of a signal from the time clock in the main ACP (with the plant control selector switch in the “Auto” position), the air conditioning system shall commence running and shall be interlocked with the fresh air units.

A Magnehelic type differential pressure gauge shall be installed at each of the fan units to provide a “dirty filter” signal to the central control system once a predetermined set point is exceeded. A “dirty filter” warning light shall also appear on the main ACP.

Should the fresh air unit trip on overload, an audible alarm shall be provided in the main ACP and an alarm signal shall be provided to the central control system.

v. Constant Volume Air Handling Unit Control Description

This section shall be read in conjunction with the A.H.U control schematic included in the drawings, the relevant A/C plants control points schedule and further applicable specifications and drawings, respectively listed under Annexures K and L in the Works Information.

The following requirements are applicable to all constant volume A.H.U’s located in the buildings, the locations of which are indicated on the drawings. The BMS control philosophy shall be the same for all these A.H.Us unless otherwise specified.

- Each supply air fan and where applicable fresh air fan, will have an “auto/off/man” selector switch located on the fan’s respective ACP (air-conditioning control panel).

This shall allow an operator to manually override the BMS start functions of these fans. The BMS shall only function with the selector switch in the "auto" position.

- However, should the selector switch be in the manual (man) position, the BMS shall detect this and allow temperature control of the plant.
- The BMS shall display a full graphic image on the remote operator's terminal of the A.H.U, indicating all the points and outputs/inputs as specified on the A/C plant control point schedule.
- On a start signal from the BMS or, where applicable, a linked remote control for that A/C unit, the supply air and, where applicable, fresh air fan shall operate. Upon confirmation of the running status from the fan motor contactor and air flow switch (wired in series), the BMS shall control the space temperature.
- The space temperature setpoint shall be adjustable via the remote control panel.

The BMS shall, upon a command by the operator, keep a running log of all specified points and display a trended graph of space temperature in combination with the space temperature setpoint, the duration of which shall be adjustable.

7.25.4 Fault / Alarm Monitoring

All air-conditioning equipment shall be monitored for fault indications. The central controller shall keep a running log of all fault indications, providing a record of the specific item of equipment, the date and the time of all fault conditions. The fault log shall also record the date and time upon which the fault condition is reset.

The alarm log shall be easily readable, password delete protected and printable via the local HMI and central control system.

All alarm/fault conditions shall be displayed in the following operator-selectable manners:

i. The equipment shall be graphically displayed on the local HMI and the central control system. The graphics for a given item of equipment shall change colour to indicate stopped, running, status and fault / alarm conditions.

ii. Upon an alarm/fault indication, the operator selectable air-conditioning equipment shall provide for the display of a prominent sign on the HMI and audible alarm, requiring operator acknowledgment.

7.26 Fire Stopping

The *Contractor* shall employ suitable fire stopping methods wherever deemed necessary in terms of these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer*'s specifications or any other applicable standards and documents related to the *works*.

All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and accepted standards. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localised and contained and not propagate via any electrical and/or electronic infrastructure. The *Contractor* shall fully comply with these requirements.

8.0 OPERATING AND MAINTENANCE SUPPORT

8.1 Maintenance and Maintenance Tools

During the twelve months defects liability period, the *Contractor* shall service and maintain the installation on a monthly basis, totalling twelve such visits. The cost of these services shall be included in the tendered rates. Such maintenance/service operations shall include the following:

i. Inspection and lubrication where required on all moving parts.

ii. Checking and adjusting where necessary of vee-belt drives.

iii. Cleaning of filters.

iv. Checking, cleaning and adjusting, where necessary, of refrigeration systems and their associated controls.

v. Checking and adjusting, where necessary, of temperature control systems and any other maintenance required in terms of the manufacturers' instructions.

The *Contractor* shall arrange for twelve service record sheets to be signed by the *Employer.* These record sheets shall be furnished to the *Employer* as documentary proof that the requirements as described above have been met.

The *Contractor* shall provide one set of all special tools, gland keys, valve keys and the like, required for testing, maintaining and operating of all items of equipment.

Duplicate keys shall be provided for all control panels, instrument locks, safety valve locks and the like. All special tools shall be handed to the *Employer* when the system handover has been completed.

8.2 Operating and Maintenance Instructions

The *Contractor shall* prepare and submit three (3) sets of operating/maintenance/fault finding instructions, pertaining to the operation and maintenance of all major items of equipment. This documentation shall be submitted for acceptance by the *Employer* prior to initial hand-over of the system and shall include the following:

i. Detailed plant description.

ii. Detailed daily plant operation description.

iii. Description of overall plant operation.

iv. Details of main items of equipment, including:

- Design capacity details.
- Tested performance details.
- Manufacturer's data sheets with operating points highlighted.
- Manufacturers' commissioning and maintenance instructions.
- List of recommend spare parts (for two year period).

v. Details of local suppliers.

vi. Schedule of set points (for controls and safety devices).

vii. "Troubleshooting List", including:

- Step-by-step procedures for unspecialised fault finding.
- What remedial action to take.
- When to call for specialised assistance.

viii. Maintenance schedule.

ix. One complete set of "as built" drawings.

x. Copies of all signed-off quality control documentation.

8.3 Training of Personnel

The *Contractor* shall provide formal training to explain and demonstrate the following matters to the operations personnel, as nominated by the *Employer*:

- General principles and functioning of equipment.
- Review of operating and maintenance manuals.
- Stopping and starting of equipment.
- Repair of minor defects.
- Adjustment of controls.
- Routine maintenance inspection.
- Routine maintenance.

Two man-days, to be arranged in conjunction with the *Employer*, shall be allocated for this training. The operating and maintenance manuals and wiring diagrams shall have been completed and be available for training purposes.

9.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for acceptance and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

10.0 INSPECTIONS, TESTING AND COMMISSIONING

10.1 Quality Assurance

10.1.1 General

The following general points shall be noted:

i. The *Contractor*, in conjunction with the appointed subcontractors and suppliers, shall be responsible for implementing a full quality assurance plan covering all activities included in the *works*.

ii. *Contractors*, subcontractors and suppliers who do not have ISO 9000 certification shall provide a comprehensive quality assurance plan in accordance with ISO 9000.

iii. The quality plan shall cover design activities, procurement, storage, construction, handover, maintenance and guarantee.

10.1.2 Quality Management Plan

A Quality Management Plan shall be prepared by the *Contractor*, in conjunction with the appointed subcontractors and suppliers. This plan shall be submitted to the *Employer* in accordance with Clause 7.5 of the Works Information. The QMP shall include at least the following:

- A responsibility matrix, identifying all parties in the *Contractor's* organisation who will be involved in the project or who are responsible for aspects of the project. The specific activities shall be identified with the responsible individual.
- A list of all applicable specifications and third party inspections required.
- A list of all inspection holds points with actions and responsibilities to ensure that these are timeously inspected. The *Employer* may add further inspection hold and/or witness points.
- A list of all inputs required from the *Employer,* with actions and responsibilities to ensure that the proper persons are advised in good time.

10.2 Testing and Commissioning

10.2.1 General

The *Contractor* shall be responsible for the commissioning and compilation of commissioning procedures for all HVAC equipment as covered in these specifications, drawings and bill of quantities.

The commissioning procedures shall include all necessary tests and test results for each item of equipment and system, which shall demonstrate that the equipment operates in a manner that meets or exceeds the minimum requirements of the specification and the accepted manufacturer's technical data. The tests and test results shall be recorded on forms accepted by the *Employer* and submitted for acceptance sign-off by the *Employer.*

The *Employer* shall be given the opportunity to witness all tests and the *Contractor* shall give the *Employer* seven (7) days' notice prior to any portion of the plant being tested.

If the *Employer* assesses that the test results are insufficient or not acceptable, the *Contractor* shall carry out all necessary remedial *works* and repeat the necessary tests at his own expense.

The testing and commissioning procedures shall form part of the quality plans submitted by the *Contractor,* as referenced in the Works Information, and shall be subject to prior acceptance by the *Employer*. The procedure shall embody the following principles:

- All plant shall be tested off Site prior to delivery. No plant or equipment will be accepted and paid for if it is not accompanied by the manufacturer/supplier certificate verifying that it has been tested.
- All plant and systems on Site shall be tested as early as possible after installation, to verify that the plant/system/sub-system is operating correctly.

- No testing or commissioning shall take place without an accepted written procedure.
- The responsibility for the proper testing and commissioning of the system rests fully with the *Contractor*. This includes the provision of all necessary test equipment, measuring and test points, valves and dampers and the like to test and commission the system.
- At the time of submitting equipment for acceptance, full details of the commissioning requirements shall be provided.

10.2.2 Testing and Commissioning Program

At least four weeks before commencing any testing and commissioning the *Contractor* shall submit a complete program for these *works* so that the *Employer* can arrange to be on Site at the appropriate times. The programme shall embody the agreed testing and commissioning procedure. The programme shall include:

- A bar chart covering all activities.
- Names and addresses of companies involved in each activity.
- The way in which each test will be carried out, complete with pro forma forms for tabulating results.

10.2.3 Equipment and Procedure

The equipment supplied under the contract shall be subject to inspection by the *Employer* at all stages of manufacture.

The tests and commissioning procedures shall include any additional tests that the *Employer* may reasonably require to prove compliance with the specification. The tests shall be carried out at the manufacturer's premises and at Site.

The *Contractor* shall provide the *Employer* with reasonable notice of the time and place where inspections and witnessing of tests for materials and equipment will be undertaken.

The *Contractor* shall provide the *Employer* with all necessary facilities to witness the tests, including any additional tests or inspections that may be reasonably required by the *Employer*.

The *Contractor* shall, at his own cost, render all assistance and supply all labour, appliances and any other materials that the *Employer* may require to check the setting out, measuring up and inspection of the *works* at any stage during the fabrication, construction, erection or painting of equipment. During such operations the *Contractor* shall, if required, suspend any or all of the *works*, at no additional cost to the *Employer.*

The testing of the plant or part thereof shall be carried out through the full operating range, or part thereof, as required by the *Employer*.

The cost of all tests, inspections and inspection facilities shall be included in the tendered rates.

During commissioning and testing the *Contractor* shall have available on Site all essential spares and all tools that may be required to immediately execute repairs, replace defective parts or attend to breakdowns.

The *Contractor* shall be responsible for the proper operation and maintenance of the plant throughout the test period, until the operator training is complete.

Acceptance by the *Employer* of any plant item following such inspection or tests shall not relieve the *Contractor* of any obligations under this contract.

All pumps shall be lined up and tested as a complete set. Test certificates shall be supplied before dispatch.

All rotors and motor/impeller combinations shall be statically and dynamically balanced. Test certificates shall be supplied before dispatch.

10.2.4 Test Certificates

The *Contractor* shall provide to the *Employer* three copies of test certificates in respect of all materials and equipment. Further copies shall be bound into the operating and maintenance manuals.

10.2.5 Insulation Tests

All electrical wiring and equipment shall be subjected to insulation tests. All instruments and other equipment for these tests shall be provided by the *Contractor*.

10.2.6 Draining and cleaning

On completion of the pressure test on a section of pipework, the water used for testing shall be drained away as quickly as possible to remove as much dirt and dross as possible. After completion of a pipework circuit, the circuit shall be flushed through to remove all pipe scale, dross and similar materials.

The *Contractor* shall provide all necessary connections, by-pass pipes, temporary strainers, temporary make-up pieces and the like to enable the systems to be drained and cleaned.

Additionally, on boiler commissioning, steam lines are to be charged with steam to full operating pressure and allowed to cool. This procedure is to be carried out three times over a period of two days. Following the third cycle, the pipes are to be left open ended and blown through.

10.2.7 Plant Commissioning

The *Contractor* shall arrange at his cost for the manufacturer's representatives to check over and fully commission all major items of equipment. These *works* are to be carried out by skilled engineers, preferably employed by the manufacturers, who are completely familiar with the equipment and capable of training the operating and maintenance staff.

On completion of the plant commissioning, the *Contractor* shall obtain written confirmation from the various manufacturers that they have completed all commissioning and are satisfied that the items of plant for which they are responsible are functioning satisfactorily.

Copies of the manufacturer's written confirmation shall be handed over to the *Employer*.

10.2.8 Tests on Completion

On completion of the balancing and commissioning of equipment, the plant shall be put into normal operation and the final adjustments of the equipment shall be made.

Thereafter the test on completion shall be carried out to ensure that the plant meets the specification. Such tests shall include the following:

- Simulated tests for all alarm and safety cut-out equipment, to prove the operation of the equipment.
- Simulated tests on automatic controls to prove the ability of the controls to correct conditions which are outside the required design conditions.
- The tests shall be carried out by manually changing the desired values to produce an incorrect condition, and then re-setting the controls to the design conditions and checking the operation of valves and the like, to restore the design conditions.
- Operational tests shall be conducted on the plant to demonstrate that the rated output and efficiency is being achieved.

The *Contractor* shall provide all necessary temporary measuring and recording equipment. The equipment shall be of a type generally used for this type of testing and shall be to the acceptance of the *Employer*. All instruments shall be accurately calibrated before the tests begin.

On completion of all tests, and once the *Contractor* is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which is has been supplied, he shall submit to the *Employer* triplicate copies of all test records and charts together with reports on all the tests required in terms of the accepted commissioning and testing plan.

The *Employer* reserves the right to instruct additional tests, or for the repetition of previous tests, as reasonably required to prove that the operation of the plant is satisfactory and in accordance with the specification.

11.0 MATERIAL SPECIFICATIONS

The annexures appended hereto contain relevant information for the selection of the following equipment:

11.1 Technical Schedules

Equipment Page No

Should the *Contractor* wish to propose alternative equipment, full details of comparative designs, functionalities, guarantees and the like shall be provided, including any further information required by the *Employer* to enable a full assessment of such alternative equipment makes and types. Acceptance of such alternatives will be at the sole discretion of the *Employer*.

WATER/AIR COOLED CHILLED WATER UNITS - SUBSTATION M
(*COOLING ONLY)*

Tag Nr.	***:***	***ACC01 & ACC 02***
Description of Application	***:***	***Chilled Water Unit (Cooling Only)***
Condenser Type	***:***	***Air Cooled***
Location	***:***	***Chiller Plant Yard (Ground Level)***
Number Required	***:***	***Two***

TECHNICAL DETAILS : EACH UNIT

	UNITS	REQUIRED	OFFERED
MANUFACTURER'S NAME :		**DAIKIN / Climaveneta / Trane**	
MODEL NO.:			
1. Unit information			
Condenser type:		Air	
Compressor type:		Scroll / ~~Screw~~	
Nameplate Voltage:	V-PH-Hz	400-3-50	
Manufacturing Country:			*
Refrigerant:		~~R134~~ / R410A	
Minimum Capacity:	%	25	*
Shipping Weight:	kg		*
Operating Weight:	kg	1200	*
Unit Width:	mm	1150	*
Unit Height:	mm	1665	*
Unit Length:	mm	3250	*
Minimum Outdoor Operating temperature:	°C	5	
A-Weighted Sound Power Level:	dBA		*
2. Performance Information			
2.1 Heat Recovery Mode:		***N/A***	
Heating Capacity:	kW		
Cooling Capacity:	kW		*
Total Compressor Power:	kW		*
Total Unit Power (without pump):	kW		*
Heating Efficiency (without pump):	COP		*
Cooling Efficiency (without pump)			*
2.2 Cooling Mode			
Cooling Capacity:	kW	142 (See note 7)	
Total Compressor Power:	kW		*
Total Fan Motor Power:	kW		*
Total Unit Power (without pump):	kW	49.7	*
Efficiency (without pump):	COP		*
3. Evaporator Information			
Fluid type:		Water	
Fouling Factor:	(m².K)/kW	0,044	
Number of Passes:			*

	UNITS	REQUIRED	OFFERED
3.1 Heat Recovery Mode		***N/A***	
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPA		*
3.2 Cooling Mode			
Leaving Temperature:	°C	6.0°	
Entering Temperature:	°C	12°	
Fluid Flow:	L/s	6,2	*
Pressure Drop	kPa	50	*
4. Condenser Information			
4.1 Heat Recovery Mode		***N/A***	
Fluid Type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
4.2 Air Cooled Mode			
Altitude:	m	Sea Level	
Number of fans:			*
External Air Resistance	Pa	30	
Total Condenser Fan Air Flow:	L/s		*
Entering Air Temperature:	°C	35.0°	
4.3 Water Cooled Mode		***N/A***	
Fluid type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
5. Electrical Information :			
Unit Voltage:	V-Ph-Hz	400-3-50	
Standby Power:	kW		*
Minimum Voltage:	Volts		*
Maximum Voltage:	Volts		*
Power Factor:			*
Max Unit Current Draw RLA :	amps	116	*
Max Start Up Current (ICF) :	amps	367	*
Nominal Unit Current Draw (A) :	amps		*

Note:

1. Machine to have entering and leaving evaporator and condenser water temperature sensors and indication.
2. Evaporator and condensers to be capable of operating under 10 bar water pressure.
3. Chilled Water Units to be supplied with compatible interlocking chilled water flow switch.
4. Tenderer to include for chilled water units to be guaranteed for 1 year after start-up.
5. Chiller Management system to be provided as described in “Control System” Section.
6. ‘ * ‘ To be completed by Tenderer.
7. Each chiller unit to be equipped with two independent refrigeration circuits. There will therefore be four circuits between two installed units, one of which is provided for operational redundancy. Each unit will operate at three-quarters of indicated cooling duty under normal conditions. In case of a failure to one circuit, the unaffected unit will then operate at full capacity, and the damaged unit at half capacity.

VENTILATION FANS - Substation M

Specified

Details						Air Data		Fan Data				Electrical			
Tag Nr.	System Served	Manufacturer	Model	Type	No. Off	Air Flow	Fan Total Pressure	Size (Diameter)	Fan Speed	Fan Sound Power Level	Blade Configuration & Angle	Shaft Duty	Fan Motor	Motor Speed	Electrical Supply
						L/s	Pa	mm	rpm	dbA		kW	kW	rpm	V/Ph/Hz
FAF 01	Entire Building Fresh Air Supply	RTS	SPIN0007 H (X) A X	Self-Clean Inertial Spin Filter	1	1 810	190 + Spin Filter Loss	m.t.s. [4]	2880			2.2			400/3/50
EAF 01	Spin Filter Dust Purge Fan	RTS	See FAF 01		1	m.t.s. [4]	200 (after fan)	m.t.s. [4]	2880			0.6			400/3/50

Notes

1. Accepted manufacturers : Rand Technical Services (RTS) or Approved Equal.
2. Fans supplied complete with electric Motor, Drives, Frame/Support for entire unit.
3. Fans supplied with matching flanges and attenuators selected in for the specified fan duty point.
4. Manufacturer to Specify

Offered

Details						Air Data		Fan Data				Electrical			
Tag Nr.	System Served	Manufacturer	Model	Type	No. Off	Air Flow	Fan Static Pressure	Size (Diameter)	Fan Speed	Fan Sound Power Level	Blade Configuration & Angle	Shaft Duty	Fan Motor	Motor Speed	Electrical Supply
		*	*	*	*	m³/sec	Pa	mm	rpm	dbA		kW	kW	rpm	V/Ph/Hz
FAF 01	Entire Building Fresh Air Supply				1										
EAF 01	Spin Filter Dust Purge Fan				1										

CHILLED WATER AIR HANDLING UNITS SCHEDULE (COOLING AND HEATING) - SUBSTATION M

Type of AHU :- V: Vertical
H: Horizontal

SPECIFIED

Details				Air Data				Electrical			Cooling Coil Section																	Heating Coil Section											Type of AHU
Tag. Nr	Manufacturer	Model	No. Off	Supply	External Total Pressure	Outside Air (Note 8)	Motor	Electrical Motor	Electric Heating Current Value	Total Cooling	Total Sensible	Water Flow	Water Pressure Drop	Water Entry Temp.	Water Leave Temp.	Air Entry db	Air Entry wb	Air Leav. db	Air Leave wb	Rows (FPI)		Heating	Water Flow	Air Pressure Drop	Water Pressure Drop	Water Entry Temp	Water Leav. Temp	Air Entry db	Air Leav. db	Rows (FPI)							
				L/s	Pa	L/s	kW	V/Ph./Hz	kW	kWR	kW	L/s	m wg	°C	°C	°C	°C	°C	°C	Min.	Max.	kW	L/s	Pa	m wg	°C	°C	°C	°C	Min.	Max.						
AHU 01	AIR OPTIONS/ HEAT PUMP INTERNATIONAL/GYGTEMAIR/ AERMEC	1	8400	425	560	7.50	400/3/50	-	170.9		7.59			6.0	12	29.9	19.2	13.7	13.2			0														V
AHU 02		1	1700	425	870	1.50	400/3/50	-	40.8		1.80			6.0	12	29.4	20.1	13.6	13.1			0														H

Notes
1) AHUs shall be suitable for indoor mounting.
2) AHUs shall be draw through, complete with forward curve centrifugal fan, belt drive, cooling and heating coils & 50 mm washable filters.
3) AHU to include Mixing Box for return air, complete with RA OBDs.
4) Spare filters to be supplied.
5) AHU to be fitted with Access Doors to fan chamber and filter bank.
6) Coils to be Cu/Al; Stainless Steel Coil Casing & Drain Pan.
7) AHU to be double skin insulated panel construction.
8) Fresh air is mixed with return air before reaching the AHU, i.e. no fresh air connection is not required.

OFFERED

Details				Air Data				Electrical			Cooling Coil Section																	Heating Coil Section											Type of AHU
Tag. Nr	Manufacturer	Model	No. Off	Supply	External Static Pressure	Outside Air	Motor	Electrical Motor	Electric Heating Current Valve	Total Cooling	Total Sensible	Water Flow	Water Pressure Drop	Water Entry Temp.	Water Leave Temp.	Air Entry db	Air Entry wb	Air Leav. db	Air Leave wb	Rows (FPI)		Heating	Water Flow	Air Pressure Drop	Water Pressure Drop	Water Entry Temp	Water Leav. Temp	Air Entry db	Air Leav. db	Rows (FPI)							
				L/s	Pa	L/s	kW	V/Ph./Hz	kW	kWR	kW	L/s	m wg	°C	°C	°C	°C	°C	°C	Min.	Max.	kW	L/s	Pa	m wg	°C	°C	°C	°C	Min.	Max.						
	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*						
AHU 01			1																																	V
AHU 02			1																																	H

CHILLED WATER PUMPS - Substaion M

Type of Pumps : Vertically Split End Suction Centrifugal Pump.

Specified

Tag Nr.	System Served	Details			Water Data			Pump Data				Electrical		
		Manufacturer	Model	Qty.	Water Flow	Water Temp.	Pressure	Max. Speed	Impeller Diameter	Pump Efficiency	NPSH	Shaft Duty	Motor Name Plate Power	Electrical Supply
					l/s	°C	m wg	rpm	mm	%	m	kW	kW	V/Ph/Hz
CWP01	Primary Pumps for Chiller 1	Grundfos	NKE 40-200/219	1	6.2	20	14	1450	219				2.2	400/3/50
CWP02	Primary Pumps for Chiller 2	Grundfos	NKE 40-200/219	1	6.2	20	14	1450	219				2.2	400/3/50

Notes

1. Accepted manufacturers : KSB, Stork, Grundfos, ITT.
2. Pump to be non-overloading
3. Construction to allow a rated operating pressure of 10 bar.
4. Pump fitted with bronze impellar, mechanical seal.
5. Pump assembly to have spacer coupling.
6. CWP01 & CWP02 to be **variable speed pumps** and fitted with VSD.
7. In-line pumps may be offered as an optional alternative.

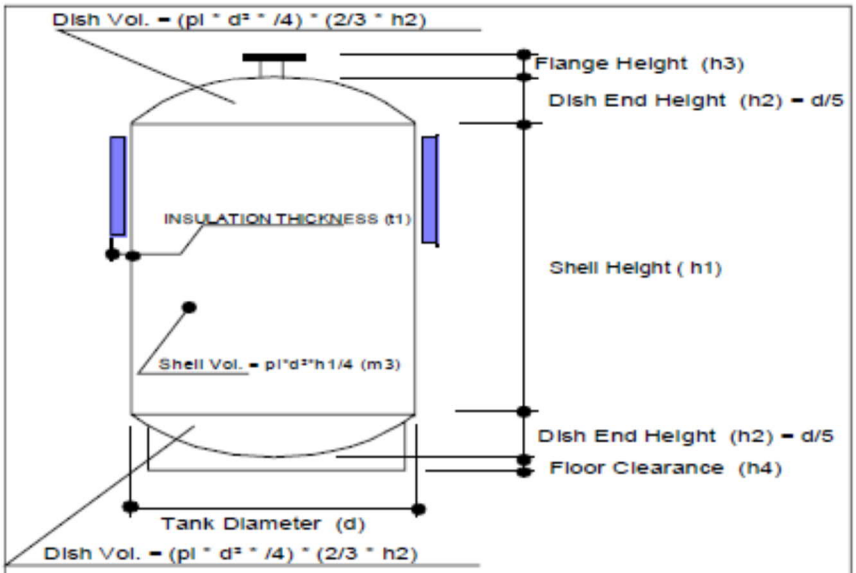
Offered

Tag Nr.	System Served	Details			Water Data			Pump Data				Electrical		
		Manufacturer	Model	No. Off	Water Flow	Water Temp.	Pressure	Max. Speed	Impeller Diameter	Pump Efficiency	NPSH	Shaft Duty	Motor Name Plate Power	Electrical Supply
		*	*		*	*	*	*	*	*	*	*	*	*
CWP01	Primary Pumps for Chiller 1			1										
CWP02	Primary Pumps for Chiller 2			1										

CHILLED WATER BUFFER TANK - VERTICAL

PROJECT NAME:	Bulk Power Supply - Substation M	DATE:
PROJECT NUMBER:	60495411	14-Jun-17
HW TANK DESCRIPTION:	CWBT1 (Chiller Plant Room)	
QUANTITY:	1	

DESCRIPTION	VALUE	UNIT
TOTAL VOLUME	1 240	litres
SHELL VOLUME	961	litres
DISH VOLUME	139	litres
TANK SHELL DIAMETER (d1)	1 100	mm
INSULATION THICKNESS: (t1)	100	mm
TANK DIAMETER (Incl. insulation) (d2)	1 300	mm
SHELL LENGTH (h1)	1 011	mm
DISH END HEIGHT (h2)	220	mm
TOP NOZZLE HEIGHT (h3)	150	mm
CLEARANCE SPACE BELOW TANK (h4)	150	mm
TANK HEIGHT(dish to dish)	1 451	mm
TANK TOTAL HEIGHT(Floor to flange)	1 751	mm



VERTICAL TANK DIMENSIONS

SPECIFICATION DETAILS

MAXIMUM WATER WORKING PRESSURE:	400.00 kPa
TEST PRESSURE:	600.00 kPa
MANUFACTURING SPECIFICATION:	ASME XIII
WORKING WATER TEMPERATURE:	10 °C
CORROSION PROTECTION LINING DETAILS:	N.A.
INSULATION MATERIAL:	100 mm 94 kg/m3 Mineral wool with 0.6 mm 304 SS Cladding
PRESSURE RELIEF VALVE SIZE:	500 kPa
ELECTRICAL IMMERSION HEATERS:	N.A.
INLET PIPE CONNECTION:	100 mm dia Flanged with Sparge Pipe
OUTLET PIPE CONNECTION:	100 mm dia Flanged
DRAIN CONNECTION:	40 mm dia - BSP Screwed Socket
OTHER CONNECTIONS:	1 x 50 mm dia, 3 x 25 mm dia & 1 x 20 mm dia BSP Sockets

TIPPLER 3 BULK POWER SUPPLY (E004) - SUBSTATION M - SCHEDULE OF BMS POINTS

CHILLER PLANT

PLANT ITEM	SWITCHBOARD	BMS FUNCTION	POINTS REQUIRED				FUNCTION / OPERATION
			INPUT		OUTPUT		
			A.I	D.I	A.O	D.O	
ACP-L0-01							
CHILLER PLANT ENABLE	BMS / ACP-L0-01	START CHILLER SYSTEM				1	SIGNALS START & STOP OF CHILLER PLANT CONTROL
CHILLER 1 (ACC 01)	ACP-L0-01	SERIAL LINK	SERIAL LINK				ALL CHILLER FUNCTIONS
CHILLER 2 (ACC 02)	ACP-L0-01	SERIAL LINK	SERIAL LINK				ALL CHILLER FUNCTIONS
PRIMARY CHW PUMP 1	ACP-L0-01	START / STOP				1	STARTS PUMP OPERATION
		RUN STATUS		1			MONITORS & CONFIRMS PUMP OPERATION IN SERIES WITH FLOW SWITCH
		FAULT / TRIP		1			VISUAL & AUDIBLE ALARM OF PUMP FAILURE / TRIP
		PUMP SPEED			1		SIGNAL TO V.S.D. TO ALTER PUMP SPEED
PRIMARY CHW PUMP 2	ACP-L0-01	START / STOP				1	STARTS PUMP OPERATION
		RUN STATUS		1			MONITORS & CONFIRMS PUMP OPERATION IN SERIES WITH FLOW SWITCH
		FAULT / TRIP		1			VISUAL & AUDIBLE ALARM OF PUMP FAILURE / TRIP
		PUMP SPEED			1		SIGNAL TO V.S.D. TO ALTER PUMP SPEED
CHW TEMPERATURE LEAVING TO BUILDING	ACP-L0-01	TEMPERATURE	1				MEASURES FOR CHILLER SEQUENCE / CONTROL PURPOSES
CHW DIFFERENTIAL PRESSURE SENSOR	BMS	MEASURE DIFF. PRESSURE	2				RECORDS DIFF. PRESSURE FOR CHW SYST. OPERATION (PER RISER)
CHILLED WATER FEED & EXPANSION TANK	BMS	FLOWRATE	1				MONITORS AMOUNT OF MAKE-UP WATER ENTERING THE SYSTEM
CHILLED WATER	BMS	TEMPERATURE	2				MONITOR SUPPLY & RETURN WATER TEMPERATURES
FIRE SIGNAL	ACP-L0-01	FIRE ALARM ACTIVATION		1			STOPS OPERATION OF CHILLER PLANT
BMS POINTS TOTAL FOR ACP-L0-01			A.I	D.I	A.O	D.O	
			6	5	2	3	

TIPPLER 3 BULK POWER SUPPLY (E004) - SUBSTATION M - SCHEDULE OF BMS POINTS								
AIR HANDLING PLANT								
PLANT ITEM	SWITCHBOARD	BMS FUNCTION	POINTS REQUIRED				FUNCTION / OPERATION	
			INPUT		OUTPUT			
			A.I	D.I	A.O	D.O		
ACP-L0-02								
AHU 01 & 02 (CONSTANT VOLUME)	ACP-L0-02	START / STOP				2	AHU FAN VIA CONTACTOR	
		RUN STATUS		2			FROM CONTACTOR & A.F.S	
		FAULT / TRIP		2			FROM OVERLOAD	
		S.A TEMPERATURE	2				MEASURES AHU S/AIR TEMPERATURE	
		TEMPERATURE	2				MEASURE SPACE / ROOM TEMPERATURE	
		CHW CONTROL VALVE			2		CHILLED WATER VALVE	
		R.A. TEMPERATURE	2				MEASURES COMMON R/AIR TEMPERATURE	
REMOTE A/C ON / OFF SWITCH		REMOTE PLANT ON / OFF		2			OVERIDES TIME CLOCK SCHEDULE TO SWITCH PLANT	
INDIVIDUAL ROOM TEMPERATURE ADJUSTMENT		REMOTE TEMP. ADJUSTMENT	2				ADJUSTS BMS DIFFUSERS TEMPERATURE SETPOINT	
FRESH AIR FAN, FAF 01	ACP-L0-02	START / STOP				1	AXIAL FAN VIA CONTACTOR	
(SPIN FILTER MAIN FAN)		RUN STATUS		1			FROM CONTACTOR	
		FAULT / TRIP		1			FROM OVERLOAD	
		ODA TEMPERATURE	1				MEASURES OUTDOOR TEMPERATURE	
SPIN FILTER PURGE FAN, EAF 01	ACP-L0-02	START / STOP				1	AXIAL FAN VIA CONTACTOR	
		RUN STATUS		1			FROM CONTACTOR	
		FAULT / TRIP		1			FROM OVERLOAD	
FIRE SIGNAL	ACP-L0-02	FIRE ALARM ACTIVATION		1			CAN STOP OPERATION OF PLANT	
BMS POINTS TOTAL FOR ACP-L0-02			A.I	D.I	A.O	D.O		
			9	11	2	4		

WATER/AIR COOLED CHILLED WATER UNITS - SUBSTATION N
(*COOLING ONLY)*

Tag Nr. : ***ACC01 & ACC 02***
Description of Application : ***Chilled Water Unit (Cooling Only)***
Condenser Type : ***Air Cooled***
Location : ***Chiller Plant Yard (Ground Level)***
Number Required : ***Two***

TECHNICAL DETAILS : EACH UNIT

	UNITS	REQUIRED	OFFERED
MANUFACTURER'S NAME :		**DAIKIN / Climaveneta / Trane**	
MODEL NO.:			
1. Unit information			
Condenser type:		Air	
Compressor type:		Scroll / ~~Screw~~	
Nameplate Voltage:	V-PH-Hz	400-3-50	
Manufacturing Country:			*
Refrigerant:		~~R134~~ / R410A	
Minimum Capacity:	%	25	*
Shipping Weight:	kg		*
Operating Weight:	kg	1700	*
Unit Width:	mm	2250	*
Unit Height:	mm	2200	*
Unit Length:	mm	3200	*
Minimum Outdoor Operating temperature:	° C	5°	
A-Weighted Sound Power Level:	dBA		*
2. Performance Information			
2.1 Heat Recovery Mode:		***N/A***	
Heating Capacity:	kW		
Cooling Capacity:	kW		*
Total Compressor Power:	kW		*
Total Unit Power (without pump):	kW		*
Heating Efficiency (without pump):	COP		*
Cooling Efficiency (without pump)			*
2.2 Cooling Mode			
Cooling Capacity:	kW	175.3 (See note 7)	
Total Compressor Power:	kW		*
Total Fan Motor Power:	kW		*
Total Unit Power (without pump):	kW	53,9	*
Efficiency (without pump):	COP		*
3. Evaporator Information			
Fluid type:		Water	
Fouling Factor:	(m².K)/kW	0,044	
Number of Passes:			*

	UNITS	REQUIRED	OFFERED
3.1 Heat Recovery Mode		***N/A***	
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPA		*
3.2 Cooling Mode			
Leaving Temperature:	°C	6.0°	
Entering Temperature:	°C	12°	
Fluid Flow:	L/s	7,7	*
Pressure Drop	kPa	50	*
4. Condenser Information			
4.1 Heat Recovery Mode		***N/A***	
Fluid Type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
4.2 Air Cooled Mode			
Altitude:	m	Sea Level	
Number of fans:			*
External Air Resistance	Pa	30	
Total Condenser Fan Air Flow:	L/s		*
Entering Air Temperature:	°C	35.0°	
4.3 Water Cooled Mode		***N/A***	
Fluid type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
5. Electrical Information :			
Unit Voltage:	V-Ph-Hz	400-3-50	
Standby Power:	kW		*
Minimum Voltage:	Volts		*
Maximum Voltage:	Volts		*
Power Factor:			*
Max Unit Current Draw RLA :	amps	133	*
Max Start Up Current (ICF) :	amps	301	*
Nominal Unit Current Draw (A) :	amps		*

Note:

1. Machine to have entering and leaving evaporator and condenser water temperature sensors and indication.
2. Evaporator and condensers to be capable of operating under 10 bar water pressure.
3. Chilled Water Units to be supplied with compatible interlocking chilled water flow switch.
4. Tenderer to include for chilled water units to be guaranteed for 1 year after start-up.
5. Chiller Management system to be provided as described in “Control System” Section.
6. ‘ * ‘ To be completed by Tenderer.
7. Each chiller unit to be equipped with two independent refrigeration circuits. There will therefore be four circuits between two installed units, one of which is provided for operational redundancy. Each unit will operate at three-quarters of indicated cooling duty under normal conditions. In case of a failure to one circuit, the unaffected unit will then operate at full capacity, and the damaged unit at half capacity

VENTILATION FANS - Substation N

Specified

Details						Air Data		Fan Data				Electrical			
Tag Nr.	System Served	Manufacturer	Model	Type	No. Off	Air Flow	Fan Total Pressure	Size (Diameter)	Fan Speed	Fan Sound Power Level	Blade Configuration & Angle	Shaft Duty	Fan Motor	Motor Speed	Electrical Supply
						L/s	Pa	mm	rpm	dbA		kW	kW	rpm	V/Ph/Hz
FAF 01	Entire Building Fresh Air Supply	RTS	SPIN0007 H (X) A X	Self-Clean Inertial Spin Filter	1	1 840	315 + Spin Filter Loss	m.t.s. [4]	2880			2.3			400/3/50
EAF 01	Spin Filter Dust Purge Fan	RTS	See FAF 01		1	m.t.s. [4]	200 (after fan)	m.t.s. [4]	2880			0.6			400/3/50

Notes
1. Accepted manufacturers : Rand Technical Services (RTS) or Approved Equal.
2. Fans supplied complete with electric Motor, Drives, Frame/Support for entire unit.
3. Fans supplied with matching flanges and attenuators selected in for the specified fan duty point.
4. Manufacturer to Specify

Offered

Details						Air Data		Fan Data				Electrical			
Tag Nr.	System Served	Manufacturer	Model	Type	No. Off	Air Flow	Fan Static Pressure	Size (Diameter)	Fan Speed	Fan Sound Power Level	Blade Configuration & Angle	Shaft Duty	Fan Motor	Motor Speed	Electrical Supply
		*	*	*	*	m³/sec	Pa	mm	rpm	dbA		kW	kW	rpm	V/Ph/Hz
FAF 01	Entire Building Fresh Air Supply				1										
EAF 01	Spin Filter Dust Purge Fan				1										

CHILLED WATER AIR HANDLING UNITS SCHEDULE (COOLING AND HEATING) - SUBSTATION N

Type of AHU : V: Vertical
H: Horizontal

SPECIFIED

Details				Air Data			Electrical			Cooling Coil Section												Heating Coil Section										Type of AHU
Tag. Nr	Manufacturer	Model	No. Off	Supply	External Total Pressure	Outside Air (Note 8)	Motor	Electrical Motor	Electric Heating. Current Value	Total Cooling	Total Sensible	Water Flow	Water Pressure Drop	Water Entry Temp.	Water Leave Temp.	Air Entry db	Air Entry wb	Air Leav db	Air Leave wb	Rows	(FPI)	Heating	Water Flow	Air Pressure Drop	Water Pressure Drop	Water Entry Temp	Water Leav. Temp	Air Entry db	Air Leav. db	Rows	(FPI)	
																				Min.	Max .									Min.	Max .	
				L/s	Pa	L/s	kW	V/Ph /Hz	kW	kWR	kW	L/s	m wg	°C	°C	°C	°C	°C	°C			kW	L/s	Pa	m wg	°C	°C	°C	°C			
AHU 01	AIR OPTIONS/ HEAT PUMP INTERNATIONAL/SYSTEMAIR/ AERMEC		1	11000	415	590	9.80	400/3/50	-	221.2		9.70		6.0	12	29.9	19.1	13.7	13.2			0										V
AHU 02			1	1700	415	870	1.50	400/3/50	-	41.7		1.90		6.0	12	29.4	20.1	13.6	13.1			0										H

Notes
1) AHUs shall be suitable for indoor mounting.
2) AHUs shall be draw through, complete with forward curve centrifugal fan, belt drive, cooling and heating coils & 50 mm washable filters.
3) AHU to include Mixing Box for return air, complete with RA OBDs.
4) Spare filters to be supplied.
5) AHU to be fitted with Access Doors to fan chamber and filter bank.
6) Coils to be Cu/Al; Stainless Steel Coil Casing & Drain Pan.
7) AHU to be double skin insulated panel construction.
8) Fresh air is mixed with return air before reaching the AHU, i.e. no fresh air connection is not required.

OFFERED

Details				Air Data			Electrical			Cooling Coil Section												Heating Coil Section										Type of AHU
Tag. Nr	Manufacturer	Model	No. Off	Supply	External Static Pressure	Outside Air	Motor	Electrical Motor	Electric Heating. Current Valve	Total Cooling	Total Sensible	Water Flow	Water Pressure Drop	Water Entry Temp.	Water Leave Temp.	Air Entry db	Air Entry wb	Air Leav db	Air Leave wb	Rows	(FPI)	Heating	Water Flow	Air Pressure Drop	Water Pressure Drop	Water Entry Temp	Water Leav. Temp	Air Entry db	Air Leav. db	Rows	(FPI)	
																				Min.	Max .									Min.	Max .	
				L/s	Pa	L/s	kW	V/Ph /Hz	kW	kWR	kW	L/s	m wg	°C	°C	°C	°C	°C	°C			kW	L/s	Pa	m wg	°C	°C	°C	°C			
	*	*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
AHU 01			1																												V
																															H
AHU 02			1																												

CHILLED WATER PUMPS - Substaion N

Type of Pumps : Vertically Split End Suction Centrifugal Pump.

Specified

Details					Water Data			Pump Data				Electrical		
Tag Nr.	System Served	Manufacturer	Model	Qty.	Water Flow l/s	Water Temp. °C	Pressure m wg	Max. Speed rpm	Impeller Diameter mm	Pump Efficiency %	NPSH m	Shaft Duty kW	Motor Name Plate Power kW	Electrical Supply V/Ph/Hz
CWP01	Primary Pump for Chiller 1	Grundfos	NKE 50-200/210	1	7.7	20	14	1450	210				2.2	400/3/50
CWP02	Primary Pump for Chiller 2	Grundfos	NKE 50-200/210	1	7.7	20	14	1450	210				2.2	400/3/50

Notes

1. Accepted manufacturers : KSB, Stork, Grundfos, ITT.
2. Pump to be non-overloading
3. Construction to allow a rated operating pressure of 10 bar.
4. Pump fitted with bronze impellar; mechanical seal.
5. Pump assembly to have spacer coupling.
6. CWP01 & CWP02 to be **variable speed pumps** and fitted with VSD.
7. In-line pumps may be offered as an optional alternative.

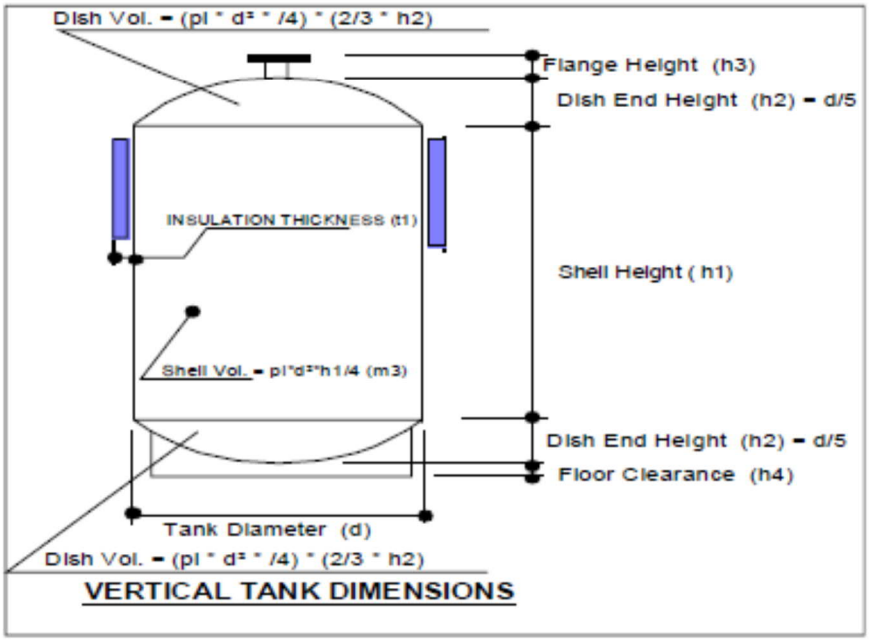
Offered

Details					Water Data			Pump Data				Electrical		
Tag Nr.	System Served	Manufacturer	Model	No. Off	Water Flow l/s	Water Temp. °C	Pressure kPa	Max. Speed rpm	Impeller Diameter mm	Pump Efficiency %	NPSH m	Shaft Duty kW	Motor Name Plate Power kW	Electrical Supply V/Ph/Hz
		*	*		*	*	*	*	*	*	*	*	*	*
CWP01	Primary Pump for Chiller 1			1										
CWP02	Primary Pump for Chiller 2			1										

CHILLED WATER BUFFER TANK - VERTICAL

PROJECT NAME:	**Bulk Power Supply - Substation N**	**DATE:**
PROJECT NUMBER:	**60495411**	**14-Jun-17**
HW TANK DESCRIPTION:	**CWBT1 (Chiller Plant Room)**	
	QUANTITY	**1**

DESCRIPTION	VALUE	UNIT
TOTAL VOLUME	1 585	litres
SHELL VOLUME	1 306	litres
DISH VOLUME	139	litres
TANK SHELL DIAMETER (d1)	1 100	mm
INSULATION THICKNESS: (t1)	100	mm
TANK DIAMETER (Incl. insulation) (d2)	1 300	mm
SHELL LENGTH (h1)	1 375	mm
DISH END HEIGHT (h2)	220	mm
TOP NOZZLE HEIGHT (h3)	150	mm
CLEARANCE SPACE BELOW TANK (h4)	150	mm
TANK HEIGHT(dish to dish)	1 815	mm
TANK TOTAL HEIGHT(Floor to flange)	2 115	mm



VERTICAL TANK DIMENSIONS

SPECIFICATION DETAILS

MAXIMUM WATER WORKING PRESSURE:	400.00 kPa
TEST PRESSURE:	600.00 kPa
MANUFACTURING SPECIFICATION:	ASME XIII
WORKING WATER TEMPERATURE:	10 °C
CORROSION PROTECTION LINING DETAILS:	N.A.
INSULATION MATERIAL:	100 mm 94 kg/m3 Mineral wool with 0.6 mm 304 SS Cladding
PRESSURE RELIEF VALVE SIZE:	500 kPa
ELECTRICAL IMMERSION HEATERS:	N.A.
INLET PIPE CONNECTION:	100 mm dia Flanged with Sparge Pipe
OUTLET PIPE CONNECTION:	100 mm dia Flanged
DRAIN CONNECTION:	40 mm dia - BSP Screwed Socket
OTHER CONNECTIONS:	1 x 50 mm dia, 3 x 25 mm dia & 1 x 20 mm dia BSP Sockets

TIPPLER 3 BULK POWER SUPPLY (E004) - SUBSTATION N - SCHEDULE OF BMS POINTS

CHILLER PLANT

PLANT ITEM	SWITCHBOARD	BMS FUNCTION	POINTS REQUIRED				FUNCTION / OPERATION
			INPUT		OUTPUT		
			A.I	D.I	A.O	D.O	
ACP-L0-01							
CHILLER PLANT ENABLE	BMS / ACP-L0-01	START CHILLER SYSTEM				1	SIGNALS START & STOP OF CHILLER PLANT CONTROL
CHILLER 1 (ACC 01)	ACP-L0-01	SERIAL LINK	SERIAL LINK				ALL CHILLER FUNCTIONS
CHILLER 2 (ACC 02)	ACP-L0-01	SERIAL LINK	SERIAL LINK				ALL CHILLER FUNCTIONS
PRIMARY CHW PUMP 1	ACP-L0-01	START / STOP				1	STARTS PUMP OPERATION
		RUN STATUS		1			MONITORS & CONFIRMS PUMP OPERATION IN SERIES WITH FLOW SWITCH
		FAULT / TRIP		1			VISUAL & AUDIBLE ALARM OF PUMP FAILURE / TRIP
		PUMP SPEED			1		SIGNAL TO V.S.D. TO ALTER PUMP SPEED
PRIMARY CHW PUMP 2	ACP-L0-01	START / STOP				1	STARTS PUMP OPERATION
		RUN STATUS		1			MONITORS & CONFIRMS PUMP OPERATION IN SERIES WITH FLOW SWITCH
		FAULT / TRIP		1			VISUAL & AUDIBLE ALARM OF PUMP FAILURE / TRIP
		PUMP SPEED			1		SIGNAL TO V.S.D. TO ALTER PUMP SPEED
CHW TEMPERATURE LEAVING TO BUILDING	ACP-L0-01	TEMPERATURE	1				MEASURES FOR CHILLER SEQUENCE / CONTROL PURPOSES
CHW DIFFERENTIAL PRESSURE SENSOR	BMS	MEASURE DIFF. PRESSURE	2				RECORDS DIFF. PRESSURE FOR CHW SYST. OPERATION (PER RISER)
CHILLED WATER FEED & EXPANSION TANK	BMS	FLOWRATE	1				MONITORS AMOUNT OF MAKE-UP WATER ENTERING THE SYSTEM
CHILLED WATER	BMS	TEMPERATURE	2				MONITOR SUPPLY & RETURN WATER TEMPERATURES
FIRE SIGNAL	ACP-L0-01	FIRE ALARM ACTIVATION		1			STOPS OPERATION OF CHILLER PLANT
BMS POINTS TOTAL FOR ACP-L0-01			A.I	D.I	A.O	D.O	
			6	5	2	3	

TIPPLER 3 BULK POWER SUPPLY (E004) - SUBSTATION N - SCHEDULE OF BMS POINTS

AIR HANDLING PLANT

PLANT ITEM	SWITCHBOARD	BMS FUNCTION	POINTS REQUIRED				FUNCTION / OPERATION
			INPUT		OUTPUT		
			A.I	D.I	A.O	D.O	
ACP-L0-02							
AHU 01 & 02 (CONSTANT VOLUME)	ACP-L0-02	START / STOP				2	AHU FAN VIA CONTACTOR
		RUN STATUS		2			FROM CONTACTOR & A.F.S
		FAULT / TRIP		2			FROM OVERLOAD
		S.A TEMPERATURE	2				MEASURES AHU S/AIR TEMPERATURE
		TEMPERATURE	2				MEASURE SPACE / ROOM TEMPERATURE
		CHW CONTROL VALVE			2		CHILLED WATER VALVE
		R.A. TEMPERATURE	2				MEASURES COMMON R/AIR TEMPERATURE
REMOTE A/C ON / OFF SWITCH		REMOTE PLANT ON / OFF		2			OVERIDES TIME CLOCK SCHEDULE TO SWITCH PLANT
INDIVIDUAL ROOM TEMPERATURE ADJUSTMENT		REMOTE TEMP. ADJUSTMENT	2				ADJUSTS BMS DIFFUSERS TEMPERATURE SETPOINT
FRESH AIR FAN, FAF 01	ACP-L0-02	START / STOP				1	AXIAL FAN VIA CONTACTOR
(SPIN FILTER MAIN FAN)		RUN STATUS		1			FROM CONTACTOR
		FAULT / TRIP		1			FROM OVERLOAD
		ODA TEMPERATURE	1				MEASURES OUTDOOR TEMPERATURE
SPIN FILTER PURGE FAN, EAF 01	ACP-L0-02	START / STOP				1	AXIAL FAN VIA CONTACTOR
		RUN STATUS		1			FROM CONTACTOR
		FAULT / TRIP		1			FROM OVERLOAD
FIRE SIGNAL	ACP-L0-02	FIRE ALARM ACTIVATION		1			CAN STOP OPERATION OF PLANT
BMS POINTS TOTAL FOR ACP-L0-02			A.I	D.I	A.O	D.O	
			9	11	2	4	

WATER/AIR COOLED CHILLED WATER UNITS – MAIN INTAKE SUBSTATION (*COOLING ONLY*)

Tag Nr. : ***ACC01***
Description of Application : ***Chilled Water Unit (Cooling Only)***
Condenser Type : ***Air Cooled***
Location : ***Roof Level (Level 2)***
Number Required : ***ONE***

TECHNICAL DETAILS : EACH UNIT

	UNITS	REQUIRED	OFFERED
MANUFACTURER'S NAME :		**DAIKIN or equal**	
MODEL NO.:		**EWAQ200-F-XS**	
1. Unit information			
Condenser type:		Air	
Compressor type:		Scroll / ~~Screw~~	
Nameplate Voltage:	V-PH-Hz	400-3-50	
Manufacturing Country:			*
Refrigerant:		~~R134~~ / R410A	
Minimum Capacity:	%	25	*
Shipping Weight:	kg		*
Operating Weight:	kg	2000	*
Unit Width:	mm	1250	*
Unit Height:	mm	2300	*
Unit Length:	mm	4450	*
Minimum Outdoor Operating temperature:	° C	5°	
A-Weighted Sound Power Level:	dBA		*
2. Performance Information			
2.1 Heat Recovery Mode:		***N/A***	
Heating Capacity:	kW		
Cooling Capacity:	kW		*
Total Compressor Power:	kW		*
Total Unit Power (without pump):	kW		*
Heating Efficiency (without pump):	COP		*
Cooling Efficiency (without pump)			*
2.2 Cooling Mode			
Cooling Capacity:	kW	194	
Total Compressor Power:	kW		*
Total Fan Motor Power:	kW		*
Total Unit Power (without pump):	kW	65	*
Efficiency (without pump):	COP		*
3. Evaporator Information			
Fluid type:		Water	
Fouling Factor:	$(m^2.K)/kW$	0,044	
Number of Passes:			*
3.1 Heat Recovery Mode		***N/A***	
Leaving Temperature:	°C		
Entering Temperature:	°C		

	UNITS	REQUIRED	OFFERED
Fluid Flow:	L/s		*
Pressure Drop:	kPA		*
3.2 Cooling Mode			
Leaving Temperature:	°C	6,0°	
Entering Temperature:	°C	11,5°	
Fluid Flow:	L/s	8,5	*
Pressure Drop	kPa	52,4	*
4. Condenser Information			
4.1 Heat Recovery Mode		***N/A***	
Fluid Type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
4.2 Air Cooled Mode			
Altitude:	m	Sea Level	
Number of fans:			*
External Air Resistance	Pa	30	
Total Condenser Fan Air Flow:	L/s		*
Entering Air Temperature:	°C	35,0°	
4.3 Water Cooled Mode		***N/A***	
Fluid type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
5. Electrical Information :			
Unit Voltage:	V-Ph-Hz	400-3-50	
Standby Power:	kW		*
Minimum Voltage:	Volts		*
Maximum Voltage:	Volts		*
Power Factor:			*
Max Unit Current Draw RLA :	amps	120	*
Max Start Up Current (ICF) :	amps	340	*
Nominal Unit Current Draw (A) :	amps		*

Note:

1. Machine to have entering and leaving evaporator and condenser water temperature sensors and indication.
2. Evaporator and condensers to be capable of operating under 10 bar water pressure.
3. Chilled Water Units to be supplied with compatible interlocking chilled water flow switch.
4. Tenderer to include for chilled water units to be guaranteed for 1 year after start-up.
5. Chiller Management system to be provided as described in “Control System” Section.
6. ‘ * ‘ To be completed by Tenderer

WATER/AIR COOLED CHILLED WATER UNITS – MAIN INTAKE SUBSTATION
(*COOLING ONLY)*

Tag Nr. : ***ACC02***
Description of Application : ***Chilled Water Unit (Cooling Only)***
Condenser Type : ***Air Cooled***
Location : ***Roof Level (Level 2)***
Number Required : ***ONE***

TECHNICAL DETAILS : EACH UNIT

	UNITS	REQUIRED	OFFERED
MANUFACTURER'S NAME :		**DAIKIN or equal**	
MODEL NO.:		**EWAQ105-G-XS**	
1. Unit information			
Condenser type:		Air	
Compressor type:		Scroll / ~~Screw~~	
Nameplate Voltage:	V-PH-Hz	400-3-50	
Manufacturing Country:			*
Refrigerant:		~~R134~~ / R410A	
Minimum Capacity:	%	50	*
Shipping Weight:	kg		*
Operating Weight:	kg	1050	*
Unit Width:	mm	1200	*
Unit Height:	mm	1800	*
Unit Length:	mm	3200	*
Minimum Outdoor Operating temperature:	° C	5°	
A-Weighted Sound Power Level:	dBA		*
2. Performance Information			
2.1 Heat Recovery Mode:		***N/A***	
Heating Capacity:	kW		
Cooling Capacity:	kW		*
Total Compressor Power:	kW		*
Total Unit Power (without pump):	kW		*
Heating Efficiency (without pump):	COP		*
Cooling Efficiency (without pump)			*
2.2 Cooling Mode			
Cooling Capacity:	kW	105 (See Note 7)	
Total Compressor Power:	kW		*
Total Fan Motor Power:	kW		*
Total Unit Power (without pump):	kW	34	*
Efficiency (without pump):	COP		*
3. Evaporator Information			
Fluid type:		Water	
Fouling Factor:	$(m^2.K)/kW$	0,044	
Number of Passes:			*
3.1 Heat Recovery Mode		***N/A***	
Leaving Temperature:	°C		
Entering Temperature:	°C		

	UNITS	REQUIRED	OFFERED
Fluid Flow:	L/s		*
Pressure Drop:	kPA		*
3.2 Cooling Mode			
Leaving Temperature:	°C	6,0°	
Entering Temperature:	°C	11,5°	
Fluid Flow:	L/s	4,6	*
Pressure Drop	kPa	52,4	*
4. Condenser Information			
4.1 Heat Recovery Mode		***N/A***	
Fluid Type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
4.2 Air Cooled Mode			
Altitude:	m	Sea Level	
Number of fans:			*
External Air Resistance	Pa	30	
Total Condenser Fan Air Flow:	L/s		*
Entering Air Temperature:	°C	35,0°	
4.3 Water Cooled Mode		***N/A***	
Fluid type:			
Fouling Factor:	(m².K)/kW		
Leaving Temperature:	°C		
Entering Temperature:	°C		
Fluid Flow:	L/s		*
Pressure Drop:	kPa		*
5. Electrical Information :			
Unit Voltage:	V-Ph-Hz	400-3-50	
Standby Power:	kW		*
Minimum Voltage:	Volts		*
Maximum Voltage:	Volts		*
Power Factor:			*
Max Unit Current Draw RLA :	amps	62	*
Max Start Up Current (ICF) :	amps	270	*
Nominal Unit Current Draw (A) :	amps		*

Note:

1. Machine to have entering and leaving evaporator and condenser water temperature sensors and indication.
2. Evaporator and condensers to be capable of operating under 10 bar water pressure.
3. Chilled Water Units to be supplied with compatible interlocking chilled water flow switch.
4. Tenderer to include for chilled water units to be guaranteed for 1 year after start-up.
5. Chiller Management system to be provided as described in “Control System” Section.
6. **‘ * ‘** To be completed by Tenderer
7. Unit ACC 02 shall serve as a back-up unit in case of a failure on one of the refrigeration circuits on Unit ACC 01 (specified elsewhere). This unit’s capacity shall therefore be equal to at least half the capacity of unit ACC 01

E

VENTILATION FANS - Main Intake Substation

Specified

Details						Air Data			Fan Data				Electrical			
Tag Nr.	System Served	Manufacturer	Model	Type	No. Off	Air Flow	Fan Total Pressure	Size (Diameter)	Fan Speed	Fan Sound Power Level	Blade Configuration & Angle	Shaft Duty	Fan Motor	Motor Speed	Electrical Supply
						L/s	Pa	mm	rpm	dbA		kW	kW	rpm	V/Ph/Hz
SAF 01	Entire Building Fresh Air Supply	RTS	SPIN00014H	Self-Clean Inertial Spin Filter	1	3 985	280 + Spin Filter Loss	m.t.s. [4]	2880	86		4.85			400/3/50
EAF 01	Spin Filter Dust Purge Fan	RTS	See SAF 01		1	m.t.s. [4]	100 (after fan)	m.t.s. [4]	2880	82		0.6			400/3/50

Notes
1. Accepted manufacturers : Rand Technical Services (RTS) or Approved Equal.
2. Fans supplied complete with electric Motor, Drives, Frame/Support for entire unit.
3. Fans supplied with matching flanges and 2D long pod attenuators.
4. Manufacturer to Specify

Offered

Details						Air Data			Fan Data				Electrical			
Tag Nr.	System Served	Manufacturer	Model	Type	No. Off	Air Flow	Fan Static Pressure	Size (Diameter)	Fan Speed	Fan Sound Power Level	Blade Configuration & Angle	Shaft Duty	Fan Motor	Motor Speed	Electrical Supply
		*	*	*	*	m³/sec	Pa	mm	rpm	dbA		kW	kW	rpm	V/Ph/Hz
SAF 01	Entire Building Fresh Air Supply				1	*	*	*	*	*	*	*	*	*	*
EAF 01	Spin Filter Dust Purge Fan				1										

CHILLED WATER AIR HANDLING UNITS SCHEDULE (COOLING AND HEATING) - MAIN INTAKE SUBSTATION

Type of AHU : V: Vertical
H: Horizontal

SPECIFIED

Tag Nr	Details			Air Data				Electrical			Cooling Coil Section																		Heating Coil Section										Type of AHU
	Manufacturer	Model	No. Off	Supply	External Total Pressure	Outside Air (Note 8)	Motor	Electrical Motor	Electric Heating Current Valve	Total Cooling	Total Sensible	Water Flow	Water Pressure Drop	Water Entry Temp.	Water Leave Temp.	Air Entry db	Air Entry wb	Air Leav db	Air Leave wb	Rows	(FPI)	Heating	Water Flow	Air Pressure Drop	Water Pressure Drop	Water Entry Temp	Water Leav. Temp	Air Entry db	Air Leav. db	Rows	(FPI)	
				L/s	Pa	L/s	kW	V/Ph /Hz	kW	kWR	kW	L/s	m wg	°C	°C	°C	°C	°C	°C	Min.	Max.	kW	L/s	Pa	m wg	°C	°C	°C	°C	Min.	Max.	
AHU 01	AIR OPTIONS/ HEAT PUMP		1	1745	340	N/A		400/3/50	-	21.7		1.00		6.0	11.5	30.0	22.0	19	18.6			0										H
AHU 02	INTERNATIONA		1	3180	430	N/A		400/3/50	-	68.2		3.00		6.0	11.5	29.8	19.3	13.7	13.2			0										H
AHU 03	L/SYSTEMAIR/ AERMEC		1	3180	395	N/A		400/3/50	-	68.2		3.00		6.0	11.5	29.8	19.3	13.7	13.2			0										H

Notes
1) AHUs shall be suitable for indoor mounting.
2) AHUs shall be draw through, complete with forward curve centrifugal fan, belt drive, cooling and heating coils & 50 mm washable filters.
3) AHU to include Mixing Box for return air, complete with RA OBDs.
4) Spare filters to be supplied.
5) AHU to be fitted with Access Doors to fan chamber and filter bank.
6) Coils to be Cu/Al; Stainless Steel Coil Casing & Drain Pan.
7) AHU to be double skin insulated panel construction.
8) Fresh air is mixed with return air before reaching the AHU, i.e. a fresh air connection is not required.

OFFERED

Tag Nr	Details			Air Data				Electrical			Cooling Coil Section																		Heating Coil Section										Type of AHU
	Manufacturer	Model	No. Off	Supply	External Static Pressure	Outside Air	Motor	Electrical Motor	Electric Heating Current Valve	Total Cooling	Total Sensible	Water Flow	Water Pressure Drop	Water Entry Temp.	Water Leave Temp.	Air Entry db	Air Entry wb	Air Leav db	Air Leave wb	Rows	(FPI)	Heating	Water Flow	Air Pressure Drop	Water Pressure Drop	Water Entry Temp	Water Leav. Temp	Air Entry db	Air Leav. db	Rows	(FPI)	
				L/s	Pa	L/s	kW	V/Ph /Hz	kW	kWR	kW	L/s	m wg	°C	°C	°C	°C	°C	°C	Min.	Max.	kW	L/s	Pa	m wg	°C	°C	°C	°C	Min.	Max.	
	"	"	"	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
AHU 01			1																												H
AHU 02			1																												H
AHU 03			1																												H
																															O
																															O
																															O
																															O
																															O
																															O
																															O
																															O

CHILLED WATER PUMPS - MAIN INTAKE SUBSTATION

Type of Pumps : Vertically Split End Suction Centrifugal Pump.

Specified

Details					Water Data			Pump Data				Electrical		
Tag Nr.	System Served	Manufacturer	Model	Qty.	Water Flow l/s	Water Temp. °C	Pressure m wg	Max. Speed rpm	Impeller Diameter mm	Pump Efficiency %	NPSH m	Shaft Duty kW	Motor Name Plate Power kW	Electrical Supply V/Ph/Hz
CWP01A	Duty Pump for Chiller 1	Grundfos	NB 32-125/137	1	8.5	20	25	2910	137				3.0	400/3/50
CWP01B	Standby Pumps for Chiller 1	Grundfos	NB 32-125/137	1	8.5	20	25	2910	137				3.0	400/3/50
CWP02	Duty Pump for Chiller 2	Grundfos	NB32-125.1/140	1	4.6	20	25	2910	140				1.5	400/3/50

Notes

1. Accepted manufacturers : KSB, Stork, Grundfos, ITT.
2. Pump to be non-overloading
3. Construction to allow a rated operating pressure of 10 bar.
4. Pump fitted with bronze impellar; mechanical seal.
5. Pump assembly to have spacer coupling.
6. CWP01A/B & CWP02 to be **variable speed pumps** and fitted with VSD.
7. In-line pumps may be offered as an optional alternative.

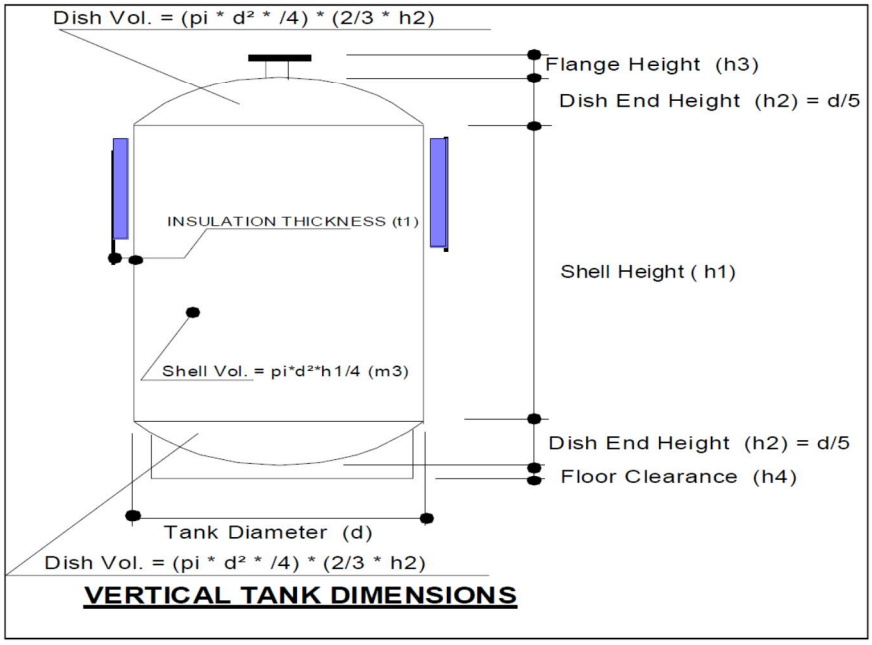
Offered

Details					Water Data			Pump Data				Electrical		
Tag Nr.	System Served	Manufacturer	Model	No. Off	Water Flow l/s	Water Temp. °C	Pressure kPa	Max. Speed rpm	Impeller Diameter mm	Pump Efficiency %	NPSH m	Shaft Duty kW	Motor Name Plate Power kW	Electrical Supply V/Ph/Hz
		*	*		*	*	*	*	*	*	*	*	*	*
CWP01A	Duty Pump for Chiller 1			1										
CWP01B	Standby Pumps for Chiller 1			1										
CWP02	Duty Pump for Chiller 2			1										

CHILLED WATER BUFFER TANK - VERTICAL

PROJECT NAME:	**Bulk Power Supply - Main In Sub**	**DATE:**
PROJECT NUMBER:	**60329837**	**19-May-16**
HW TANK DESCRIPTION:	**CWBT1 (HVAC Plant Room)**	
QUANTITY	**1**	

DESCRIPTION	VALUE	UNIT
TOTAL VOLUME	875	litres
SHELL VOLUME	768	litres
DISH VOLUME	54	litres
TANK SHELL DIAMETER (d1)	800	mm
INSULATION THICKNESS: (t1)	100	mm
TANK DIAMETER (Incl. insulation) (d2)	1 000	mm
SHELL LENGTH (h1)	1 527	mm
DISH END HEIGHT (h2)	160	mm
TOP NOZZLE HEIGHT (h3)	150	mm
CLEARANCE SPACE BELOW TANK (h4)	150	mm
TANK HEIGHT(dish to dish)	1 847	mm
TANK TOTAL HEIGHT(Floor to flange)	2 147	mm



VERTICAL TANK DIMENSIONS

SPECIFICATION DETAILS

MAXIMUM WATER WORKING PRESSURE:	400.00 kPa
TEST PRESSURE:	600.00 kPa
MANUFACTURING SPECIFICATION:	ASME XIII
WORKING WATER TEMPERATURE:	10 °C
CORROSION PROTECTION LINING DETAILS:	N.A.
INSULATION MATERIAL:	100 mm 94 kg/m3 Mineral wool with 0.6 mm 304 SS Cladding
PRESSURE RELIEF VALVE SIZE:	500 kPa
ELECTRICAL IMMERSION HEATERS:	N.A.
INLET PIPE CONNECTION:	100 mm dia Flanged with Sparge Pipe
OUTLET PIPE CONNECTION:	100 mm dia Flanged
DRAIN CONNECTION:	40 mm dia - BSP Screwed Socket
OTHER CONNECTIONS:	1 x 50 mm dia, 3 x 25 mm dia & 1 x 20 mm dia BSP Sockets

TIPPLER 3 BULK POWER SUPPLY (E004) - MAIN INTAKE SUBSTATION 11 KV SWITCHOUSE - SCHEDULE OF BMS POINTS

CHILLER PLANT - LEVEL 2

PLANT ITEM	SWITCHBOARD	BMS FUNCTION	POINTS REQUIRED				FUNCTION / OPERATION
			INPUT		OUTPUT		
			A.I	D.I	A.O	D.O	
ACP-L02-01 (in Chiller "Plant-room")							
CHILLER PLANT ENABLE	BMS / ACP-L2-01	START CHILLER SYSTEM				1	SIGNALS START & STOP OF CHILLER PLANT CONTROL
CHILLER 1 (ACC 01)	ACP-L2-01	SERIAL LINK	SERIAL LINK				ALL CHILLER FUNCTIONS
CHILLER 2 (ACC 02)	ACP-L2-01	SERIAL LINK	SERIAL LINK				ALL CHILLER FUNCTIONS
PRIMARY CHW PUMP 1A	ACP-L2-01	START / STOP				1	STARTS PUMP OPERATION
		RUN STATUS		1			MONITORS & CONFIRMS PUMP OPERATION IN SERIES WITH FLOW SWITCH
		FAULT / TRIP		1			VISUAL & AUDIBLE ALARM OF PUMP FAILURE / TRIP
		PUMP SPEED			1		SIGNAL TO V.S.D. TO ALTER PUMP SPEED
PRIMARY CHW PUMP 1B	ACP-L2-01	START / STOP				1	STARTS PUMP OPERATION
		RUN STATUS		1			MONITORS & CONFIRMS PUMP OPERATION IN SERIES WITH FLOW SWITCH
		FAULT / TRIP		1			VISUAL & AUDIBLE ALARM OF PUMP FAILURE / TRIP
		PUMP SPEED			1		SIGNAL TO V.S.D. TO ALTER PUMP SPEED
PRIMARY CHW PUMP 2	ACP-L2-01	START / STOP				1	STARTS PUMP OPERATION
		RUN STATUS		1			MONITORS & CONFIRMS PUMP OPERATION IN SERIES WITH FLOW SWITCH
		FAULT / TRIP		1			VISUAL & AUDIBLE ALARM OF PUMP FAILURE / TRIP
		PUMP SPEED			1		SIGNAL TO V.S.D. TO ALTER PUMP SPEED
CHW TEMPERATURE LEAVING TO BUILDING	ACP-L03-01	TEMPERATURE	1				MEASURES FOR CHILLER SEQUENCE / CONTROL PURPOSES
CHW DIFFERENTIAL PRESSURE SENSOR	BMS	MEASURE DIFF. PRESSURE	2				RECORDS DIFF. PRESSURE FOR CHW SYST. OPERATION (PER RISER)
CHILLED WATER FEED & EXPANSION TANK	BMS	FLOWRATE	1				MONITORS AMOUNT OF MAKE-UP WATER ENTERING THE SYSTEM
CHILLED WATER	BMS	TEMPERATURE	2				MONITOR SUPPLY & RETURN WATER TEMPERATURES
FIRE SIGNAL	ACP-L2-01	FIRE ALARM ACTIVATION		1			STOPS OPERATION OF CHILLER PLANT
BMS POINTS TOTAL FOR CHILLER PLANT			A.I	D.I	A.O	D.O	
			6	7	3	4	

TIPPLER 3 BULK POWER SUPPLY (E004) - MAIN INTAKE SUBSTATION 11 kV SWITCHOUSE - SCHEDULE OF BMS POINTS

LEVEL 01

PLANT ITEM	SWITCHBOARD	BMS FUNCTION	POINTS REQUIRED				FUNCTION / OPERATION
			INPUT		OUTPUT		
			A.I	D.I	A.O	D.O	
ACP-L1-01 - Service Level South End							
AHU 01, 02 & 03 (CONSTANT VOLUME)	ACP-L1-01	START / STOP			3		AHU FAN VIA CONTACTOR
		RUN STATUS		3			FROM CONTACTOR & A.F.S
		FAULT / TRIP		3			FROM OVERLOAD
		S.A TEMPERATURE	3				MEASURES AHU S/AIR TEMPERATURE
		TEMPERATURE	3				MEASURE SPACE / ROOM TEMPERATURE
		CHW CONTROL VALVE			3		CHILLED WATER VALVE
		R.A. TEMPERATURE	3				MEASURES COMMON R/AIR TEMPERATURE
REMOTE A/C ON / OFF SWITCH		REMOTE PLANT ON / OFF		3			OVERIDES TIME CLOCK SCHEDULE TO SWITCH PLANT
INDIVIDUAL ROOM TEMPERATURE ADJUSTMENT		REMOTE TEMP. ADJUSTMENT	3				ADJUSTS BMS DIFFUSERS TEMPERATURE SETPOINT
FRESH AIR FAN, FAF 01	ACP-L1-01	START / STOP			1		AXIAL FAN VIA CONTACTOR
(SPIN FILTER MAIN FAN)		RUN STATUS		1			FROM CONTACTOR
		FAULT / TRIP		1			FROM OVERLOAD
		ODA TEMPERATURE	1				MEASURES OUTDOOR TEMPERATURE
SPIN FILTER PURGE FAN, EAF 01	ACP-L1-01	START / STOP			1		AXIAL FAN VIA CONTACTOR
		RUN STATUS		1			FROM CONTACTOR
		FAULT / TRIP		1			FROM OVERLOAD
FIRE SIGNAL	ACP-L1-01	FIRE ALARM ACTIVATION		1			CAN STOP OPERATION OF PLANT
BMS POINTS TOTAL FOR ACP 03-01			A.I	D.I	A.O	D.O	
			13	14	3	5	

Technical Specification Tippler 3 Bulk Power Supply -

Fire Suppression

Document Number 1924701-2-300-B-SP-0003

Document Details

Ref (SA)	1924701-2-300-B-SP-0003
Date	6 June 2018
Prepared by	Johan Jooste
Reviewed by	Andrew Dally, Reinhard Nachenius
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	6 June 2018	For Construction	Andrew Dally	pp

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

The new bulk power installations include three new substation buildings (Main Intake Substation and Substations M and N). Automatic fire suppression systems are required within parts of the new substation buildings for the protection of critical equipment. This specification includes the minimum technical requirements for the provision of these fire suppression systems.

1.2 Purpose

The purpose of this specification is to set out the minimum technical requirements for quality and workmanship for the design (where required), fabrication, supply, installation, construction, testing and commissioning of the automatic fire suppression system, employing an aerosol suppressant for each of the following spaces:

- Substation M:
  - i. VSD and Transformer Room.
  - ii. MV Switchgear Room.
  - iii. LV and Electronics Room.
- Substation N:
  - i. VSD and Transformer Room.
  - ii. MV Switchgear Room.
  - iii. LV and Electronics Room.
- Main Intake Substation - 11 kV Switch House:
  - i. MV Switchgear Room.
  - ii. Relay Room.
  - iii. Metering Room.
  - iv. SCADA Room.
  - v. LV Room.

All elements of the fire detection system, including the fire panel, shall be designed, supplied, installed and commissioned by a specialist fire detection subcontractor, to be nominated and appointed by the *Contractor*, subject to approval by the *Employer*.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site Information.
- Drawings.
- All other associated contract documentation.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
NBR	National Building Regulations
OEM	Original Equipment Manufacturer
SCADA	Supervisory Control and Data Acquisition
UL	Underwriters Laboratory
FM	Factory Mutual (approval)
SANS	South African National Standards
ISO	International Standards Organisation
AHJ	Authority Having Jurisdiction
QA	Quality Assurance
QC	Quality Control
FAT	Factory Acceptance Test
SAT	Site Acceptance Test

3.0 CODES, STANDARDS, SPECIFICATIONS & REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on-Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.
- National Building Regulations and Building Standards Act 103 of 1977.

3.3 South African and International Standards

The *Contractor* shall ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include, but are not necessarily limited to, the following.

Table 3 : South African Standards

Code	Standard Title
SANS 15779	Condensed aerosol fire extinguishing systems – Requirements and test methods for components and system design, installation and maintenance
SANS 10142-1	The wiring of premises, Part 1: Low voltage installations

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 4 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 SCOPE OF *WORKS*

The *works* shall include, but are not limited to, the following:

- Detailed design, supply, installation, commissioning and testing of all hardware, software, consumables and the like for the fire suppression system, as per the requirements of this specification, drawings, bills of quantities, Works Information and other associated contract documentation as required to complete the *works*. This shall include any items that may not be explicitly described in these specifications, but are essential to meet all functional and reliability requirements and ensure the safe operation and integrity of the installations, including successful testing and commissioning of the system.
- Provision of all facilities required for transport, off-loading, storage, installation, supervision, testing and commissioning.
- All related project management activities, such as coordination and cooperation with the *Employer* and the Others as applicable.
- Adherence to safe working practices throughout the execution of the *works*. This shall include safety inductions of all personnel required to be on Site during any point in the execution of the *works.*
- Provision of a competent final testing and commissioning team,
- All QA/QC documentation as covered in these specifications and the Works Information.
- Inspection and testing of the entire installation after completion of the *works*. All defects shall be listed on a punch list and shall be rectified by and at the expense of the *Contractor,*
- Issuing the required Certificates of Compliance for the completed fire suppression system,
- Handover of the completed system to the *Employer*.

6.0 BASIC REQUIREMENTS

6.1 General

The fire suppression systems shall comprise of products and systems with a well-established track record, to be supplied and installed by suppliers and specialist subcontractors with extensive previous experience in this field.

All equipment shall be of a failsafe design and shall incorporate state of the art, available technology.

6.2 Design Basis

The fire suppression system to be installed shall be of the condensed aerosol type, to be supplied complete with all components necessary for the proper operation of the system.

All components shall be of a quality commensurate with the requirements of an industrial fire suppression system. Component materials shall be flame retardant and moisture and fungus resistant.

6.3 Defining Zones

Defining zones shall be configured to eliminate any potential confusion regarding the location from which a fire signal is received and the fire suppression system is activated and to initiate essential actions without delay. Establishment of defining zones shall be based upon the following considerations:

- A zone area shall be less than 2000 m^2.
- The search distance shall not exceed 30 meters.
- A zone area shall not cover more than one floor level.
- For areas with phased evacuation schemes, zoning shall be compatible with the adopted evacuation procedures, i.e.:
  - i. Areas with different fire risk level shall be defined as separate zones.
  - ii. Areas designated for different occupations shall be defined as separate zones.
  - iii. Each of the spaces given in Section 1.2 shall be considered to be a zone.
- Zones should be defined in collaboration with the fire detection specialist subcontractor.

6.4 Service Conditions

The suppression system, as specified, is required to perform its functions in a continuously operating environment. System design must ensure that downtime is kept to an absolute minimum. Account shall be taken of potential condensation on equipment surfaces.

The environmental conditions shall be as indicated in Table 4 and as defined in the Site Information document.

Any inherent environmental limitations of the proposed fire suppression system shall be identified and communicated by the *Contractor* to the *Employer* prior to the placement of any orders.

6.5 Safety

The suppression system shall be designed to ensure the safety of operating and maintenance personnel at all times.

Damage arising from component failure must be confined to the component concerned. Component materials shall be non-flame propagating, wherever practical.

6.6 Accessibility and Maintenance Safety

Items requiring access for maintenance shall be located so as to facilitate any required maintenance from the front of the unit. Locating suppression units inside or directly above electrical switchgear or similar equipment is not allowed.

6.7 Marking

All components shall be identifiable by numerical or alphabetical markings which shall also appear on the *Contractor's* drawings.

The following information shall be inscribed on a non-destructive, corrosion-resistant, indelible name plate/tag attached securely to the outside of the unit enclosure:

- *Employer's* order number.
- Year of manufacture.
- Name of manufacturer.
- Unit's type and serial number.

All other labels/nameplates shall be of corrosion resistant material with indelible inscriptions in the English language.

7.0 TECHNICAL REQUIREMENTS

7.1 General

The *Contractor's* scope of *works* shall include all manufacturing, procurement, inspection, factory acceptance testing, packing, delivery to Site, off-loading, installation, commissioning and Site acceptance testing of the fire suppression system.

The supply and installation of actuated dampers, required to close off existing ventilation openings, as well as the electrical wiring to the damper from a nearby local isolator, shall be executed by a separate specialist subcontractor to be appointed by the *Contractor*, subject to approval by the *Employer*. The location of the actuated dampers is shown on the drawings.

Individual equipment items for the suppression system shall be sourced from a single manufacturer/supplier and shall be in accordance with the manufacturer/suppliers latest design, suitable to perform the intended functions.

All devices and equipment shall be UL Listed and/or FM approved.

The "fire alarm interface'' with the SCADA, access control and ventilation equipment shall be undertaken by a specialist subcontractor/OEM that is to be separately appointed by the *Contractor*.

7.2 Spares and Attendance

The *Contractor*/specialist subcontractor shall supply all critical and recommended spare parts required for commissioning and start-up, as well as all spares required during the defects liability period. The cost of these spares shall be included in the tendered rates. The *Contractor* shall guarantee all spare parts for at least ten (10) years.

The *Contractor* shall also provide two inspections during the first year of service, during the defects liability period. Inspections shall be made at 6-month intervals, with the intervals commencing when the system is first placed into normal service.

The *Contractor* shall submit to the *Employer* a priced list of critical and recommended spare parts for one year of normal operation and maintenance of the system (after expiry of the defects liability period). The *Contractor* shall also provide separate prices for maintenance and call-back service for one year.

7.3 Fire Suppression System

The suppression system shall be designed and installed in accordance with South African National Specification SANS 15779 and the standards referenced therein.

The suppression system is to be installed in electrical substations and shall be able to suppress surface burning class A, class B and electrical fires (as defined by ISO 3941).

The suppression system shall be a "total flood" suppression system using a proved condensed aerosol compound.

The system shall provide a minimum design concentration by volume as specified in SANS 15779 and as directed by the equipment manufacturer, taking account of the relevant hazard classification and/or protected spaces at all areas and the minimum anticipated temperature within the protected areas.

The system shall include all mechanical and electrical components, any auxiliary devices, functional checkout and testing, training and all other operations that are required to provide a functional, UL Listed and/or FM approved fire suppression system.

The *Contractor* shall be responsible for sealing and securing the protected spaces against suppression medium loss and/or leakage during the "hold" period. Actuated dampers and closing mechanisms shall be provided for openings that need to remain open during normal operation of each building, as shown on the drawings.

Activation of the suppression system shall be via a fire detection panel and/or extinguishant release panel, to be supplied and installed by a separate subcontractor, to be appointed by the *Contractor*. All activation inputs, including all sensors or manual activation mechanisms (e.g. break glass units), will be routed to the fire detection panel, which will 'instruct' the extinguishant release panel to provide an activation signal to the suppression system. The fire detection panel will also provide the necessary signal to close any actuated dampers, as may be required.

The scope of *works* includes the provision and installation of wiring between the extinguishant release panel and the aerosol generator units.

7.4 Suppression Medium Storage and Distribution

Any special guidelines for the storage and distribution of the fire suppression medium, as stipulated by the suppression medium supplier, shall be incorporated in the system design.

7.5 Power Supply

All power supplies shall be provided by the *Contractor*. This includes power supply to all actuated dampers provided to seal off existing ventilation openings. Local isolators shall be provided within 1.5 m of any actuated dampers.

All incoming and outgoing cables to and from the suppression unit shall be terminated on dedicated terminal rails.

7.6 System Installation

The *Contractor* shall perform risk assessments for each portion of the *works* and obtain the necessary clearances and permits prior to commencing with the installation. This applies in particular to any live or energised systems to which the fire suppression system will be connected.

The *Contractor* shall supply all anchor bolts and fastening material required for the suppression system and any associated signage.

The installation shall be protected against physical damage and from damage in the case of a fire.

The following tests shall be performed by the *Contractor.* Test results and completion certificates issued to the *Employer*:

- Visual Inspection : 100% of the purchased equipment prior to installation.
- Operational Test: 100% of the purchased equipment prior to commissioning.
- Testing procedures for the operational test shall be compiled by the *Contractor* and submitted to the *Employer* for approval prior to commencement of this test.

7.7 System Inspection and Checkout

After the system installation has been completed, the entire system shall be checked out, inspected and functionally tested by qualified, trained personnel, in accordance with best practice procedures and in compliance with South African standards.

All components of the suppression system shall be checked for proper mounting and installation.

The complete system shall be functionally tested, in the presence of the *Employer* or his appointed representative, and all functions, including system and equipment interlocks, must be operational at least five (5) days prior to the final acceptance tests.

7.8 Site Acceptance Testing

The *Contractor* shall submit a proposal for suppression system pre-commissioning and Site acceptance testing and SAT File to the *Employer* for approval, prior to commencement of *works* on Site.

7.9 Fire Stopping

The *Contractor* shall employ suitable fire stopping methods wherever deemed necessary in terms of these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer*'s specifications or any other applicable standards and documents related to the *works*.

All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and approved standards. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localised and contained and not propagate via any electrical and/or electronic infrastructure. The *Contractor* shall fully comply with these requirements.

7.10 Corrosion Protection

7.10.1 General Corrosion Protection

Corrosion protection of steel materials shall be as per the requirements of these specifications, the *Employer's* and Eskom (where applicable) standards and associated minimum SANS and other requirements. The protection of the specified steel materials shall make allowance for the harsh, coastal environment at the Site.

Any equipment not strictly complying with the above requirements shall be rejected. The *Contractor* shall furnish written confirmation that all equipment complies with the specifications. Should the *Contractor* fail to furnish such confirmation, the *Employer* reserves the right to reject the equipment.

7.10.2 Galvanic Corrosion Protection

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer*.

The table below provides a general indication/guide only, of which metals can be connected to each other without the need of special measures to avoid interaction, and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The responsibility will remain with the *Contractor* to avoid bimetal/galvanic corrosion between different metal equipment.

Table 1 : Combinations Of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	StSt	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Allowed	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Allowed	Permissible	Permissible	Permissible
Copper	Not Allowed	Not Allowed	Permissible	Permissible	Not Allowed	Permissible
StSt	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Allowed	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

Where equipment has been exothermically welded together, 3 thick layers of bitumen shall be applied afterwards, unless otherwise specified or instructed.

8.0 DOCUMENTATION

Upon completion of each system, the *Contractor* shall provide four (4) copies of system "as-built" drawings to the *Employer*. The drawings shall also show all room or facilities modifications, including door and/or damper installations. The drawings shall show actual installation details, including all equipment locations (i.e. control panel(s), suppression medium container(s), and the like, as well as all piping and conduit routing details.

Upon completion and commissioning of each system the *Contractor* shall submit certificates as per SANS 15779.

Upon completion of the systems and upon acceptance by the *Employer,* the *Contractor* shall submit the manufacturer's manuals and spare parts lists for all equipment to the *Employer.*

All procedures for the compilation and submission of documentation, as described in the Works Information, shall be adhered to.

9.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

10.0 INSPECTIONS AND TESTING

The *Contractor* shall formally document the quality management procedures that will be applicable to the fire suppression system, in accordance with the requirements as set for the in the Works Information.

The *Contractor* shall be responsible for ensuring that the design and installation are in accordance with the specifications and standards referred to herein and/or as shown on the drawings and any other related contract documentation. The *Contractor* shall bring to the *Employer*'s attention any conflicts and/or discrepancies found in the documentation for clarification. Any unauthorized deviations or changes implemented by the *Contractor* may result in the components or equipment being rejected by the *Employer*.

The *Contractor* shall notify the *Employer* a minimum of two weeks prior to inspections and factory testing that are to be witnessed by the *Employer*. Prior to such inspections or factory testing, the *Contractor* shall provide the *Employer* with adequate proof that the *Contractor*'s QA/QC activities have been successfully completed. The *Contractor* shall supply all necessary tools and testing equipment required.

Acceptance of inspections and factory testing by the *Employer* does not constitute final acceptance by the *Employer* nor does it relieve the *Contractor* of his obligation to provide a fully functional and compliant system upon final handover.

11.0 O&M MANUALS, TRAINING AND BACK-UP SUPPORT

11.1 O&M Manuals

Technical, training, maintenance and operating manuals shall be provided for each type and model of equipment. Technical manuals shall include all technical data, construction information and leaflets for each individual component used in the equipment as provided. Where generic manuals are provided, an addendum is to be included, indicating the applicable project specific components.

Manuals shall be of a good quality and shall. as a minimum, cover the following:

- Technical descriptions of the equipment and component parts.
- General arrangement drawings.
- Installation instructions with drawings or pictures.
- Operating and maintenance instructions for all components.
- Detailed parts lists, accompanied by exploded view type drawings clearly detailing the part and uniquely identifying each part.
- Spare part ordering instructions.

Any special instructions pertaining to storage of spare parts or their shelf life shall be included in the maintenance manual. All drawings required for component location, dismantling and re-assembly for maintenance purposes shall be included in the maintenance manual. All special tools required for operating and maintenance of the equipment shall be presented in the form of a schedule in the operating and maintenance manual.

The content of the training manuals shall be based on the content of the technical, operating and maintenance manuals.

11.2 Training

The *Contractor* shall arrange certified/accredited training for the *Employer*'s operating personnel, to be provided by the *Contractor* in conjunction with knowledgeable representatives of the equipment suppliers/OEM's. The scope, content, venue and duration for training shall be approved by the *Employer*.

Training shall be directly applicable to the actual equipment supplied for the *works*. Generalised training based on similar equipment shall not be acceptable. The training shall also include practical hands-on training for each individual trainee.

The training to be provided shall demonstrate the operation, function, trouble-shooting and maintenance requirements of the services, including, but not limited to the fire detection system.

11.3 Training of Maintenance Personnel

Maintenance personnel shall be trained to operate all components and understand the function of the equipment, i.e. methods of maintenance, fault finding, correction, routine maintenance (frequency and methods of testing).

Training shall include familiarisation with documentation (maintenance plan, procedures and the like), hardware familiarisation and maintenance of the installation. Maintenance training shall be provided prior to the installation of the equipment.

11.4 Training of Operators

Operators shall be trained and declared competent to operate the new systems prior to the equipment being dispatched from the factory. This will include familiarisation with the relevant documentation, including drawing configuration logic, as well as operator interface familiarisation, e.g. operational functions, alarms and the like. The *Contractor* shall make provision for training of all the operators.

11.5 Back-Up Support

Back-up support services, including the provision of on-Site technical support by the specialist subcontractors/OEMs for the fire suppression installation, shall be available 24 hours a day, 7 days a week. Contact details for the companies and persons providing these support services shall be provided to the *Employer*. Payment for such back-up support will be subject to the relevant provisions of the contract.

12.0 REFERENCE DRAWINGS

Table 5 – Reference Drawings

Document Number	Document Title
1924701-2-510-M-LA-0014-01	Substation M, Fire Plans
1924701-2-510-M-LA-0016-01	Substation N, Fire Plans
1924701-2-510-M-LA-0011-01	Main Intake Substation Level 00 Fire Protection Plan
1924701-2-510-M-LA-0012-01	Main Intake Substation Level 01 Fire Protection Plan
1924701-2-510-M-LA-0013-01	Main Intake Substation Level 02 Fire Protection Plan

13.0 MEASUREMENT AND PAYMENT

13.1 General

The tendered rates shall be deemed to include all and every cost item required for the completion, handover and commissioning of the *works,* in full compliance with these specifications, the Works Information and the drawings, including, but not limited to, the following:

- Design (including shop drawings), supply and installation of the *works* that are required to deliver a complete, fully functional and fully compliant system.
- Supply of installation and commissioning spares and operational (critical and recommended) spares required for normal wear and tear during plant operation for the period of one year after commissioning.
- Supply of special tools required for maintenance purposes.
- All testing and commissioning activities that are required to get the installed equipment ready for operations.
- Compilation and submission of all handover documentation as described in these specifications.
- Training of *Employer's* operational staff, as detailed in these specifications.

Allowances to be made in the tendered rates are as described below.

13.2 Payment Items

13.2.1 Aerosol Suppressant Generators, Warning Signs and Associated Fixing Materials

The tendered rates shall cover all costs for the supply and installation of all above items, including where applicable, cable trays, wire meshes, ladders, racks and ducts, mounting materials and accessories required to perform the *works,* including, but not limited to, procurement, transport, handling, storage, inspections, installation at any height of all necessary fixings, joints, terminations, bends, elbows, expansion joints, earthing, all necessary scaffolding, hoisting and the like and suitable associated fire stopping material where required.

Technical Specification Tippler 3 Bulk Power Supply -

Civil Works

Document Number 1924701-2-300-C-SP-0001

Document Details

Ref (SA)	1924701-2-300-C-SP-0001
Date	27 June 2018
Prepared by	Francois van Loon
Reviewed by	Jochem van Bruggen, Karel Biesot
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	27 June 2018	Issued for Construction	Karel Biesot Project Manager	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy.

The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

This specification covers the requirements for the civils *works* to be undertaken as part of the new bulk power facilities.

1.2 Purpose

This specification sets out the minimum technical requirements for quality and workmanship for the design (where required), manufacture, supply, installation, construction, testing and commissioning of the internal and external civil engineering and building services for the Tippler 3 bulk power supply project.

The *Contractor* is advised that these specifications cover the preliminary and general items for all parts of Package E004 (Civil, Structural, Electrical, Electronic, Mechanical and Architectural parts), based on the provisions of SANS 1200 A, as amended in these specifications.

The Civil *works* to be undertaken by the *Contractor* shall include, but are not limited to, the following:

1.2.1 New Main Intake Substation

- Vegetation search and rescue operations, including rehabilitation.
- Site clearance.
- Accommodation of traffic.
- Protection of existing underground services.
- Bulk earthworks (excavation and backfilling) for substation platforms and internal roads.
- Bulk earthworks (excavation and backfilling) for external roads and detention pond.
- Excavation and backfilling for substation steel structure foundations.
- Detention pond associated concrete and lining works.
- Substation platform and hardstand layerworks.
- Hardstand and roads surfacing.
- External and internal civil and building services, including:

    i. Fire hydrant and building water infrastructure and connections.
    ii. Stormwater channels, open drains and underground pipe infrastructure for the collection and conveyance of rainwater run-off from buildings, hardstands and roads.
    iii. Subsoil cut-off drainage and pipe infrastructure for the collection and conveyance of sub-surface water.
    iv. Stormwater detention pond and associated inflow, overflow and floor structures.
    v. Services sleeves and trenches for all current and future electrical and electronic cables.
    vi. Conservancy tank for Eskom.
    vii. Wastewater and oil wastage channels, structures and underground pipework.

- Perimeter and internal fencing.
- Perimeter and internal pedestrian and vehicular sliding and swing gates.

1.2.2 New Substation M

- Vegetation search and rescue operations, including rehabilitation.
- Site clearance.
- Accommodation of traffic.
- Protection of existing underground services.

- Protection of new underground services installed by other Contracting parties carrying out work for the *Employer* (i.e. Others).
- Bulk earthworks (excavation and backfilling).
- Reinforced shotcrete retaining wall, complete with drainage and soil nail anchors.
- Substation platform and hardstand layerworks.
- Hardstand surfacing.
- Tie-in with new Tippler 3 asphalt Service Road 1.
- External and internal civil and building services, including:

    i. Fire hydrant and building water infrastructure and connections.
    ii. Stormwater channels, open drains and soakaway drains for the collection and conveyance of rainwater run-off from buildings and hardstands.
    iii. Services sleeves for all current and future electrical and electronic cables.

1.2.3 New Substation N

- Vegetation search and rescue operations, including rehabilitation.
- Site clearance.
- Accommodation of traffic.
- Protection and relocation of existing services.
- Protection of new underground services installed by Others.
- Bulk earthworks (excavation and backfilling).
- Slurry cut-off wall with reinforced shotcrete retaining wall, complete with drainage and soil nail anchors.
- Substation platform and hardstand layerworks.
- Hardstand surfacing.
- External and internal civil and building services, including:

    i. Fire hydrant and building water infrastructure and connections.
    ii. Stormwater channels, open drains and soakaway drains for the collection and conveyance of rainwater run-off from buildings and hardstands.
    iii. Services sleeves for all current and future electrical and electronic cables.

1.2.4 Bulk Power Cables Installation

- Vegetation search and rescue operations, including rehabilitation.
- Site clearance.
- Accommodation of traffic.
- Protection of existing underground services.
- Protection of new underground services installed by Others.
- Cable trenching, including excavation, bedding and backfilling of new electrical and electronic cables.
- Installation of new road crossing services sleeves/ducts.
- Horizontal directional drilling.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information, including geotechnical and environmental reports.
- Bill of quantities.
- Site Information.
- Drawings (as listed in the Works Information).
- Other technical specifications.
- Further sections of the contract documents, as applicable.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1: Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2: Abbreviations

Abbreviation	Meaning Given to the Abbreviation
ASME	American Society of Mechanical Engineers
AWWA	American Water Works Association
BS	British Standards
ISO	International Standards Organisation
AIA	Authorised Inspection Authority
BBBEE	Broad Based Black Economic Empowerment
CBR	California Bearing Ratio
CEMP	Construction Environmental Management Plan
CEMPr	Construction Environmental Management Programme
CD	Compact Disc
CDR	*Contractor* Documentation Register
CDS	*Contractor* Documentation Schedule
CoC	Certificate of Compliance
CM	Construction Manager
CRL	*Contractor* Review Label
CSHEO	*Contractor*'s Safety, Health and Environmental Officer
Cu	Copper
DCP	Dynamic Cone Penetrometer

Table 2: Abbreviations

Abbreviation	Meaning Given to the Abbreviation
DEA	Department of Environmental Affairs
DI	Ductile Iron
DIN	German Institute for Standardisation
DTI	Department of Trade and Industry
EN	European Standards
EO	Environmental Officer
ECC	Engineering and Construction Contract
FEM	European Federation of Materials Handling
HAW	Hazard Assessment Workshop
HAZOP	Hazard and Operability Study
HDPE	High Density Polyethylene
HSSP	Health and Safety Surveillance Plan
INC	Independent Nominated Consultant
IP	Ingress Protection
IR	Industrial Relations
IPP	Industrial Participation Policy
IPO	Industrial Participation Obligation
IPS	Industrial Participation Secretariat
IRCC	Industrial Relations Co-ordinating Committee
ISO	International Standards
JSA	Job Safety Analysis
CIRP	*Contractor*'s Industrial Relations Practitioner
Native	Original electronic file format of documentation
OEM	Original Equipment Manufacturer
PE	Polyethylene
PES	Project Environmental Specifications
PHA	Preliminary Hazard Assessment
PIRM	Project Industrial Relations Manager
PIRPMP	Project Industrial Relations Policy and Management Plan
PLA	Project Labour Agreements
PP	Polypropylene
PSIRM	Project Site Industrial Relations Manager
PSPM	Project Safety Program Manager
PSSM	Project Site Safety Manager
ProgEM	Programme Environmental Manager
ProjEM	Project Environmental Manager
QA	Quality Assurance

Table 2: Abbreviations

Abbreviation	Meaning Given to the Abbreviation
R&D	Research and Development
RSA	Rolled Steel Angles
SAGC	South African Geomatics Council
SANS	South African National Standards
SASRIA	South African Special Risks Insurance Association
SAT	Site Acceptance Tests
SES	Standard Environmental Specification
SHE	Safety, Health and Environment
SHEC	Safety, Health and Environment Co-ordinator
SIP	Site Induction Programme
SIS	Swedish International Standard
SMP	Safety Management Plan
SS	Stainless Steel
SSRC	Site Safety Review Committee
TCP	Transnet Capital Projects
TFR	Transnet Freight Rail
TGC	Transnet Group Capital
TNPA	Transnet National Ports Authority
TPT	Transnet Port Terminals
UL	Underwriters Laboratory
uPVC	Unplasticized poly(vinyl chloride)

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 South African and International Standards

The *Contractor* shall ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include, but are not necessarily limited to, the following:

Table 3: South African Standards

Civil and Structural Engineering *Works*: SANS 1200 Standards

Code	Standard Title
SANS 1200 A (1986)	General
SANS 1200 AB (1986)	Engineer's Office
SANS 1200 C (1980)	Site Clearance
SANS 1200 D (1988)	Earthworks
SANS 1200 DA (1988)	Earthworks (Small Works)
SANS 1200 DB (1989)	Earthworks (Pipe Trenches)
SANS 1200 DM (1981)	Earthworks (Roads, Subgrade)
SANS 1200 G (1982)	Concrete (Structural)
SANS 1200 L (1983)	Medium-Pressure Pipelines
SANS 1200 LB (1983)	Bedding (Pipes)
SANS 1200 LC (1981)	Cable Ducts
SANS 1200 LD (1982)	Sewers
SANS 1200 LE (1982)	Stormwater Drainage
SANS 1200 M (1996)	Roads (General)
SANS 1200 ME (1981)	Subbase
SANS 1200 MF (1981)	Base
SANS 1200 MH (1996)	Asphalt Base and Surfacing
SANS 1200 MJ (1984)	Segmented Paving
SANS 1200 MK (1983)	Kerbing and Channelling
SANS 1200 MM (1984)	Ancillary Roadworks

Table 4: South African Standards

Further Standards for Civil and Structural Engineering *Works*

Code	Standard Title
SANS 32 (1997)	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants
SANS 62-1 (2013)	Steel pipes Part 1: Pipes suitable for threading and of nominal size not exceeding 150mm
SANS 62-2 (2013)	Steel pipes Part 2: Screwed pieces and pipe fittings of nominal size not exceeding 150mm
SANS 121 (2011)	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
SANS 460 (2011)	Plain-ended solid drawn copper tubes for potable water
SANS 664-1 (2011)	Wedge gate and resilient seal valves for waterworks Part 1: General
SANS 664-2 (2011)	Wedge gate and resilient seal valves for waterworks Part 2: Wedge gate valves
SANS 664-3 (2011)	Wedge gate and resilient seal valves for waterworks Part 3: Resilient seal valves
SANS 677 (2010)	Concrete non-pressure pipes
SANS 719 (2011)	Electric welded low carbon steel pipes for aqueous fluids (large bore)

Table 4: South African Standards

Further Standards for Civil and Structural Engineering *Works*

Code	Standard Title
SANS 725 (2010)	IEEE guide for safety in a.c. substation grounding
SANS 776 (2005)	Copper alloy gate valves - Heavy duty
SANS 791 (2014)	Unplasticized poly(vinyl chloride) (PVC-U) sewer and drain pipes and pipe fittings
SANS 974-2 (2007)	Rubber joint rings (non-cellular) Part 2: Joint rings for use in the dairy industry
SANS 974-3 (2009)	Rubber joint rings (non-cellular) Part 3: Joint rings for use in pressure cookers
SANS 966-1 (2014)	Components of pressure pipe systems Part 1: Unplasticized poly(vinyl chloride) (PVC-U) pressure pipe systems
SANS 967 (2014)	Unplasticized poly(vinyl chloride) (PVC-U) soil, waste and vent pipes and pipe fittings
SANS 1056-1 (2008)	Ball valves Part 1: Fire-safe valves
SANS 1056-2 (2012)	Ball valves Part 2: Heavy duty valves (not fire-safe)
SANS 1067-2 (2005)	Copper-based fittings for copper tubes Part 2: Capillary solder fittings
SANS 1083 (2014)	Aggregates from natural sources - Aggregates for concrete
SANS 1091 (2012)	National colour standard
SANS 1123 (2015)	Pipe flanges
SANS 1128-1 (2010)	Firefighting equipment Part 1: Components of underground and above-ground hydrant systems
SANS 1143 (2008)	Mushroom- and countersunk-head bolts and nuts
SANS 1408 (2002)	Mechanical components for tendon based rock support systems
SANS 1519-1 (2014)	Road signs Part 1: Retro-reflective sheeting material
SANS 1519-2 (2004)	Road signs Part 2: Performance requirements for road signs
SANS 1551-1 (2008)	Check valves (flanged and wafer types) Part 1: PN series
SANS 1556-2 (2005)	ISO metric screw threads Part 2: Selected limits of size for general purpose screw threads
SANS 1700 (1996 to 2011)	Fasteners Part 1 to Part 19
SANS 1808-2 (2013)	Water supply and distribution system components Part 2: Metallic compression type pipe couplings
SANS 4001-BT1 (2014)	Civil engineering specifications Part BT1: Penetration grade bitumen
SANS 4427 (1996)	Polyethylene (PE) pipes for water supply - Specifications
SANS 4427-1 (2008)	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 1: General
SANS 4427-2 (2008)	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 2: Pipes
SANS 4427-3 (2008)	Plastics piping systems - Polyethylene (PE) pipes and fittings for water supply - Part 3: Fittings
SANS 5865 (1994)	Concrete tests - The drilling, preparation, and testing for compressive strength of cores taken from hardened concrete
SANS 10044-1 (2004)	Welding Part 1: Glossary of terms
SANS 10162-1 (2011)	The structural use of steel Part 1: Limit-states design of hot- rolled steelwork
SANS 10162-2 (2011)	The structural use of steel Part 2: Cold-formed steel structures
SANS 10162-4 (1997)	Structural use of steel Part 4: The design of cold-formed stainless steel

Table 4: South African Standards

Further Standards for Civil and Structural Engineering *Works*

Code	Standard Title
	structural members
SANS 10198-5 (2004)	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 5: Determination of thermal and electrical resistivity of soil
SANS 10199 (2010)	The design and installation of earth electrodes
SANS ISO 15874 (2004)	Plastics piping systems for hot and cold water installations - Polypropylene (PP) Part 1, Part 2, Part 3, Part 5 and Part 7
SANS 17025 (2005)	General requirements for the competence of testing and calibration laboratories
SANS 50025-1 (2009)	Hot rolled products of structural steels Part 1: General technical delivery conditions
SANS 50025-2 (2009)	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels
SANS 50025-3 (2009)	Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
SANS 50025-4 (2009)	Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels
SANS 50025-5 (2009)	Hot rolled products of structural steels Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
SANS 50025-6 (2009)	Hot rolled products of structural steels Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition
SANS 50197-1 (2013)	Cement Part 1: Composition, specifications and conformity criteria for common cements
SANS 50197-2 (2000)	Cement Part 2: Conformity evaluation
SANS 61386-24 (2005)	Conduit systems for cable management Part 24: Particular requirements - Conduit systems buried underground
TRH 14	Guidelines for Road Construction Materials : Committee of State Road Authorities: 1985
South African Institute of Civil Engineers (Geotechnical Division) – Code of Practice on Lateral Support in Surface Excavations, 1989	

International standards shall include, but are not necessarily limited to, the following.

Table 5 : International Standards

Code	Standard Title
BS 534 (1990) REPLACED	**BS EN 10311:2005** Joints for the connection of steel tubes and fittings for the conveyance of water and other aqueous liquids **BS EN 10224:2002** Non-alloy steel tubes and fittings for the conveyance of water and other aqueous liquids. Technical delivery conditions
BS 4772 (1988) REPLACED	**BS EN 598:2007+A1:2009** Ductile iron pipes, fittings, accessories and their joints for sewerage applications. Requirements and test methods **BS EN 545:2002** Ductile iron pipes, fittings, accessories and their joints for water pipelines. Requirements and test methods **BS EN 969:2009** Ductile iron pipes, fittings, accessories and their joints for gas pipelines. Requirements and test methods
BS 2494 (1990) REPLACED	**BS 7874:1998** Method of test for microbiological deterioration of elastomeric seals for joints in pipework and pipelines **BS EN 681-1:1996** Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Vulcanized rubber **BS EN 682:2002** Elastomeric seals. Materials requirements for seals used in pipes and fittings carrying gas and hydrocarbon fluids **BS EN 681-2:2000** Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Thermoplastic elastomers
BS 970 REPLACED	**BS EN 10095:1999** Heat resisting steels and nickel alloys **BS EN 10250-4:2000** Open steel die forgings for general engineering purposes. Stainless steels **BS EN 10085:2001** Nitriding steel. Technical delivery conditions **PD 970:2005** Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels **BS EN 10087:1999** Free cutting steels. Technical delivery conditions for semi-finished products, hot rolled bars and rods **BS EN 10083-1:2006** Steels for quenching and tempering. General technical delivery conditions **BS EN 10084:2008** Case hardening steels. Technical delivery conditions
BS 729 REPLACED	**BS EN ISO 1461:2009** Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

Table 5 : International Standards

Code	Standard Title
BS 2035 REPLACED	**BS EN 598:2007+A1:2009** Ductile iron pipes, fittings, accessories and their joints for sewerage applications. Requirements and test methods **BS EN 545:2010** Ductile iron pipes, fittings, accessories and their joints for water pipelines. Requirements and test methods **BS EN 969:2009** Ductile iron pipes, fittings, accessories and their joints for gas pipelines. Requirements and test methods
BS 2874 REPLACED	**BS EN 12163:2011** Copper and copper alloys. Rod for general purposes **BS EN 12167:2011** Copper and copper alloys. Profiles and bars for general purposes **BS EN 12164:2011** Copper and copper alloys. Rod for free machining purposes
BS 5135 REPLACED	**BS EN 1011-2:2001** Welding. Recommendations for welding of metallic materials. Arc welding of ferritic steels **BS EN 1011-1:2009** Welding. Recommendations for welding of metallic materials. General guidance for arc welding
BS 5163	**BS 5163-1:2004** Valves for waterworks purposes. Predominantly key-operated cast iron gate valves. Code of practice
BS 4416 REPLACED	**BS 6443:1984** Method for penetrant testing of welded or brazed joints in metals
ISO 898	**ISO 2936:2014** Assembly tools for screws and nuts -- Hexagon socket screw keys **ISO 4162:2012** Hexagon bolts with flange -- Small series – Product grade A with driving feature of product grade B **ISO 21670:2014** Fasteners -- Hexagon weld nuts with flange
ASME 9	Qualification standard for welding and brazing procedures, welders, brazers, and welding and brazing operators
AWWA C219	Bolted, sleeve-type couplings for plain-end pipe
BS EN 1567 (2000)	Building valves. Water pressure reducing valves and combination water reducing valves. Requirements and tests.
BS EN 50086-2-4 REPLACED	**BS EN 61386-24:2010** Specification for conduit systems for cable management. Particular requirements. Conduit systems buried underground
BS EN 12842 (2012)	Ductile iron fittings for PVC-U or PE piping systems. Requirements and test methods
DIN EN 13703 (2004)	Bitumen and bituminous binders - Determination of deformation energy
DIN 1693	Standard for Ductile Iron
SIS 05 59 00	Pictorial Surface Preparation Standards for Painting Steel Surface

4.0 SITE CONDITIONS

Material and equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 6: Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 SPECIFICATIONS

5.1 Preamble

Descriptions covering the required scope, type and quality of materials and the *works* to be performed by the *Contractor*, to be covered also in the tendered rates, are included in the bill of quantities, these specifications, other technical specifications (listed in Clause 3.3 above), the relevant architectural, civil, structural, mechanical and electrical drawings, the referenced standardized specifications and contract documentation. Any errors, omissions or discrepancies between the documents shall be brought to the immediate attention of the *Employer*.

The specifications to which the *works* are to be provided are as follows:

- Preliminary and General Items: South African Bureau of Standard's Standardized Specifications for Civil Engineering Construction SANS 1200, as listed in Table 3.

- Civil and structural engineering *works*, including wet services: South African Bureau of Standard's Standardized Specifications for Civil Engineering Construction SANS 1200, as listed in Table 3 and further South African and international specifications as listed in Table 4 and Table 5 respectively.

In certain clauses, the standard, standardised and particular specifications allow a choice to be specified in the project specifications between alternative materials or methods of construction and for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in these specifications, which also contain additional requirements for this particular contract.

The number of the relevant clauses and payment items in the further project specifications consists of the prefix PS, followed by a number corresponding to the number of the relevant clause or payment item in the standard specifications, as and where applicable. The number of a new clause or payment item, which does not form part of a clause or a payment item in the standard specifications and is included here, is also prefixed by PS, followed by a new number. The new numbers follow on the last clause or item number used in the relevant section of the standard specifications.

Where, in the bill of quantities, reference is not made to a standardized or a particular SANS 1200 clause, the descriptions included in the bill of quantities shall be read in conjunction with the relevant drawings and specifications and the item shall be priced accordingly. The tendered rate shall also, for each item, include the supply of materials, installation and construction, testing and commissioning, all as required to render the *works* complete and fully functional in every aspect upon final handover.

All *works* shall be performed to the specified standards or consistent with recognized, good industry norms and practices, to provide the *works* in a complete, fully functional, operable and compliant manner.

5.2 General Precautionary Measures

These specifications shall be read in conjunction with the project drawings issued for the various disciplines (i.e. structural, architectural, mechanical and electrical) where applicable, the bill of quantities and all other associated contract documentation. Any errors, omissions and discrepancies between the drawings and documents shall be brought to the immediate attention of the *Employer* by the *Contractor*.

The *Contractor* shall check all project dimensions, levels and setting out data on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*. No scaling-off of drawings shall be done.

The *Contractor* shall confirm all invert levels of connection points to existing services on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*.

Where new construction ties into existing structures, the *Contractor* shall cross check and confirm all critical dimensions and levels related to the existing structures, before any construction or manufacturing commences.

Products or construction methods different to those specified in any project document or drawing may only be used subject to the written approval from the *Employer*. Such approval shall be requested in writing by the *Contractor*.

It remains the responsibility of the *Contractor* to compare drawings of the various engineering and architectural disciplines and notify the relevant parties/disciplines of any discrepancies immediately in writing.

Where conflicting requirements between the drawings, specifications and the bill of quantities occur, the *Contractor* shall inform the *Employer* in writing of any such occurrence. The *Employer* will make a final determination.

The *Contractor* shall be required to co-ordinate closely with the *Employer*, Others engaged by the *Employer* and where applicable associated 3rd parties, as well as furnish any technical information as may be required where called upon.

5.3 PSA: GENERAL

5.3.1 PSA-2: INTERPRETATIONS

PSA-2.2: APPLICABLE EDITION OF STANDARDS

Add the following at the beginning of sub-clause 2.2:

"Unless a specific edition of the standardized specifications as listed under Section 3.0 above is indicated, each ....."

PSA-2.3: DEFINITIONS

Delete the last item under Section c) Measurement and Payment and replace with the following:

“No additional compensation of provisional and general costs will be made, which are attributable to a change in the value of the works.”

PSA-2.8: ITEMS IN SCHEDULE OF QUANTITIES

PSA-2.8.1: Principle

In the fourth line of sub-clause 2.8.1 after the word "specification", add "or particular specification".

Add the following:

"The pay item descriptions within the various sections of these specifications are intended to be for the guidance of the *Contractor* only. Detailed descriptions of the required *works* and materials are included in the specifications and the drawings."

5.3.2 PSA-3: MATERIALS

PSA-3.1: QUALITY

Add the following:

"The onus rests on the *Contractor* to produce *works* which will conform in quality and accuracy of detail to the requirements of the drawings, the technical specifications, the Works Information and the bill of quantities and the *Contractor* shall, at his own expense (included in his rates), institute a quality control system and provide experienced technical staff together with all transport, instruments and equipment to ensure adequate supervision and positive control of the *works* at all times. The *Contractor* shall keep the *Employer* fully informed on all aspects of the quality control system.

All materials that are required to comply with a standard specification shall, where applicable, bear the official mark of the appropriate standard. The mark on a pipe or sleeve (to be installed underground) shall be visible from above, after the pipe/sleeve is laid.

Rubber articles shall be stored in a suitable shed/container and kept away from sunlight, oil or grease.

Large items, not normally stored in a building, shall be neatly stacked or laid out on suitable cleared areas on the Site. Grass or vegetation shall not be allowed to proliferate within the storage area and the material shall be kept free of dust and mud and be protected from stormwater.

Every precaution shall be taken to keep cement dry and prevent access of moisture to it from the time it leaves the place of manufacture until it is required for use on the Site. Bags of cement, which show any degree of hydration and setting, shall be removed from the Site and replaced at the *Contractor*'s expense.

Materials shall be handled with proper care at all times. Under no circumstance may materials be dropped from vehicles.

Alternate materials proposed by the *Contractor* shall require the approval of the *Employer* prior to being used as part of the *works.* Further test results may be required prior to the acceptance of such materials by the *Employer*. The costs of these tests shall be borne by the *Contractor*.

Where specified or directed by the *Employer*, the *Contractor* shall submit to the *Employer* samples of the materials that are to be used, for the approval of the *Employer,* prior to their incorporation in the *works*. Samples may also be required to serve as standards to be applied to construction methods, (e.g. surface finishes) for the duration of the contract. The costs of all tests and samples shall be borne by the *Contractor*.

The *Contractor* shall further submit to the *Employer* for approval the relevant written specifications of the material that the *Contractor* intends on delivering and installing on Site. For example, the specifications of the proposed stormwater pipes (name of supplier, type of pipe, size, class of pipe, manufacturing certificates and the like) to be utilized by the *Contractor* shall be submitted to the *Employer* for approval prior to the material being ordered.

The *Contractor* shall be responsible for the location and procurement of all imported materials. Rates tendered for all imported material shall include all haulage. Overhaul will not be payable for any materials obtained from commercial sources.

No crushed rubble or crushed concrete materials shall be used in the earthworks or layerworks.

It is the *Contractor*'s responsibility to confirm that all necessary materials are available to successfully complete the *works* within the contract period. No claims based on the non-availability of materials will be considered.

The *Contractor* shall inform the *Employer* of any control testing to be done at least 7 days before such tests are required and must allow in his program for the time necessary for the tests and the processing of the test results.

The *Contractor* shall produce *works* that conform to the requirements of the specifications and drawings. The *Contractor* shall institute a quality control system in accordance with the requirements of the Works Information. The cost of these obligations is to be provided for in the tendered rates.

Equipment and materials used, shall be of high quality design and manufacture, and shall comply with the relevant specifications and recommendations mentioned in this specification."

5.3.3 PSA-4: PLANT

PSA-4.2: *CONTRACTOR'S* OFFICE, STORES AND SERVICES

Replace the third paragraph with the following:

"Upon completion of the *works,* and with the written consent of the *Employer*, the Site establishment shall be removed. The whole area of the Site establishment, including temporary access roads and other working areas, shall be cleared and appropriately re-vegetated where necessary. Where existing road surfaces have been damaged by the *Contractor*, the *Contractor* shall re-surface the road to at least its original state prior to construction, including all applicable layerworks. Damaged kerbing, edging and channelling shall also be replaced. Walls, fences, hedges and access to other properties, damaged by the *Contractor*, shall also be replaced and/or repaired. The cost of all such remedial *works* shall be deemed to be included in the rate for removal of Site establishment."

Add the following new clause:

"PSA-4.3: CORRECT PLANT TO BE PRICED

The *Contractor* shall familiarise himself with the Site conditions and type of construction *works* that need to be performed and allow in the rates for the correct plant and equipment, with sufficient capacity to carry out the *works*."

5.3.4 PSA-5: CONSTRUCTION

PSA-5.1: SURVEY

PSA-5.1.1: Setting Out of the *Works*

Add the following:

"Before the commencement of construction, the *Contractor* shall be provided with a general survey drawing of the work area and all boundary pegs and/or survey reference marks will be pointed out and

handed over to the *Contractor*. These boundary pegs and reference marks shall be protected by the *Contractor* throughout the contract period.

Setting out of the *works* is the sole responsibility of the *Contractor* and shall be done from fixed points as indicated on the drawings. The *Contractor* shall use a SAGC registered surveyor for the setting out and monitoring of the *works*. The *Contractor* shall, within two (2) weeks after the Site has been handed over to him or drawings issued for construction, verify the correctness of all setting out points. Any discrepancy shall immediately be reported in writing to the *Employer*. Any costs arising from discrepancies not reported to the *Employer* within the aforementioned period shall be for the *Contractor*'s account."

PSA-5.1.2: Preservation and Replacement of Beacons and Pegs subject to the Land Survey Act

Add the following:

"All boundary pegs shall be clearly marked by the *Contractor* with a white painted wooden batten protruding 1.0m above natural ground level before commencement of construction *works* and must be retained until completion of the *works*.

Any survey beacons, boundary pegs or survey reference marks that are disturbed, covered or removed by the *Contractor* without the prior consent of the *Employer* shall be replaced by a registered professional land surveyor (registered with the South African Geomatics Council (SAGC)) at the *Contractor's* expense. The *Contractor* shall, in such cases, provide to the *Employer* a certificate, signed by the professional land surveyor, listing the actual beacons, boundary pegs or survey reference marks that have been replaced."

Add the following new sub-clause:

"PSA-5.1.3: As-built Information

The *Contractor* shall appoint a suitable professional SAGC registered surveyor to survey the following as-built items:

a) All final cable routes as well as the position and levels of cable draw boxes. Cable routes shall be surveyed at the start and finish of the route, at 10m intervals and at any change of direction.
b) The position and levels of masts and other electrical infrastructure, including the footprint and level of underground foundations.
c) The position, routes and levels of all relocated services (underground or above-ground). Relocated services shall be surveyed at the start and finish of the route, at 10m intervals and at any change of direction.
d) The position, routes and levels (cover and invert levels) of all new underground civil services, manhole chambers, above-ground channels, etc. All new services shall be surveyed at the start and finish of the route, at 5m intervals and at a change in gradient and/or direction.
e) The position, route and levels of all new roads, hardstand areas, road infrastructure (kerbs, bollards, etc.). New roads shall be surveyed on the edges and centre of the road at 10m intervals and at a change in gradient and/or direction. Hardstand areas and kerbs, channels and edgings shall be surveyed on the edges and at 5m intervals, at a change in gradient and/or direction and on a 5m grid.
f) The position and route of all new fences and gates. Fencing routes shall be surveyed at 10m intervals and at a change of direction.

The *Contractor* shall submit these As-built drawings in hard and soft copies ('rvt', 'dgn', 'dxf', 'dwg' and 'PDF' formats) to the *Employer*.

There will not be a separate payment item for the above-mentioned survey work and the production of the required As-built drawings. These costs shall be included in the *Contractor*'s tendered rates for the *works*."

PSA-5.2: WATCHING, BARRICADING, LIGHTING AND TRAFFIC CROSSINGS

Add the following:

"The minimum requirements for road signs, barricades and delineators, required to control traffic during the execution of the *works*, shall be in accordance with the CSRA-CUTA: Road Traffic Signs Sub-committee; Road Signs Note no. 13, the South African Road Traffic Signs Manual. No *works* may proceed in any section where accommodation of traffic is required until such time as the relevant requirements with regard to signposting are met.

The *Contractor* shall keep sufficient surplus signs, barricades and delineators on Site to allow for the immediate replacement of damaged or missing items.

All arrangements in connection with the accommodation of traffic shall be submitted to the *Employer,* in the form of a method statement(s) and indicative drawing(s), for approval prior to being instituted.

Reference is made to the accommodation of traffic drawing(s) for the Site for the minimum requirements for traffic accommodation. The *Contractor* shall carry out all road crossing *works* (where required) in two stages, i.e. all trench excavations, laying and bedding of services, backfilling and placement of road layerworks shall be carried out in full for one half of the road width. The other half of the road width shall remain open to all traffic at all times.

The *Contractor* shall, where necessary, carry out temporary *works* to maintain the normal flow of traffic during the construction of the *works*.

The cost of these temporary *works* shall be included in the preliminary and general Items tendered for under Item PSA-8.8.2: Dealing with Traffic.

The *Contractor* shall further place flagmen on either side of the section of the *works* adjoining each side of the road. These costs shall also be included under PSA-8.8.2: Dealing with Traffic."

PSA-5.3: PROTECTION OF STRUCTURES

Change the heading to read as follows:

"PSA-5.3: PROTECTION OF STRUCTURES AND THE *WORKS*"

Add the following:

"From the start of the *works* (date of Site hand-over to *Contractor*) until the completion of the *works* and hand-over to the *Employer*, the *Contractor* shall be responsible for protecting the *works* (in progress and completed) and surrounding infrastructure from any damage caused by the construction *works*. This shall include any damage to the *works* and any adjoining structures, civil services infrastructure, layerworks and the like. The cost of any such repairs as a result of the above shall be deemed to be included in the tendered rates."

PSA-5.5: DEALING WITH WATER ON *WORKS*

Add the following:

"The *Contractor*'s attention is drawn to the fact that the Site is located in an area where a high water table may be encountered, especially in areas where deep excavation cuts occur and during the rainy season.

All water, whether from rain, floods, pipeline failures, subsurface water or infiltration (subterranean water), shall be dealt with in such a way as to ensure the safety of the *works*.

The *Contractor* shall take adequate preventive measures and maintain these measures to ensure that the *works* are protected from damage due to water. Should these measures fail to protect the *works*, additional steps shall immediately be taken by the *Contractor* to protect the *works* and prevent further damage to adjoining properties. The cost of these protection *works*, including rectification of damages, shall be borne by the *Contractor*.

The *Contractor* shall be responsible for and shall repair at his expense any damage to new or existing foundations and structures or any part of the *works* caused by floods, water or failure of any part of the dewatering and flood protection works. The *Contractor* shall furthermore ensure that the method used to deal with water on the *works* is monitored 24 hours a day and during weekends and holidays. The cost of all flood protection and dewatering measures shall be included in the tendered rates.

In addition to the requirements of sub-clause 5.5 of SANS 1200 A, the *Contractor* shall design, construct and maintain all channels, drains, sumps, pumps, pipework and any other temporary *works* necessary for the dewatering and flood protection of the permanent *works*. All methods of dewatering and flood protection shall be in accordance with the requirements of the environmental management plans, as referenced in the Works Information, and shall be subject to approval by the *Employer*.

The *Contractor* shall supply and maintain all submersible pumps, where required, and have additional pumps, in good working order, available at all times as back-up should any of the primary pumps breaks down or have to undergo maintenance.

The *Contractor* shall supply, install and maintain all pipework as required to safely pump all water collected to the closest stormwater inlet or temporary settlement pond.

The *Contractor* must take note that pipelines, other below-ground installations and structures may become buoyant due to the inflow of stormwater or groundwater. Measures shall be taken by the *Contractor* to mitigate any attendant risks to the *works.*

The *Contractor* shall also implement measures to prevent, reduce and mitigate water contamination, including prevention of contamination by suspended sediments. Water removed during all dewatering operations must be pumped at low pressures into suitable settling ponds for treatment, or through filters for removal of sediments. The concentration of suspended solids within treated water released back into the sea shall not be increased by more than 10% of the ambient concentration (as defined in the Department of Water Affairs' South African Water Quality Guidelines for Coastal Marine Waters, Volume 2 (March 2012). The suspended solid limit value shall apply at the last point where the discharge of wastewater enters into the sea, dilution being disregarded when determining compliance with the limit value.

Notwithstanding the above, the minimum allowable suspended solids to be discharged from the Site into any stormwater infrastructure or onto any part of the *Employer*'s property (or any other property in close vicinity to the Site), shall be equal to or less than 25mg/ℓ. The *Contractor* must therefore plan, source, set-up and manage his de-watering and surface water collection systems in such a manner that the above minimum requirement is achieved and maintained. The *Contractor* shall further have the treated water tested for suspended solids on a weekly basis (for the first 2 months) and after that on a monthly basis, by an ISO 17025 accredited SANAS laboratory.

The cost for the installation, operation and maintenance of legally compliant flood protection and dewatering measures as well as to set up a proper filtration and sedimentation system (and maintaining it during the course of the project), including suspended solids testing, as outlined above, shall be included in the tendered rate for dealing with water on Site."

PSA-5.6: POLLUTION

Add the following:

"The onus shall vest solely with the *Contractor* to control sand erosion and dust nuisance. The *Contractor* shall be responsible for all legitimate claims resulting from damage to adjacent property as a result of sand and dust. The *Contractor* shall take due care not to unnecessarily disturb the existing vegetation.

Measures to minimise dust shall include regular and effective treatment and watering of gravel haul and access roads and working areas. No additional payment will be made for such measures and the *Contractor* shall allow for these in his tendered rates.

The *Contractor* shall be responsible for the prevention of material loss by wind erosion and no additional payment will be made for replacing soil lost by wind erosion due to the failure of the *Contractor* to take sufficient and reasonable means to prevent such loss.

The *Contractor* shall ensure that all construction debris (e.g. cement bags, timber, wire, nails, etc.) waste and surplus food, food packaging, litter, organic waste and the like are properly collected and disposed of at a registered waste disposal site approved by the *Employer*. Waste bins shall be provided on Site as necessary, to collect such debris prior to disposal.

The *Contractor* shall clean up the *Contractor*'s camp and working areas at least once a week."

PSA-5.7: SAFETY

Add the following:

"The *Contractor* shall comply with all health and safety requirements, as stated in the Works Information. The cost of compliance with these requirements shall be provided for in the tendered rates."

PSA-5.8: GROUND AND ACCESS TO *WORKS*

Add the following:

"Before commencement of the *works*, the *Contractor* shall submit a report describing the prevailing Site conditions prior to the commencement of the *works*. The report shall include photos and written statements, highlighting any observed damages or adverse conditions pertaining to existing infrastructure at the Site, including all access roads envisaged to be used by the *Contractor*.

Upon completion of the *works*, the *Contractor* shall restore the ground surface of all areas outside of the new construction footprint that may have been disturbed during the construction activities, to its original condition. Excess materials shall be removed and all temporary excavations and ruts shall be filled with material similar to the adjoining natural ground. Planting of grass and shrubs may also be required to restore any disturbed areas. Boundary fences, which may have been removed or damaged during construction, shall be repaired and reinstated.

All roads used for access to the Site shall be maintained by the *Contractor* and upon completion of the *works*, be left in at least the original condition.

The *Contractor* shall remove from Site all temporary structures and infrastructure used during the performance of construction activities. These items shall be removed to the *Contractor's* permanent offices/yard; alternatively all items shall be removed directly to a registered landfill site.

Reference is made to Clause PSS: SOIL AND VEGETATION REHABILITATION for further details, requirements and specifications pertaining to the restoration/rehabilitation of the soil and vegetation of the Site after the completion of all earthworks, backfilling and construction activities.

Acceptance of the restoration of the Site shall be subject to the *Employer's* approval.

The cost of these restoration *works* shall be provided for in the tendered rates by the *Contractor*."

Add the following new clauses:

"PSA-5.9: FIRE PROTECTION

Every reasonable precaution shall be taken by the *Contractor* to prevent fires. The cost of these precautionary measures shall be provided for in the tendered rates. No fires shall be allowed on site under any circumstances.

PSA-5.10: FURTHER GENERAL OBLIGATIONS AS STATED IN WORKS INFORMATION

The *Contractor* shall provide all manpower, services, documentation and the like, in compliance with the further general obligations stated in the Works Information, including, but not limited to, the following:

a) Management meetings.
b) Documentation control.
c) Safety risk management.
d) Environmental management.
e) Quality assurance requirements.
f) Programming and progress reporting.
g) Industrial relations management
h) Factory acceptance tests
i) Site acceptance tests
j) Other

PSA-5.11: NAME BOARDS

The project name boards shall be erected within a month of the commencement date of the contract and shall be placed at the positions indicated by the *Employer*. The detail of the required name boards shall be in accordance with drawing number 1924701-2-510-C-DE-0010-01. The quantity of name boards required shall be indicated in the bills of quantities.

Any damage to these name boards shall be repaired within fourteen days of a written instruction issued by the *Employer*.

The *Contractor*'s attention is drawn to the requirements of Act 21 of 1940 (as amended) whereby it is an offence to display any advertising signboards that are visible from a proclaimed road without the relevant road authority's written permission.

The *Contractor* shall be permitted to erect a maximum of two of his own signboards, at positions approved by the *Employer*. The *Employer* reserves the right to order the removal of these boards if they are not kept in good repair.

PSA-5.12: SURVEY EQUIPMENT

The *Contractor* shall provide the following survey equipment on Site for the full duration of the *works*:

a) 1 Tacheometer capable of reading to 20 seconds of arc, with tripod.
b) 2 Tacheometer staffs with staff bubbles.
c) 2 Automatic levels and levelling staffs complete with tripods and staff bubbles.
d) Laser beam control instruments for laying pipelines.
e) 2 Measuring tapes of length 50m.

All equipment may be shared by arrangement between the *Contractor* and the *Employer*. The *Contractor* shall insure the equipment against any loss, damage or theft and shall indemnify the *Employer* against any claims in this regard.

The fixed cost of providing the above-listed equipment shall be covered under the payment item 8.3.2.2.f and the time-related cost of maintaining the equipment shall be covered under the payment item 8.4.2.2.f.

The *Contractor* shall maintain the equipment in good working order and keep it clean throughout the contract period. The *Contractor* shall further ensure that the minimum required field, calibration and equipment tests are regularly carried out for each instrument and shall provide the necessary certificates as proof thereof."

5.3.5 PSA-6: TOLERANCES

PSA 6.2: DEGREE OF ACCURACY

Replace this clause with the following:

"All *works* shall be carried out to a degree of Accuracy II as specified in the relevant standard specifications, unless stated otherwise in these specifications or instructed on Site by the *Employer*."

5.3.6 PSA-7: TESTING

PSA-7.1: PRINCIPLES

PSA-7.1.1: Checking

Add the following:

"All required quality control tests shall be performed by a SANAS-registered service provider. The *Contractor* is not required to provide an approved field laboratory on Site. The tendered rates shall include full compensation for all quality control tests."

5.3.7 PSA-8: MEASUREMENT AND PAYMENT

Change payment item 8.3 to read as follows:

"PSA-8.3: SCHEDULED FIXED-CHARGE ITEMS"

PSA-8.3.2: Establishment of Facilities on the Site

Change payment item 8.3.2.1 to read as follows:

"PSA-8.3.2.1: Facilities for *Employer*"

PSA-8.3.2.1.c): Name boards (2 No.) ..... Unit: Sum

Add the following to this payment clause:

"The tendered rate shall cover all fixed costs (plant, equipment, material, labour, transport, etc.) for procuring, manufacturing, transporting, providing to Site and erecting 2 No. project name boards, in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*. Reference is made to clause PSA-5.11. The rate shall also cover the removal of the name boards upon completion of the *works.*"

PSA-8.3.3: Other Fixed-charge Obligations

Replace the wording under this payment item with the following:

"The tendered sum shall include full compensation for the fixed cost of providing the services as listed above in clause PSA-5.10 and as further described in the Works Information."

PSA-8.4: SCHEDULED TIME-RELATED ITEMS

PSA-8.4.2: Operation and maintenance of facilities on Site, for duration of construction, except where otherwise stated

Change payment item 8.4.2.1 to read as follows:

"PSA-8.4.2.1: Facilities for *Employer*"

PSA-8.4.2.1.c): Name boards (2 No.) ..... Unit: Sum

Add the following to this payment clause:

"The tendered rate shall cover all time-related costs (plant, equipment, material, labour, transport, etc.) for maintaining the project name boards, in accordance with this specification."

PSA-8.4.5: Other Time-related Obligations

Replace the wording under this payment item with the following:

"The tendered sum shall include full compensation for the time-related cost of providing the services as listed above in clause PSA-5.10 and as further described in the Works Information."

PSA-8.5: SUMS STATED PROVISIONALLY BY ENGINEER

Change the heading to read "SUMS STATED PROVISIONALLY BY *EMPLOYER*".

Replace this payment item with the following:

"PSA-8.5.a): Additional Information, Tests and Certificates:

i) Additional test certificates, etc. and information and/or tests ordered by the *Employer*, over and above the Contract requirements, carried out by approved commercial laboratories and institutions ..... Unit: Provisional Sum

The provisional sum shall cover the cost of all additional tests ordered by the *Employer.* Such costs will only be payable if such tests are beyond the scope of the *Contractor's* responsibilities in terms of the contract, or if tests and results previously submitted by the *Contractor* are found to provide a true, adequate and accurate reflection of the quality of the *works* performed by the *Contractor*.

PSA-8.5.b): Additional Equipment:

i) Provision, installation, commissioning, testing etc. of any *Employer* specified new equipment or changes, including installations or any other requirements/works, as instructed by the *Employer* - all costs included ..... Unit: Provisional Sum

ii) Complete new 66kV T-off branch line ..... Unit: Provisional Sum

The provisional sum shall cover all costs (plant, equipment, material, labour, transport, etc.) the *Contractor* require to attend to above listed item(s).

PSA-8.5.c): Checking of As-built Information

i) Checking by independent surveyor ..... Unit: Provisional Sum

The provisional sum is provided for checking of as-built information by an independent surveyor, if so ordered by the *Employer*.

The *Contractor* must note that this provisional sum is not for the use of the *Contractor* to carry out the required as-built survey as stipulated in clause PSA-5.1.3."

PSA-8.8: TEMPORARY *WORKS*

PSA-8.8.2: Dealing with Traffic.....Unit: Sum

Add the following:

"The tendered rate shall cover all costs for the provision, erection, moving, re-erection and maintenance of all barriers, road signs, lights and flagmen necessary for the protection of the *works*, for compliance with traffic regulations, liaison with road authorities and affected third parties, the temporary filling of trenches overnight at road and driveway crossings and all other costs necessary in respect of the accommodation of traffic and in accordance with clause PSA-5.2: WATCHING, BARRICADING, LIGHTING AND TRAFFIC CROSSINGS."

PSA-8.8.3: Protection of the *Works* and Surrounding Structures Until Construction in Vicinity is Complete.....Unit: Sum

Add the following:

"From the start of the contract (date of Site hand-over to *Contractor*) until the completion of the contract and hand-over to the *Employer*, the *Contractor* shall be responsible for protecting the *works* (in progress and completed) from any damage caused by the construction *works*, weather, theft and/or interference from the public. The *works* include any structures, civil services infrastructure, layerworks and any other items described in the drawings, specifications and the bill of quantities. Any repairs of damages to the *works* during this period as a result of the above shall be for the *Contractor*'s account."

5.4 PSC: SITE CLEARANCE

5.4.1 PSC-1: SCOPE

PSC-1.1: Insert the phrase "rubbish, rubble" before "vegetation" in the first line.

Add the following:

"This specification furthermore covers:

a) Location, protection, relocation and removal of existing services.
b) Road crossings of services.
c) The stockpiling, re-use and/or removal of excavated materials at road crossings and road excavations.
d) Search and rescue of vegetation identified to be relocated.
e) Clearing of vegetated areas and treatment by grinding and mulching, for re-use during restoration of disturbed areas.

Further *works* associated with services crossing roads, the relocation of services and new service connections are covered under the following section:

a) PSDB: Earthworks (Pipe Trenches).
b) PSLB: Bedding (Pipes).
c) PSL: Medium-Pressure Pipelines.
d) PSLD: Sewers.
e) Installation of the new electrical and communication cables, including all new connections, shall be in accordance with the following further specifications:

- High and Medium Voltage Installations : Doc. No. 1924701-2-300-E-SP-0006
- Low Voltage Installations : Doc. No. 1924701-2-300-E-SP-0008
- Monitoring and Control Installation : Doc. No. 1924701-2-300-E-SP-0010

Reinstatement of layerworks, surfacing and ancillary roadworks are covered under the following sections/codes:

a) PSG: Concrete (Structural).
b) PSM: Roads (General).
c) PSME: Subbase.
d) PSMF: Base.
e) PSMH: Asphalt Base and Surfacing.
f) SANS 1200 MJ: Segmented Paving.
g) PSMK: Kerbing and Channelling.
h) PSMM: Ancillary Roadworks"

5.4.2 PSC-3: MATERIALS

Delete Clause 3.1 and replace as follows:

"PSC-3.1: DISPOSAL OF MATERIAL

a) The *Contractor* shall be responsible for the proper disposal of waste (rubble, non-composite rubbish, contaminated soil, surplus material and the like) in accordance with the Environmental Conservation Act of 1982. This shall include the disposal of high risk substances as defined in the Occupational Health and Safety Act (Act No. 85 of 1993) under GAR Annexure 4, and in particular the disposal of asbestos in accordance with AR R17 of that Act. The burning of combustible material is prohibited.
b) The *Contractor* shall dispose of clean, granular materials, including hard rock excavations and unsuitable, oversized materials (cobbles and/or boulders) at the designated stockpile area as indicated in Part C.4: Site Information. Payment for overhaul of these materials shall be made as described in these specifications.
c) All other spoil materials, including materials from Site clearance operations (unless indicated otherwise in clause PSC-5.3) and sections of existing road surfacing that are to be removed as part of road crossings, shall be taken to a registered waste disposal site, to be approved by the

Employer. The *Contractor* shall present a valid certificate to the *Employer* for the disposal of all materials spoiled at the registered waste disposal site.

d) All hazardous waste shall be disposed of at a registered hazardous waste landfill site."

5.4.3 PSC-4: PLANT

Add the following to clause 4.1:

"The *Contractor* shall further familiarise himself with the Site conditions and type of site clearance *works* that need to be performed and allow in the rates for the correct plant and equipment, with sufficient capacity to carry out the *works*."

5.4.4 PSC-5: CONSTRUCTION

PSC-5.1: AREAS TO BE CLEARED AND GRUBBED

Add the following:

"No clearing and grubbing shall be done other than on the written instructions of the *Employer*, who shall designate in detail the exact areas to be cleared and grubbed and the time when it shall be done. The *Contractor* shall note that, in order to avoid re-clearing, the clearing and grubbing may have to be done at the last practicable stage of construction."

PSC-5.3: CLEARING

Under section PSC-5.3.c) replace the flywheel power of 130kW with "145kW".

Add the following:

"PSC-5.3.1: Search and Rescue

Prior to commencement of any clearing and grubbing, a comprehensive search and rescue survey of the Site is to be undertaken by a nominated soil and vegetation specialist, to be appointed by the *Employer,* to identify any species that are to be relocated. The relocation of such species shall also be carried out by the nominated specialist. Reference is made to Section PSS of these specifications.

PSC-5.3.2: Clearing and Treatment of Vegetated Areas

All trees and shrubs within the Site with a height exceeding 1.0m shall be removed by hand and collected for further processing by grinding and mulching, using "Bandit" type chippers or approved equivalent. The collection point for such chipping operations shall be agreed with the *Employer* on Site. The recovered chippings shall be placed in a stockpile and carefully preserved for later mulching of areas where natural vegetation is to be re-established. The exposed surfaces of the stockpile shall be covered in hessian or equivalent approved matting. De-stumping of roots and stumps shall be done as part of the subsequent further clearing and grubbing of Site and removal of topsoil."

Add the following new clauses:

"PSC-5.9: ROAD CROSSINGS AND EXCAVATION OF ROAD SECTIONS

This part of the specifications covers the crossing of asphalt, concrete, block-paved and gravel roads or surfaced areas for the installation of new underground services and ducts.

PSC-5.9.1: Asphalt Roads

Where required, the asphalt surfacing shall be neatly saw-cut along the full length of the excavation perimeter and through the full thickness of the asphalt layer(s). Sufficient space shall be allowed between the saw cuts to allow for the excavations and benching of layerworks during backfilling. The layerworks for asphalt surfaced roads will typically be as follows:

a) 30mm to 70mm asphalt surfacing.
b) 150mm G1 base.
c) 150mm C3 subbase.
d) 150mm C4 subbase.
e) Selected layers/roadbed.

All excavated asphalt and stabilised layerworks shall be disposed of at a registered waste disposal site, as described under PSC-3.1. The asphalt surfacing shall be reinstated in accordance with this specification, the drawings and relevant clauses of SANS 1200 M and SANS 1200 MH.

PSC-5.9.2: Concrete Roads

Where required, the concrete surfacing shall be neatly saw-cut along the full length of the excavation perimeter and through the full thickness of the surface bed. Sufficient space shall be allowed between the saw cuts to allow for the excavations and benching of layerworks during backfilling. The *Contractor* is advised that dowels and/or other reinforcing may be encountered within the concrete surfacing. The layerworks for concrete pavements will typically be as follows:

a) 250mm Reinforced 40MPa (19mm stone) concrete surface bed.
b) 150mm C2 subbase.
c) 150mm G7 selected subgrade.
d) Roadbed/selected layers.

All excavated concrete materials and stabilised layerworks shall be disposed of at a registered waste disposal site, as described under PSC-3.1. Concrete pavements shall be re-instated in accordance with this specification, the drawings and the relevant clauses of SANS 1200 G.

PSC-5.9.3: Block Paved Roads

Where required, segmental paving blocks shall be neatly and carefully removed and stockpiled for later re-use. The width to which blocks are removed shall be sufficient to allow for the excavations and benching of layerworks during backfilling. The layerworks for segmental block pavements will typically be as follows.

a) 80mm heavy duty 35MPa block pavers laid in herringbone pattern
b) 20mm bedding sand
c) 150mm C3 subbase
d) 150mm G5 subbase
e) 150mm G7 selected subgrade
f) Roadbed/selected Layers

All excavated stabilised materials and damaged paving blocks shall be disposed of at a registered waste disposal site, as described under PSC-3.1. Where instructed by the *Employer*, the *Contractor* shall provide new pavers, of a similar size, shape, thickness and colour as the adjoining paved areas, to make up for any shortages. Paving blocks shall be re-instated in accordance with this specification, the drawings and relevant clauses of SANS 1200 MJ.

PSC-5.9.4: Gravel Service Roads

Where required, the gravel wearing course layer shall be removed, stockpiled and conserved for re-use. The width to which the wearing course shall be removed shall be sufficient to allow for the excavations and benching of layerworks during backfilling. The layerworks for gravel roads will typically be as follows:

a) 150mm Subbase gravel wearing course
b) 150mm G7 selected subgrade
c) Roadbed/selected Layers

The gravel roads shall be re-instated in accordance with this specification, the drawings and the relevant clauses of SANS 1200 DM, SANS 1200 M and SANS 1200 ME.

PSC-5.9.5: Precast Concrete Road Edgings/Kerbs

Where required, all precast concrete road edgings/kerbs, including concrete bedding and backing material, shall be removed. All concrete rubble shall be disposed of at a registered waste disposal site, as described under PSC-3.1. Re-instatement of the new concrete edgings shall be in accordance with this specification, the drawings and the relevant clauses of SANS 1200 MK.

PSC-5.9.6: Layerworks

Where required, all existing unstabilized layerworks shall be stockpiled for re-use as part of the backfilling. Payment for the backfilling of trenches shall be covered under payment items PSDB-8.3.2.

All excavated stabilized layerworks shall be taken to the designated stockpile area, as described in Part C.4: Site Information. Re-instatement of layerworks with imported materials shall be in accordance with these specifications, the drawings and the relevant clauses of SANS 1200 DM, SANS 1200 M, SANS 1200 ME and SANS 1200 MF, as applicable. Re-instatement of all pavement layers shall include benching in steps of no less than 150mm wide per layer and re-compaction to the specified densities.

PSC-5.10: PROTECTION, RELOCATION AND REMOVAL OF EXISTING SERVICES

PSC-5.10.1: Protection of Overhead and Underground Services

Prior to commencement of Site clearance, the *Contractor* shall carry out comprehensive surveys of the Site to identify and establish the location of all existing underground services. These investigations shall include a review of all available as-built services drawings and a full sweep of the Site using suitably calibrated and fit for purpose ground-penetrating radar systems and cable locators, operated by qualified and experienced personnel.

If the existence of a service can be reasonably expected, or such services have been identified as part of the surveys as outlined above, the *Contractor* shall, in conjunction with all relevant authorities and landowners, determine the exact depth and location of such services before the commencement of construction. This shall include excavation of trial pits and proving trenches by hand to expose such services. After locating the exact position of services, such services shall be deemed to be known services and the *Contractor* shall be liable for all costs arising from the damage thereof as a result of the *Contractor*'s activities. These services must also be indicated on the "As Built" drawings submitted by the *Contractor*.

The *Contractor* shall provide all temporary protection of underground services, which shall include, but is not limited to, the following:

a) Demarcation and fencing off of services.
b) Split sleeving and concrete encasing of services.
c) Providing protective earth filled raised platforms over services.

The *Contractor* shall ensure that all existing services that are to be abandoned are decommissioned and/or safe before any Site clearing or excavations commences.

Known services include, but are not limited to, the following:

i. At the Main Intake Substation Platform and Access Roads:

   a) 1 x 160mm Ø water main line (crossed by new Access Roads 3 & 4).
   b) 1 x 160mm Ø foul sewer rising main line (crossed by new Access Roads 3 & 4).
   c) 3 x HV electrical cables (crossed by new Access Roads 3 & 4).
   d) 2 x communication cables (crossed by new Access Roads 3 & 4).
   e) 1 x communication and 1 x HV electrical cable (building and internal road platform toe lines constructed on top of cables).
   f) 1 x existing duct (crossed by new Access Road 1)

   Table 7 details the *works* to be undertaken for the protection of the above services.

ii. Substation N:

   a) 1 x 160mm Ø water main line (to be relocated)
   b) 1 x 160mm Ø foul sewer rising main line (to be relocated)
   c) 3 x HV electrical cables (to be relocated)
   d) 2 x communication cables (to be relocated)
   e) 1 x electrical lighting cable (to be removed)
   f) Electrical light posts (to be removed)

   Above known services are located in the area between the boundary fence to the east and the ArcelorMittal conveyor CV-305 to the west (as indicated on the drawings).

iii. Substation M:

   a) 1 x 160mm Ø foul sewer rising main (to remain)
   b) 1 x 200mm Ø foul sewer rising main (to remain)

Above known services are located in the area between the eastern boundary fence and the Saldanha Steel conveyor to the east of the eastern boundary fence.

Refer to the following survey drawings for assistance and guidance only on known services:

1) 1924701-2-100-C-LA-0001-01: Iron Ore Tippler 3 Survey Layout Sheet 1
2) 1924701-2-100-C-LA-0001-02: Iron Ore Tippler 3 Survey Layout Sheet 2
3) 1924701-2-100-C-LA-0001-03: Iron Ore Tippler 3 Survey Layout Sheet 3
4) 1924701-2-100-C-LA-0001-04: Iron Ore Tippler 3 Survey Layout Sheet 4
5) 1924701-2-100-C-LA-0001-05: Iron Ore Tippler 3 Survey Layout Sheet 5
6) 1924701-2-100-C-LA-0001-06: Iron Ore Tippler 3 Survey Layout Sheet 6
7) 1924701-2-100-C-LA-0001-07: Iron Ore Tippler 3 Survey Layout Sheet 7
8) 1924701-2-100-C-LA-0001-08: Iron Ore Tippler 3 Survey Layout Sheet 8
9) 1924701-2-100-C-LA-0001-09: Iron Ore Tippler 3 Survey Layout Sheet 9
10) 1924701-2-100-C-LA-0001-10: Iron Ore Tippler 3 Survey Layout Sheet 10

Table 7: Protection of Existing Known Services: Main Intake Substation

Task	Known Underground Service to be Protected					
	160mm Ø Water Pipe	160mm Ø Sewer Pipe	2 x Comms. Cables	3 x HV Electrical Cables	1 x Comms. & 1 x HV Electrical Cables	1 x Existing Duct
Length of work sections (L)	2 x 15m sections	2 x 20m sections	2 x 15m sections per cable	3 x 18m sections per cable	150m x 3m section	1 x 15m section
Excavate/expose existing service and stockpile excavated material adjacent to trench	Yes	Yes	Yes	Yes	No	No
Place split sleeve around applicable service	Yes 250mm Ø split sleeve	Yes 250mm Ø split sleeve	Yes 160mm Ø split sleeves	Yes 160mm Ø split sleeves	No	No
Wrap split sleeve in geotextile (Kaytech A2 bidim or equivalent approved) with 500mm minimum overlap	Yes	Yes	Yes	Yes	No	No
Encase split sleeve in 30MPa concrete at least 250mm all around the split sleeve	Yes	Yes	Yes	Yes	No	No
After sufficient curing of concrete (minimum 7 days), backfill trench with stockpiled material (adjacent to trench) in 150mm layers and compact to at least 93% of MOD AASHTO density (100% for sand)	Yes	Yes	Yes	Yes	No	No
Dispose of excess material at designated stockpile area	Yes	Yes	Yes	Yes	No	No
Excavate to maximum 500mm above existing service and stockpile excavated material adjacent to excavation	No	No	No	No	Yes	Yes
Cast 30MPa slab (section length L x 3m wide x 0.15m thick) above cables	No	No	No	No	Yes	Yes
After sufficient curing of concrete (minimum 7 days), backfill trench with stockpiled material (adjacent to trench) in 150mm layers and compact to at least 93% of MOD AASHTO density (100% for sand)	No	No	No	No	Yes	Yes

PSC-5.10.2: Relocation/Removal of Services

The following procedures shall be implemented by the *Contractor* for the relocation of existing services:

a) Compile a detailed method statement on how the required *works* will be carried out and submit to the *Employer* for comments and approvals.
b) Verify the proposed route for the relocated service in conjunction with the *Employer* and service owner, including the junction points between the existing and relocated portions of the service.
c) Install the new service along the new route, in accordance with the specifications applicable to the specific service, to include testing, witnessing by the *Employer* and backfilling.
d) Arrange with the *Employer* and service owners for date and time for cross-over and reconnection between the existing and relocated services.
e) Undertake checks as required to confirm that existing service is isolated. Lock-out procedures shall be strictly enforced for all electrical cables. For wet services, all upstream and downstream isolation valves shall be closed off and the affected pipelines shall be drained, where possible. For communication cables, switch-overs to alternate lines shall be in place.
f) Cut the existing services at the junction points and make tie-ins, in accordance with applicable specifications and method statements.
g) Re-commission service, including tests and integrity checks as required.
h) Redundant sections of existing service shall be removed, if so instructed by the *Employer*.
i) Dispose of excess excavated material to the designated stockpile area (as indicated in Part C.4: Site Information)."

5.4.5 PSC-8: MEASUREMENT AND PAYMENT

Delete pay items 8.2.2 to 8.2.10 and replace as follows:

"PSC-8.2.2: Clearing of vegetated areas and treatment by grinding and mulching

a) Clear trees and shrubs by hand ..... Unit: m^2
b) Treatment by grinding and mulching ..... Unit: Sum
c) Stockpiling and protection of recovered organic materials ..... Unit: Sum

The tendered rate for Item a) shall include all costs (plant, equipment, material, labour, transport and the like) for clearing the Site of all shrubs and trees with a height in excess of 1.0m, using hand-held tools and equipment and transporting the cleared shrubs and branches to a designated area as agreed with the *Employer* on Site, for further treatment and conservation.

The tendered rate for Item b) shall include all costs (plant, equipment, material, labour, transport and the like) for treating the recovered shrubs and branches by grinding, using a suitable sized and equipped chipper (type "Bandit" or similar), to produce mulch for later restoration of disturbed areas.

The tendered rate for Item c) shall cover all costs arising from the stockpiling and protection of the processed and recovered mulch prior to re-use for the restoration of disturbed areas. All stockpiles shall be fully covered with hessian or similar approved matting.

PSC-8.2.3: Remove existing steel palisade fences and hand over to *Employer* ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for carefully disconnecting steel palisade fence panels from steel columns and handing the panels over to the *Employer*. The rate shall also cover the costs to remove all steel columns and foundations and disposal of rubble at a registered waste disposal site, as described under PSC-3.1. The steel poles shall also be handed over to the *Employer*.

PSC-8.2.4: Location of Existing Services

PSC-8.2.4.a): Site survey by ground-penetrating radar and cable detector ..... Unit: Sum

The tendered sum shall cover all costs (plant, equipment, material, labour, transport and the like) to carry out comprehensive surveys of the Site, prior to the commencement of any *works,* by ground-penetrating radar and cable detectors to identify and establish the location of all existing underground services.

The tendered sum shall also include the pegging out of the various services on Site and marking the pegs with different colours in accordance with the type of service identified. The cost for adding the services onto As-built drawings shall not form part of this tendered sum, but shall form part of the Preliminary and General costs, as explained in clause PSA-5.1.3.

PSC-8.2.4.b): Excavation by hand in soft and intermediate materials to expose existing services ..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) to locate and expose existing services by hand which may affect the *works*, as required under this contract and as agreed beforehand with the *Employer*.

Excavation by hand in soft and intermediate material to expose existing services shall only be measured and paid for if so ordered in writing by the *Employer*.

Extra-over payments for hand excavations will not be made where the height difference between the bottom of the trench and the top of the service exceeds 300mm.

PSC-8.2.5: Temporary protection of known underground services:

a) 1 x 160mm Ø Water main line ..... Unit: Sum
b) 1 x 160mm Ø Foul sewer rising main line ..... Unit: Sum
c) 3 x HV electrical cables ..... Unit: Sum
d) 2 x Communication cables ..... Unit: Sum
e) 1 x Electrical lighting cable ..... Unit: Sum
f) Existing duct at northern entrance to Main Intake substation on Access Road 1 ..... Unit: Sum

The tendered rates shall cover all costs (plant, equipment, material, labour, transport, etc.) for the temporary protection of the above listed services as described in Table 7, in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSC-8.2.6: Temporary protection of known above-ground services:

a) 66kV Overhead electrical lines ..... Unit: Sum

The tendered rates shall cover all costs (plant, equipment, material, labour, transport, etc.) for the temporary protection of the above listed services and the structures these services are connected to or suspended from, in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSC-8.2.7: Remove existing cable- and pipe markers for later re-use ..... Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport, etc.) for the careful removal and storing of cable and pipe markers on Site, as shown on drawings or as instructed on Site by the *Employer*.

PSC-8.2.8: Remove all redundant underground services from Site

a) 160mm Ø Water main line ..... Unit: Sum
b) 160mm Ø Foul sewer rising main line ..... Unit: Sum
c) HV electrical cables ..... Unit: Sum
d) Communication cables ..... Unit: Sum
e) Electrical lighting cable ..... Unit: Sum

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for removing of all redundant services from excavated trenches and disposing of it at a registered waste disposal site, as described also under Clause PSC-3.1 and Clause PSC-5.10.2 of this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.9: Remove all redundant light poles from Site ..... Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the careful removal of redundant light poles, including concrete bases, and handing the light poles over to the *Employer*. The rate shall include making good all excavations and backfilling with G7 materials compacted to 93% MOD AASHTO (100% for sand). Reference is made to clause PSC-5.10.2 of this specification.

The rate shall also include disposal of all excess concrete rubble at the registered waste disposal site, as described under Clause PSC-3.1, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.10: Temporary protection and relocation of unknown existing services ..... Unit: Provisional Sum

The provisional sum shall cover all costs (plant, equipment, material, labour, transport and the like) required by the *Contractor* for the temporary protection and relocation of any unknown underground services, defined as services that are not listed in these specifications or shown on the drawings.

Payment under this item shall only be made upon a written instruction and approval of a compensation event by the *Employer*, in accordance with the conditions of contract.

PSC-8.2.11: Remove and dispose of asphalt surfacing..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for saw-cutting the asphalt surfacing, breaking up of these materials and disposing of all asphalt at a registered waste disposal site, as described also under Clause PSC-3.1 and Clause PSC-5.9.1 of this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.12: Remove and dispose of concrete from existing pavements ..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for saw-cutting the concrete pavement, including any steel reinforcement, breaking up of these materials and disposing of all concrete and steel reinforcing rubble at a registered waste disposal site, as described also under Clause PSC-3.1 and Clause PSC-5.9.2 of this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.13: Remove and stockpile 80mm thick segmental paving blocks for re-use ..... Unit: m^2

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for carefully removing and safe storage of segmental paving blocks on Site for later re-use, as described also under Clause PSC-3.1 and Clause PSC-5.9.3 of this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.14: Remove and stockpile gravel wearing course of existing gravel service roads for re-use..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for excavation of the existing gravel wearing course and temporary stockpiling on Site for later re-use, as described also under Clause PSC-3.1 and Clause PSC-5.9.4 of this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.15: Remove existing precast concrete edgings/kerbs..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for breaking up and removing existing precast concrete edgings/kerbs and disposal at the registered waste disposal site, as described under Clause PSC-3.1 and Clause PSC-5.9.5 of this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.16: Demolish and remove from Site redundant manhole chambers

a) Existing foul sewer line scour manhole chamber.....Unit: No.
b) Existing water line scour manhole chamber .....Unit: No.
c) Existing communications cable manhole chamber.....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for demolishing redundant manhole chambers as instructed by the *Employer* or as indicated on the drawings and disposal of all rubble at the registered waste disposal site, as described under Clause PSC-3.1.

The rate shall include filling of all excavations with G7 quality material from the Site, to be placed in layers of 300mm and compacted to at least 93% of MOD AASHTO density (100% for sand).

PSC-8.2.17: Remove existing base material and stockpile for re-use ..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for excavating the existing base course and temporary stockpiling on Site for later re-use, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.18: Remove and dispose of existing stabilized subbase .....Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport, etc.) for excavating existing stabilized subbase materials and disposal thereof at the registered waste disposal site, as described under Clause PSC-3.1, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.19: Remove existing unstabilized subbase and stockpile for re-use .....Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for excavating the existing unstabilized subbase course and temporary stockpiling on Site for later re-use, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.20: Remove existing granular layers and stockpile for re-use.....Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for excavation of granular materials (i.e. layerworks and subgrade) from trenches within existing roads or hardstanding areas and temporary stockpiling on Site for later re-use, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.21: Remove existing road signs .....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the removal of road sign boards and sign posts, including supporting structures and concrete bases, and handing the sign boards and sign posts over to the *Employer*.

The rate shall include making good all excavations and backfilling with G7 quality material from the Site, to be placed in layers of 300mm and compacted to at least 93% of MOD AASHTO density (100% for sand).

The rate shall also include disposal of all excess rubble (i.e. concrete bases, etc.) at the registered waste disposal site, as described under Clause PSC-3.1, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*."

5.5 PSD: EARTHWORKS

5.5.1 PSD-1: SCOPE

Add the following:

"This specification covers the bulk earthworks (cut-to-fill, cut-to-spoil and borrow-to-fill) for all roads, building platforms, yards, parking areas, the new stormwater detention pond, and the like.

This specification also covers the removal and preservation of topsoil."

5.5.2 PSD-3: MATERIALS

Delete Clause 3.1 and replace as follows:

"PSD-3.1: CLASSIFICATION FOR EXCAVATION PURPOSES

a) Soft and intermediate excavations

Soft and intermediate excavations shall include all materials, except materials that can only be loosened by blasting. No distinction will be made between soft and intermediate excavations.

All calcrete, regardless of the hardness of such materials, shall be classified as soft and intermediate excavations and shall be measured and paid as such.

b) Hard excavation

Hard excavation shall be materials that can only be loosened by means of blasting."

Delete Clause 3.2 and replace as follows:

"PSD-3.2: CLASSIFICATION FOR PLACING PURPOSES

PSD-3.2.1: Classification for Placement Purposes

In-situ excavated soft and intermediate materials shall either be used as fill material for the new building and electrical yard platforms, access roads and parking/loading yards or be disposed of at the designated stockpile area, as detailed in Part C.4: Site Information.

Fill materials used for the building and electrical yard platforms, access roads, parking areas, loading yards and the like shall comprise of free-draining, granular material, conforming to at least TRH 14: G7 standard of material. Such material shall preferably be obtained from selected soft and intermediate excavations within the Site.

PSD-3.2.2: Processing of Excavated Materials

Excavated materials for fills shall be spread in layers with a loose thickness not exceeding 150mm, thoroughly mixed, watered, processed and compacted.

Where instructed by the *Employer*, oversized material shall be spread out or bladed to a windrow, for further processing by heavy grid or padfoot roller, as described below.

Oversized material shall be broken down by heavy grid or padfoot vibratory rollers with an operating mass of no less than 15 tons. The roller shall move at a speed of at least 12km/hr.

Any materials that cannot be broken down to a size less than 75mm by heavy grid or padfoot rolling shall be taken to windrow or removed by hand, and shall be separately stockpiled for disposal to the designated stockpile area.

Following the breakdown of oversized materials, the fill shall be processed and compacted to the standards reflected in Table 11 in sub-clause PSD-7.2 below."

Delete Clause 3.3 and replace as follows:

"PSD-3.3: SELECTION

If suitable fill materials cannot be obtained from Site, and only if so instructed by the *Employer*, such materials shall be obtained from one of the following sources for imported fill material:

a) Stockpiled soft and intermediate excavations at the Tippler 3 construction area.
b) Designated stockpile area as indicated in Part C.4: Site Information.

The *Contractor* shall be responsible for identifying and selecting materials from the above areas that meet the specified requirements for fill materials. The *Contractor* shall deal with all cut materials so that usable material is not contaminated with unsuitable material. If usable material is contaminated, such contaminated material shall be removed and replaced with suitable material at the *Contractor*'s expense.

All hard rock excavation material shall be deemed unsuitable material and discarded at the designated stockpile area, as indicated in Part C.4: Site Information."

5.5.3 PSD-5: CONSTRUCTION

PSD-5.1: PRECAUTIONS

PSD-5.1.1: Safety

PSD-5.1.1.2: Safeguarding of Excavations

Add the following sub-paragraphs:

"g) The *Contractor* shall not require or allow any person to work under unsupported overhanging material or in an excavation which is more than 1.5m deep, unless the excavation has been adequately supported, shored or braced and there is no danger of the overhanging material or the sides of the excavation collapsing. The support, shoring or bracing (that shall be designed and constructed by the *Contractor*) shall be strong and sturdy enough to support the sides of the excavation in question. The cost for the design, construction and maintenance of such support, shoring and/or bracing shall be allowed for in the *Contractor's* tendered excavation rates."

PSD-5.1.4: Nuisance

PSD-5.1.4.1: Dust Nuisance

Add the following:

"The *Contractor* shall be responsible for dust control and is liable for all claims that may result from dust nuisance on all parts of the Site at all times, from the date of handing over of the Site to the completion date. Separate payment for these measures will not be made and all such costs are deemed to be covered by the tendered rates."

PSD-5.2: METHODS AND PROCEDURES

PSD-5.2.1: Site Preparation

Delete Clause 5.2.1.2 and replace as follows:

"PSD-5.2.1.2: Conservation of Topsoil

Topsoil, including grass and other vegetation, shall be removed from within the footprint of the Site to a depth of 200mm. Sufficient quantities of topsoil shall be stockpiled on Site (within the freehaul distance) as indicated on drawings or as instructed on Site by the *Employer*, for later re-use in the rehabilitation of exposed embankments and other disturbed areas.

The balance of the topsoil (not required for rehabilitation purposes) shall, only when instructed by the *Employer* in writing, be taken to the designated stockpile area, as described in Part C.4: Site Information, and placed in a separate stockpile for later re-use by Others. Overhaul for topsoil taken to the designated stockpile area shall be payable in accordance with PSD-5.2.5 of this specification.

Table 8 overleaf provides a provisional estimate of the volumes of topsoil to be retained on the various Sites and the volumes to be taken to the designated stockpile area.

Table 8: Handling of Topsoil

Site	Total Volume of Topsoil to be Removed	Volume to be Retained on Site for Reuse	Volume to be Hauled to Designated Stockpile Area
Substation M	400m³	140m³	260m³
Substation N	1,110m³	610m³	500m³
Main Intake Substation	8,600m³	3,300m³	5,300m³
Bulk Power Reticulation	2,600m³	2,600m³	0m³

The following measures shall be adopted during the removal and stockpiling of topsoil:

a) Naturally occurring vegetation removed by site clearance operations may be grubbed in with the topsoil for stockpiling.
b) Topsoil stripping shall not occur in wet weather.
c) During stripping and stockpiling, the topsoil shall not be compacted or pushed for a distance of more than 50m.
d) Topsoil shall only be handled twice, i.e. once to strip and stockpile, and secondly to replace, level, shape and scarify.

All stockpiles of topsoil shall be managed as follows:

a) Stockpile(s) shall not be higher than 2.0m.
b) The slopes of the stockpiles shall be no steeper than 1:2.
c) Topsoil materials shall not be contaminated with any other granular materials, rubble or building material or be subjected to compaction or contamination by the *Contractor*'s vehicles and machinery.
d) The *Contractor* shall be liable for the replacement of any topsoil rendered unsuitable for use during rehabilitation.
e) All stockpiles shall be protected from erosion due to wind or rain.
f) All exposed stockpile surfaces shall be fully covered with hessian or similar approved matting.
g) The topsoil stockpiles shall be kept damp by regular watering.
h) The *Contractor* shall remove exotic/invasive species from the topsoil stockpiles.

Where topsoil can be removed without the necessity of first doing clearing and grubbing, no payment will be made for clearing and grubbing under section PSC: SITE CLEARANCE.

The re-instalment of the conserved topsoil shall be undertaken as described under section PSS: SOIL AND VEGETATION REHABILITATION."

Add the following new sub-clause:

"PSD-5.2.1.4: Survey of Site

Immediately upon completion of the search and rescue, Site clearance and topsoil stripping operations, and prior to commencement of any further bulk earthworks, the *Contractor* shall carry out a detailed topographical survey of the whole Site footprint.

The survey shall include spot shots (X-Y-Z) at a grid of no more than 10m, as well as any break lines, where sudden changes in the slope of the Site occur. The survey shall be submitted to the *Employer* in an electronic format that is compatible with digital terrain model software (Modelmaker, AutoCAD Civil 3D or similar). This survey, in conjunction with the lines and levels of the earthworks as shown on the drawings, or as instructed by the *Employer*, shall form the basis for the measurement and payment for the bulk earthworks, including hard rock excavations and overhaul for such materials.

Should any hard rock be encountered during the bulk earthworks, the full extent of such areas shall be exposed and a further survey, to determine the surface level of the hard rock formations, shall be undertaken prior to drilling and blasting. This survey, in conjunction with the lines and levels of the earthworks as shown on the drawings, or as instructed by the *Employer*, shall be used for the measurement and payment of hard rock excavations, including overhaul of such materials.

The surveys shall be undertaken by a SAGC registered surveyor, to be appointed by the *Contractor* and to be approved by the *Employer*.

The surveys shall be submitted to the *Employer* within two weeks of the completion of the field surveys. Payment for the above surveys will be made under the scheduled pay item."

PSD-5.2.2: Excavation

PSD-5.2.2.1: Excavations for General Earthworks and for Structures

Add the following:

"f) All bulk earthworks embankments shall not be steeper than 1:2, unless otherwise specified by the *Employer* or otherwise indicated on the drawings.
g) The *Contractor* shall ensure that all excavations are done according to the relevant safety and environmental requirements.
h) All oversized, excavated materials that cannot be broken down on Site and all hard rock excavations shall be spoiled at the designated stockpile area as indicated in Part C.4 : Site Information."

PSD-5.2.2.3: Disposal

Add the following:

"All waste products generated through the demolition of existing structures or through excavation and compaction activities shall be removed and shall be disposed of at the relevant spoil sites, as described under PSC-3.1.

Waste material that is temporarily stockpiled on Site shall be removed within a period of no more than 60 days of excavation and/or demolition, and prior to completion of the *works*. Separate payment for disposing of waste materials will not be made and all costs are deemed to be covered by the tendered rates."

Add the following new sub-clause:

"PSD-5.2.2.4: Excavations for Lateral Support Walls

The *Contractor* shall inform the *Employer*'s design engineer of his intent to commence with the excavation work on the lateral support walls (at substation M and N) 7 days in advance.

The *Employer*'s design engineer shall witness the excavation of these lateral support walls from the start and the *Contractor* shall allow the *Employer*'s design engineer to sample and/or profile the excavation as it continues.

The *Contractor* shall under no circumstances carry out excavations for the lateral support walls unless witnessed by the *Employer*'s design engineer or instructed to continue with such excavation by the *Employer*'s design engineer."

PSD-5.2.3: Placing and Compaction

PSD-5.2.3.2: Backfilling of Trenches and Backfilling or Filling against Structures

Replace sub-clauses 5.2.3.2.a) and 5.2.3.2.b) with the following:

"No backfilling behind concrete retaining or structure walls or on top of suspended slabs shall occur prior to these concrete elements having reached the required concrete strength or before the *Employer* has provided his approval. Where applicable, backfilling shall be done simultaneously on both sides of walls to minimize the relative height difference in soil levels.

All backfilling behind retaining walls shall be compacted in layers not exceeding 150mm thickness. The compaction density shall be 95% MOD AASHTO, unless the material comprises of cohesionless sand, in which case compaction shall be to 100% MOD AASHTO."

PSD 5.2.4: Finishing

PSD 5.2.4.1: Final Grading:

Add the following:

“Finished levels for bulk earthworks shall be as follows:

a) Within areas that are to be landscaped or revegetated:

   i. 200mm below the final levels, to allow for re-spreading of topsoil and mulch.

b) Beneath substation buildings:

   i. 1.50m below the underside of the concrete floors.

c) Beneath open areas beyond the Substation N and M buildings:

   i. below the underside of the layerworks to the hardstanding areas surrounding the substation buildings.

d) Beneath open areas around the Main Intake Substation building:

   i. 1.15m below the top of imported G5 engineering fill platform.
   ii. below the underside of the layerworks to the hardstanding areas and roads surrounding the substation building”

Delete and replace clause 5.2.5 as follows:

“PSD-5.2.5: Transport for Earthworks

PSD-5.2.5.1: Freehaul

Replace the last paragraph with the following:

“The freehaul distance for all materials disposed from Site shall be 1.0km.”

Delete Clause 5.2.5.2 and replace as follows:

PSD-5.2.5.2: Overhaul

“The transportation of all excavated material beyond the freehaul distances applicable will be regarded as overhaul.

There will be no distinction made between limited overhaul and long overhaul.

Haul distances shall be measured as follows:

a) For Substation M, haul distances shall be measured from the centre of the new Substation M building.
b) For Substation N, haul distances shall be measured from the centre of the new Substation N building.
c) For the Main Intake Substation, haul distances shall be measured from the centre of the new Main Intake Substation building.
d) For the Bulk Power Reticulation, haul distances shall be measured from the centre of the new Substation N building.

Overhaul shall only be payable for conveyance of the following materials:

i. Overhaul Measured to Line and Level

   Overhaul for the following materials, to be taken to the designated stockpile area as described in Section C.4: Site Information, shall be measured to line and level, as described below:

   a) Cut to spoil of excess soft and intermediate materials.
   b) Hard rock excavations (blasting)

   The quantities to be used for the calculation of overhaul for the above items shall be based on the

in-situ or nett, compacted volumes as determined from the surveys, as described under PSD-5.2.1.4 and the final lines and levels of the excavations, as indicated on the drawings or as instructed by the *Employer*. Haul distances shall be via the shortest feasible route to the designated stockpile area.

ii. Overhaul Measured per Truckload

Overhaul for the following materials shall be measured per truckload, as described below:

a) Disposal of oversized material.
b) Disposal of excess topsoil, as described under Clause PSD-5.2.1.2.
c) Fill materials imported from the Tippler 3 construction area or designated stockpile area, as described in Clause PSD-3.3. Payment for the importation and overhaul of such materials shall only be made if a written instruction to this effect has been issued by the *Employer.*
d) Removal of excess or unsuitable clean, granular trench excavations, where so instructed by the *Employer.*

The volume of materials for which overhaul is payable by truckload shall be based on the loose volume in the truck, adjusted as follows for bulking:

a) Nett volume for calculation of overhaul = 0.75 x loose volume in truck

For materials where overhaul is measured loose, per truckload, the following shall apply:

a) The type and nett, full volumes per truck shall be submitted to the *Employer* for record purposes, prior to the commencement of overhaul.
b) Part payments shall be made in cases where trucks are not fully laden.
c) Tallies for overhaul shall be handed to the *Employer* on a daily basis, to include the following:

- Type of materials conveyed.
- Registration number and name of truck driver.
- Make of truck.
- Nett, full or part volume transported.

Payment for overhaul of loose materials will not be made if complete records have not been received or approved by the *Employer*.

Haul distances shall be via the shortest feasible route to the designated stockpile area. Table 9 below provides a further summary of payments for overhaul.

Table 9: Overhaul

Earthworks Item	Area of Application	Pay Items	Basis
Cut to Fill	Bulk earthworks to create platforms	Not payable	n/a
Temporary stockpiling on Site as part of the *works*	During earthworks for the creation of platforms	Not payable	n/a
Borrow to Fill	Import materials from Tippler 3 or designated stockpile area	PSD-8.3.6	Loose, per truckload
Cut to Spoil	Rock excavations	PSD-8.3.6	Survey, design line and level
	Oversized materials that cannot be broken down by grid rollers	PSD-8.3.6	Loose, per truckload
	Excess granular material from soft and intermediate excavations	PSD-8.3.6	Survey, design line and level
	Unsuitable materials from trench excavations	PSD-8.3.6	Loose, per truckload
Removal of Topsoil	Excess topsoil not to be used for rehabilitation of embankments, etc.	PSD-8.3.6	Loose, per truckload

Overhaul will not be payable for any materials obtained from commercial sources or waste materials disposed of at a registered waste disposal site, other than the designated stockpile area, as described under Clause PSC-3.1 above, including, but not limited to, the following:

a) Disposal of building rubble resulting from the demolition of existing buildings, structures and the like, where applicable.
b) Disposal of road surfacing, where applicable.
c) Disposal of any other waste materials generated as a result of construction activities.

The above materials shall be disposed of at an approved, registered waste disposal site. The costs of disposing of these materials shall be included in other scheduled rates."

Add the following new sub-clauses:

"PSD-5.2.6: Keeping Excavations Dry

The *Contractor* shall be responsible for the control of all ground- and surface water entering any part of the excavated areas. This control shall be carried out by means of proper water catchment and channel systems, dewatering systems and the like, which shall be subject to the approval by the *Employer*. The *Contractor* shall ensure that all excavations are completely dry prior to the placing of concrete.

The design, installation, operation and maintenance of the approved method of dealing with water on Site shall be the responsibility of the *Contractor* and the cost of these measures shall be provided for under pay items PSA-8.3.2.2 and PSA-8.4.2.2 of PSA: GENERAL.

Reference is also made to Clause PSA-5.5: DEALING WITH WATER ON *WORKS*."

5.5.4 PSD-6: TOLERANCES

PSD-6.1: POSITION, DIMENSIONS, LEVELS, ETC.

Add the following:

"Cut and fill operations shall comply with the tolerances set out for terraces and embankments in Clause 6.1.b) of SANS 1200 D (Degree of Accuracy I) except for the final 150mm layer of fill material placed, which shall comply with the tolerances for a selected layer as set out in clause 6.3 of SANS 1200 DM (Degree of Accuracy II) and clause 6.2 of SANS 1200 M."

5.5.5 PSD-7: TESTING

Delete Clause 7.2 and replace as follows:

"PSD-7.2: TAKING AND TESTING OF SAMPLES

The minimum testing frequency for process control for the construction of the earthworks shall not be less than the frequency set out in Table 10 below.

Table 10: Test Frequencies: Bulk Earthworks

Test	Testing Frequency
Density (Relative Compaction at OMC):	
a) Beneath buildings	1 test per 100m^2 of floor area per 150mm of fill layer
b) For roads and open platform areas	1 test per 200m^3 of fill materials
Indicator Tests and Grading	1 test per 2,000m³ of fill material placed (or part thereof)
CBR	1 test per 2,000m³ of fill material placed (or part thereof)

The *Contractor* shall conduct the appropriate tests as given in TMH1 to check that the materials and workmanship comply with the applicable requirements given in this specification.

Should the average and minimum density of a test(s) carried out in accordance with Table 10 above be equal to or exceed the applicable values given in Table 11 below, the compaction shall be deemed to comply with the requirements for density.

Table 11: Compaction Densities: Bulk Earthworks

Layer	Density Specified (% of MOD AASHTO max density)	Average Density (%) of At Least 3 Positions Tested	Minimum Density for Any Single Test (%)
General backfill materials (other than cohesionless sand)	93.0	93.7	90.4
General backfill materials (cohesionless sand)	100.0	101.0	98.0

The cost for all process control tests (as set out in Table 10 above) shall be included in the rates for supplying, processing, placing, watering and compacting of the various layers."

5.5.6 PSD-8: MEASUREMENT AND PAYMENT

Delete Clause 8.2 and replace as follows:

"PSD-8.2: COMPUTATION OF QUANTITIES

The calculated volume for measurement and payment purposes for soft and intermediate materials (cut to fill, cut to spoil) and hard rock materials (cut to spoil) shall be based on the following:

a) The topographical surveys to be conducted upon removal of topsoil, as described under PSD-5.2.1.4.
b) The lines and levels of the excavations in soft/intermediate and hard rock soils, as determined from the drawings or as instructed by the *Employer.*

Overhaul quantities shall be measured as described in Clause PSD-5.2.5.2."

PSD-8.3: SCHEDULED ITEMS

PSD-8.3.1: Site Preparation

Delete payment item 8.3.1.2 and replace as follows:

"PSD-8.3.1.2: Remove topsoil to a nominal depth of 200mm and stockpile on Site ..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, water, labour, transport, etc.) for the loosening and careful removal of topsoil, loading, transporting it within the freehaul distance, unloading and stockpiling it on Site and conserving the topsoil in strict accordance with Clause PSD-5.2.1.2 of this specification, as shown on drawings or as instructed on Site by the *Employer*."

Add the following new payment item:

"PSD-8.3.1.3: Carry out topographic survey of the Site:

a) After search and rescue, Site clearance and removal of topsoil ..... Unit: m^2
b) After exposure of rock surface ..... Unit: m^2

The tendered rates shall cover all costs (plant, equipment, material, labour, transport and the like) to conduct the surveys as detailed under PSD-5.2.1.4, including compilation and handing over of all hard copy and electronic data to the *Employer*."

PSD-8.3.2: Bulk Excavation

Change payment item 8.3.2.a) as follows:

"PSD-8.3.2.a) Excavate in soft and intermediate materials and use for embankment or backfill or dispose, as ordered ..... Unit: m^3"

Delete payment item 8.3.6 and replace as follows:

"PSD-8.3.6: Overhaul ..... Unit: m^3.km

The tendered rate shall cover all costs for loading, transporting and off-loading materials for which overhaul is payable, as described under Clause PSD-5.2.5. The overhaul quantities shall be calculated as described under Clause PSD-5.2.5.2."

Add the following new payment items:

"PSD-8.3.14: Additional processing of materials by heavy, vibratory grid or padfoot rollers ..... Unit: m^3

The unit of measurement shall be the cubic meter of compacted material upon which an additional heavy, vibratory grid or padfoot rolling operation is performed, in accordance with the instructions of the *Employer.*

The tendered rate shall include all plant, labour and materials required for the additional processing of materials as described under clause PSD-3.2.2 and shall include full compensation for at least four passes of the designated rollers. An area shall be taken to have received one roller pass when a roller has passed once over such an area.

PSD-8.3.15: Removal of oversize materials ..... Unit: m^3

The unit of measurement shall be the cubic metre of oversized materials that cannot be broken down as specified and is removed. The volume shall be determined as the loose volume of oversized materials, measured in stockpiles or per loose, full truckload.

The tendered rate shall include full compensation for blading oversize materials to windrow, loading and transporting the material within the freehaul distance to temporary stockpile or onto trucks."

5.6 PSDA: EARTHWORKS (SMALL WORKS)

5.6.1 PSDA-1: SCOPE

Add the following:

"This specification covers the earthworks (excavations and backfilling) required for the foundations of the steel supporting structures at the Main Intake Substation switchyard and all excavations and compaction required for the foundations of all substation buildings. These excavations will be required after completion of the G5 selected layer, as described under Clause PSDM-3.2.5.

This specification also covers the excavation and backfilling for minor structures to be provided at the existing Eskom Iscor substation."

5.6.2 PSDA-3: MATERIALS

PSDA-3.1: CLASSIFICATION FOR EXCAVATION PURPOSES

Delete sub-clause 3.1.2 and replace as follows:

"PSDA-3.1.2: Classes of Excavation

The classification of excavated materials shall be as described under Clause PSD-3 of this technical specification."

Delete Clause 3.2 and replace as follows:

"PSDA-3.2: EMBANKMENTS AND BACKFILL

All backfilling done for the structures and buildings to be constructed at the new substations shall be done using the G5 materials obtained from the excavation of the foundations.

Backfilling for minor structures at the Eskom Iscor substation shall be done using the excavated materials.

Backfill material shall be spread in layers with a loose thickness not exceeding 150mm, thoroughly mixed, watered, processed and compacted to at least 95% Modified AASHTO Maximum Density."

5.6.3 PSDA-5: CONSTRUCTION

PSDA-5.1: PRECAUTIONS

PSDA-5.1.1: Safety

PSD-5.1.1.2: Safeguarding of Excavations

Add the following sub-paragraphs:

"g) The *Contractor* shall not require or allow any person to work under unsupported overhanging material or in an excavation which is more than 1.5m deep, unless the excavation has been adequately supported, shored or braced and there is no danger of the overhanging material or the sides of the excavation collapsing. The support, shoring or bracing (that shall be designed and constructed by the *Contractor*) shall be strong and sturdy enough to support the sides of the excavation in question. The cost for the design, construction and maintenance of such support, shoring and/or bracing shall be allowed for in the *Contractor's* tendered excavation rates."

PSDA-5.2: METHODS AND PROCEDURES

PSDA-5.2.2: Excavation

Add the following:

"PSDA-5.2.2.h): The *Contractor* shall be responsible for the control of all ground- and surface water entering any part of the excavated areas. This control shall be carried out by means of

proper water catchment and channel systems, dewatering systems and the like, which shall be subject to the approval by the *Employer*. The *Contractor* shall ensure that all excavations are completely dry prior to the placing of concrete.

The design, installation, operation and maintenance of the approved method of dealing with water on Site shall be the responsibility of the *Contractor* and the cost of these measures shall be provided for under pay items PSA-8.3.2.2 and PSA-8.4.2.2 of PSA: GENERAL.

Reference is also made to Clause PSA-5.5: DEALING WITH WATER ON *WORKS*."

PSDA-5.2.5: Finishing

PSDA-5.2.5.1: Final Grading

Add the following to Clause 5.2.5.1:

"Once the excavated design level for a concrete foundation is reached the *Contractor* shall scarify, water and compact the top 150mm of the in-situ material to 95% Mod AASHTO."

5.6.4 PSDA-6: TOLERANCES

PSDA-6.2: PERMISSIBLE DEVIATIONS

Under clause PSDA-6.2.b), change the permissible deviations (PD) under the Degree of Accuracy column III to the following:

1) For "Position on Plan" : ..... change the PD to ± 25 mm
2) For "Dimensions on Plan" : ..... change the PD to ± 25 mm
3) For "Foundation Level" : ..... change the PD to ± 25 mm
4) For "Level" : ..... change the PD to ± 15 mm

5.6.5 PSDA-7: TESTING

PSDA-7.2: TAKING AND TESTING OF SAMPLES

Add the following:

"The minimum testing frequency for process control for the compaction of the base and backfilling of foundations shall not be less than the frequency set out in Table 12 below.

Table 12: Test Frequencies: Foundations

Test	Testing Frequency
Density (Relative Compaction at OMC):	
Base of foundations for steel structures at Main Intake Substation and Iscor Substation	1 test per foundation base
Base of foundations for buildings	1 test per 20m length of foundation
Backfilling of foundations for steel structures at Main Intake Substation and Iscor Substation	1 test per foundation base

The *Contractor* shall conduct the appropriate tests as given in TMH1 to check that the materials and workmanship comply with the applicable requirements given in this specification. Should the average and minimum density of a test(s) carried out in accordance with Table 12 above be equal to or exceed the applicable values given in Table 13 overleaf, the compaction shall be deemed to comply with the requirements for density.

Table 13: Compaction Densities: Foundations

Layer	Density Specified (% of MOD AASHTO max density)	Average Density (%) of At Least 3 Positions Tested	Minimum Density for Any Single Test (%)
General backfill/in-situ materials (other than cohesionless sand)	95.0	95.7	92.4
General backfill/in-situ materials (cohesionless sand)	100.0	101.0	98.0

The cost for all process control tests (as set out in Table 13 above) shall be included in the rates for supplying, processing, placing, watering and compacting of the various layers."

5.6.6 PSDA-8: MEASUREMENT AND PAYMENT

PSDA-8.3: SCHEDULED ITEMS

PSDA-8.3.1: Excavation

Replace payment item 8.3.1.b) with the following:

"PSDA-8.3.1.b): Excavate in all soft and intermediate materials, use for backfill or dispose of excess material ..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for the excavation, basic selection, loading, transportation within freehaul distance, offloading, spreading, backfilling, watering and compacting (in-situ and backfill), final grading, complying with the requirements for tolerances and providing for testing, in accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*."

5.7 PSDB: EARTHWORKS (PIPE TRENCHES)

5.7.1 PSDB-1: SCOPE

Replace this clause with the following:

"This specification covers all earthworks (excavations, preparation of trench bottom, backfilling, and the like) for the following types of trenches:

a) Trenches for all types and sizes of pipes.
b) Trenches for all types and sizes of cables.
c) Trenches for all types and sizes of ducts/sleeves.
d) Trenches for V-drains.
e) Trenches for channels.
f) Trenches for earthing mat cables."

5.7.2 PSDB-3: MATERIALS

Delete Clause 3.1 and replace as follows:

"PSDB-3.1: CLASSES OF EXCAVATION

The classification of excavated materials shall be as described under Clause PSD-3."

PSDB-3.5: BACKFILL MATERIAL

Replace Clause 3.5.b) with the following:

"PSDB-3.5.b): All pipe trenches underneath roadways, parking areas and all hard standing areas subject to road traffic or building loads shall be backfilled with sand up to the underside of the layerworks in layers of not more than 150mm thick and compacted to 100% modified AASHTO maximum density. Sand is defined as non-plastic material and shall comply with the following sieve analysis:

% passing:	4.740mm sieve	- 95% minimum
	0.425mm sieve	- 50% minimum
	0.075mm sieve	- 10% maximum"

Add the following new clause:

"PSDB-3.5.c): Backfilling of Pipe Trenches Under Non-trafficable and Landscaped areas

If the material excavated from the trench is unsuitable for backfilling, suitable free-draining granular material, obtained from the stockpiled soft excavated material at the Tippler 3 construction area or designated stockpile area, shall be used for the backfilling of all trenches under non-trafficable areas and landscaped areas. Importation of such backfill material shall only be undertaken where so instructed by the *Employer*."

5.7.3 PSDB-5: CONSTRUCTION

PSDB-5.1: PRECAUTIONS

PSDB-5.1.1: General

Add the following:

"No excavations may be done in environmentally no-go areas. The *Contractor* shall confirm these areas prior to commencement of any excavations."

PSDB-5.1.3: Accommodation of Traffic and Access to Properties

Add the following:

"Excavation and backfilling of trenches shall be done so that disruption to road users is minimized and

existing accesses to premises and properties are not unduly impeded. No additional payment shall be made for providing measures to mitigate such disruptions."

Add the following new sub-clauses:

"PSDB-5.1.5: Trench Excavations

The maximum length of trench that may be open or partially backfilled at any stage is 400m. The *Contractor* shall ensure that trenches are safe and are properly demarcated at all times, including night times, and do not pose a safety hazard to members of the public.

The *Contractor* shall take all steps necessary to ensure that no person is required or allowed to work in a trench or any other unsupported overhanging excavation which is more than 1.5m deep unless the excavation has been adequately supported, shored or braced and there is no danger of the overhanging material or the sides of the excavation collapsing. The support, shoring or bracing (that shall be designed and constructed by the *Contractor*) shall be strong and sturdy enough to support the sides of the excavation in question. The cost for the design, construction and maintenance of such support, shoring and/or bracing shall be allowed for in the *Contractor's* tendered excavation rates.

PSDB-5.1.6: Dealing with Water on Site

The *Contractor* shall be responsible for the control of all ground- and surface water entering any part of the excavated areas. This control shall be carried out by means of proper water catchment and channel systems, dewatering systems and the like, which shall be subject to the approval by the *Employer*. The *Contractor* shall ensure that all excavations are completely dry prior to the placing of services.

The design, installation, operation and maintenance of the approved method of dealing with water on Site shall be the responsibility of the *Contractor* and the cost of these measures shall be provided for under pay items PSA-8.3.2.2 and PSA-8.4.2.2 of PSA: GENERAL.

Reference is also made to Clause PSA-5.5: DEALING WITH WATER ON *WORKS*."

PSDB-5.2: MINIMUM BASE WIDTHS

Add the following:

"All excavations exceeding the widths as specified, or as shown on the drawings, shall be backfilled with approved selected material. No payment shall be made for excavations and backfilling exceeding the specified widths."

PSDB-5.4: EXCAVATION

Add the following:

"The *Contractor* shall ensure that usable, excavated materials from trenches are not contaminated with unsuitable material. If usable material is contaminated, such material shall be removed and replaced with suitable material at the *Contractor*'s expense.

All unsuitable material shall be removed from Site prior to importing fill material to such areas. Importation of such backfill material shall only be undertaken where so instructed by the *Employer*."

PSDB-5.5: TRENCH BOTTOM

Substitute "90%" in the second paragraph with "93% (100% for sand)".

Add the following:

"Should the *Contractor,* having undertaken all measures as specified for the dewatering of the *works*, still find that the conditions in a trench, open channel or open V-drain remains unstable due to the nature of the soil and the degree of saturation, the *Contractor* shall advise the *Employer,* who may instruct the *Contractor* to place a layer of 13mm crushed stone at the base of the trench in order to produce a more stable trench bottom."

PSDB-5.6: BACKFILLING

PSDB-5.6.3: Disposal of Soft Excavation Material

Replace this sub-clause with the following:

"All surplus and unsuitable material from trench excavations shall be disposed of at the designated stockpile area as described in Section C.4: Site Information and levelled off."

PSDB-5.7: COMPACTION

PSDB-5.7.2: Areas Subjected to Traffic Loads

Delete this clause, to be superseded by clause PSDB-3.5.b).

Add the following new clauses:

"PSDB-5.11: EXCAVATION OF ELECTRICAL AND ELECTRONIC/COMMUNICATION CABLE TRENCHES

All trenches for cables shall be excavated to the depth as indicated on electrical layout and detail drawings and as per the associated specifications. Excavation depths shall be determined with reference to fixed levels, such as kerbs, or alternatively final finished ground level. Cable trenches shall generally be excavated along straight lines and the bottom of the trench shall be level and free from obstacles that could cause damage to the cables.

No electronic cables or other services shall be permitted to be installed in the electrical cable trenches.

Where a single cable is installed in a trench, the cable shall be installed in the centre of the trench. Where more than one cable is installed in a trench, neither cable shall be installed directly against the walls of the trench and shall be offset from the trench wall by at least 50mm.

The *Contractor* shall obtain confirmation of the cable routes from the *Employer* before commencing with any excavations. The *Contractor* shall ensure that excavations do not endanger any persons, structures, roads, services, property or the like.

The *Contractor* shall take all necessary precautions and provide the required warning signs, barricading, fencing and the like. Trenches across roads, pathways and entrances shall be backfilled as soon as practically possible.

Excavated material shall not be sifted and re-used for bedding and padding material, but only for general backfilling purposes, unless otherwise approved by the *Employer*.

The *Contractor* shall obtain the *Employer*'s approval of cable trenches after excavation and prior to the installation of any bedding and padding material and cables.

PSDB-5.12: BACKFILLING OF CABLE TRENCHES

Excavated material may only be used for backfilling purposes and not as bedding and padding material. Material imported for backfilling purposes shall consist of clean soil, imported from commercial sources (if required).

Backfill material shall be sifted where necessary to remove oversized materials (larger than 12mm). Prior to backfilling the *Contractor* shall confirm with the *Employer* whether the excavated materials are suitable for backfilling or whether such backfilling materials need to be imported.

Backfilling above cables shall be done in layers with thickness before compaction of not more than 150mm.

The backfilling shall be compacted by means of a mechanical compactor to the same density as that of undisturbed surrounding ground or to 93% of MOD AASHTO density for materials other than cohesionless sand (100% of MOD AASHTO density for cohesionless sand materials), whichever is the greater.

After backfilling of trenches, the *Contractor* shall arrange for compaction tests in positions as indicated on Site by the *Employer*. DCP testing shall be used to confirm the compaction. The *Employer* may also request, at his sole discretion, that an independent soil laboratory be engaged to perform additional

compaction tests. The costs of these tests will be for the expense of the *Contractor* if it is found that the levels of compaction do not comply with the specifications.

Upon completion of backfilling, the final surfaces shall be shaped to match the surrounding area. Any surplus material shall be suitably disposed of at the designated stockpile area as described in Section C.4: Site Information and levelled off.

PSDB-5.13: TRANSPORT FOR EARTHWORKS

Freehaul and overhaul under this section of the specification shall be read with and treated in accordance with clause PSD-5.2.5 of section PSD of the specification.

Payment for overhaul shall not be made under this section of the specification and shall be deemed to be included under payment item PSD-8.3.6 of section PSD of the specification."

5.7.4 PSDB-7: TESTING

Replace this clause with the following:

"PSDB-7.1: PROCESS CONTROL

The minimum testing frequency for process control by the *Contractor* shall not be less than the frequencies set out in Table 14 below.

Table 14: Test Frequencies for Trench Excavation & Backfilling

Test	Position in Layer	Testing Frequency
Density (Relative Compaction at OMC)	Trench bottom: road crossings	Two tests for each road crossing
	Trench bottom: open areas	One test per 50m of trench
	Backfilling: road crossing	Two tests per 150mm layer per road crossing
	Backfilling: open areas	One test per 50m of trench per 150mm layer

The *Contractor* shall conduct the appropriate tests as given in TMH1 to check that the materials and workmanship comply with the applicable requirements given in this specification. Should the average and minimum density of a test(s) carried out in accordance with Table 14 above be equal to or exceed the applicable values given in Table 15 below, the compaction shall be deemed to comply with the requirements for density.

Table 15: Compaction Requirements for Trench Excavation & Backfilling

Layer	Density Specified (% of MOD AASHTO max density)	Average Density (%) of At Least 3 Positions Tested	Minimum Density for Any Single Test (%)
Backfill materials other than Cohesionless Sand	93.0	93.7	90.4
Backfill materials Cohesionless Sand	100.0	101.0	98.0

The cost for all process control tests (as set out in Table 15 above) shall be included in the rates for supplying, processing, placing, water and compacting of the various layers."

5.7.5 PSDB-8: MEASUREMENT AND PAYMENT

PSDB-8.1: BASIC PRINCIPLES

Replace sub-clause 8.1.1 with the following:

"PSDB-8.1.1: The basic principle of measurement and payment of earthworks for all trenches (as described in PSDB-1 above) is that the rates tendered for excavation shall cover the cost of excavation and the re-use of the excavated material for backfilling and the disposal of

any surplus material at the designated stockpile area as described in Section C.4: Site Information within the freehaul distance."

Replace sub-clause 8.1.4 with the following:

"PSDB-8.1.4: Excavation volumes shall be calculated in accordance with clause 8.2.3 of SANS 1200 DB. Reference is made to clause PSDB-5.13 above in terms of the requirements for the freehaul and overhaul transportation of surplus excavated materials."

Add the following new sub-clause:

"PSDB-8.1.5: Site clearance for pipe and cable trenches shall not be measured separately under this section. All such *works* shall be measured under Section PSC: SITE CLEARANCE."

PSDB-8.3: SCHEDULED ITEMS

Replace payment item 8.3.2 with the following:

"PSDB-8.3.2: Excavation and backfilling of all trenches

PSDB-8.3.2.a): Excavate in all soft and intermediate materials for all trenches, backfill, compact and dispose of surplus material .....Unit: m or m^3

In cases where a service is aligned within the face of a sloped embankment, the depth of the excavation will be measured along the centre of the trench.

Where payment is made per m^3, the quantity of excavated materials shall be measured to the line and levels indicated on the drawings or as instructed in writing by the *Employer*. Additional excavations, as required for instance in loose sand, will not be payable.

There will be no extra-over payment in terms of boulder excavation, but only for hard rock excavation.

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the excavation, backfilling, spreading, watering, compacting, complying with the requirements for tolerances, providing for testing, and transportation of spoil material within the freehaul distance, all in accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSDB-8.3.2.b): Extra-over item a) above for:

1) Hard rock excavation……...Unit: m^3

Volumes will be computed from the trench width determined in accordance with clause 8.2.3 of SANS 1200 DB (or as indicated on drawings) and the depth from the top of the hard rock excavation either to the bottom of the same material or to the bottom of the trench as specified in a) above, whichever is the lesser.

The rate tendered under this item shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for the additional cost of the excavation and handling of the hard rock excavation and transporting it within the freehaul distance for disposal at the designated stockpile area as indicated in Part C.4: Site Information."

PSDB-8.3.3: Excavation Ancillaries

Replace payment item 8.3.3.4 with the following:

"PSDB-8.3.3.4: Overhaul ..... Unit: m^3.km

Overhaul shall be paid under payment item PSD-8.3.6 of section PSD of this specification."

Change the heading of payment item 8.3.5 to read as follows:

"PSDB-8.3.5: Existing Services that Intersect or Adjoin a Trench"

PSDB-8.3.5.a): Services that intersect a trench .....Unit: No

Add the following:

“Payment under this item will be made only if the service is located above the bottom of the trench. If the service is located beneath the bottom of the trench, it will be classified as an intersecting service if the depth between the bottom of the trench and the top of the service is less than 300mm.

The rate shall also allow for the following costs:

i. Clear photographic evidence of the existing service shall be provided to the *Employer,* to be recorded prior to installation of pipes and backfilling, and which shall form a basis for further assessments.
ii. If such a service is damaged, it has to be repaired to its original condition or to a standard agreed to in writing with the relevant owner. This agreement has to be approved by the *Employer*.
iii. If such a service is removed, it has to be replaced as per original.”

PSDB-8.3.5.b): Services that adjoin a trench ..... Unit: m

Add the following:

“An existing service will be classified as adjoining a trench if the horizontal distance between the nearest edge of the trench is within 1.0m of the existing service.

For measurement and payment purposes, existing fences and conveyors shall be treated as “services”.

No payment will be made for overhead services, apart from masts and supports in close proximity to the *works*. Poles, walls and structures are classified as adjoining services if they are within 1.0m of the nearest edge of the pipe trench.”

5.8 PSDM: EARTHWORKS (ROADS, SUBGRADE)

5.8.1 PSDM-1: SCOPE

Replace this clause with the following:

"This specification covers the following:

a) Roadbed preparation for roads and parking areas.
b) In-situ surface preparation for building, walkway and yard platforms and landscape/open areas prior to placement of fill materials.
c) Importation and placing of selected subgrade layers.
d) Importation and placing of G5 subbase engineered platforms for all substation buildings and for the Main Intake Substation yard area."

5.8.2 PSDM-3: MATERIALS

Add the following new sub-clause:

"PSDM-3.2.5: Engineered Fill for Building and Electrical Yard Platforms

All three substation buildings shall be constructed above a top layer of engineered fill with a minimum thickness of 1.50m. The Main Intake Substation yard, excluding the footprint of the substation building, shall be constructed above a top layer of engineered fill of minimum thickness 1.15m.

The top layer of the engineered fills shall consist of imported G5 subbase material, complying with the following minimum requirements:

a) The material shall meet all quality requirements for G5 materials or better in accordance with SANS 1200 M and SANS 1200 ME.
b) The soil resistivity shall be between 10Ω·m and 100Ω·m, unless otherwise approved by the *Employer*.
c) The materials shall be non- to mildly corrosive.

The *Contractor* shall carry out sufficient soil resistivity tests on the virgin (undisturbed) subbase material at the commercial source (quarry) prior to the loading and transporting of the material to Site.

A specialist subcontractor, to be appointed by the *Contractor* and approved by the *Employer*, shall perform soil resistivity tests at the source (quarry) prior to delivery of such materials to Site. The soil resistivity tests shall be done in strict accordance with SANS 725 (IEEE 80), SANS 10199, Eskom requirements and all other relevant standards and specifications, as applicable, unless otherwise instructed by the *Employer*. The Wenner four pin method shall be used to obtain the results. Final soil resistivity values shall be between 10 Ω·m and 100 Ω·m as stated above.

One soil resistivity test shall be performed per lot. A lot is defined as an exposed area at the source/quarry, within the materials and formations that are proposed for use in the top layer of the engineered fills. The size of the exposed area shall be no less than 150m x 150m. The test shall be carried out under dry soil conditions (i.e. soil moisture content shall be less than optimum moisture content).

The *Contractor* shall submit the test result(s) in accordance with the format specified or required by Eskom, unless otherwise instructed by the *Employer*.

If the soil resistivity test(s) fail, the source may be rejected by the *Employer* and an alternate source will have to be identified by the *Contractor.* Materials may only be imported to Site once the source has been approved by the *Employer*, as per the above requirements.

The top layer of the engineering fill shall be placed in layers not exceeding 150mm and shall be compacted to 95% MOD AASHTO. Upon the completion of top layer of engineered fill, and prior to commencement of the building foundations, the specialist subcontractor shall repeat the soil resistivity test as described above on the completed *works* on Site. The *Contractor* shall compile and submit a final, comprehensive report to the *Employer* on the test results, in accordance with Specification No. 1924701-2-300-E-SP-0008: Low Voltage Installations, unless otherwise instructed by the *Employer*.

If the final soil resistivity is found to be inadequate, the *Employer* may instruct the *Contractor* to undertake further electrode enhancement in the form of conductive concrete applications, which will include drilling of 400mm diameter auger holes (refer to clause PSDM-5.2.9 below) at predetermined depths and positions. Separate payments will be made for such measures, if these are required. Payment for auguring will be covered by these specifications.

The tendered rates for the G5 (subbase) top layer of engineered fill, as described above, shall further include all other costs for the sourcing, testing, loading, transporting, off-loading, placing, processing, watering, compaction and testing of the layer.

Upon completion of the G5 (subbase) top layer of engineered fill, as described above, the *Contractor* shall commence with the excavations for the installation of the earthing mat and associated infrastructure, as shown on the drawings or as instructed by the *Employer*.

The earthing mat trenches shall be backfilled once the earthing mat has been successfully installed and signed off by the *Employer.* Trench backfilling shall be in layers of no more than 150mm, compacted to at least 95% of MOD AASHTO. Payment for the excavation and backfilling for the earthing mats are covered by these specifications."

5.8.3 PSDM-5: CONSTRUCTION

PSDM-5.2: METHODS AND PROCEDURES

PSDM-5.2.4: Fill

PSDM-5.2.4.1: Preparation

PSDM-5.2.4.1.b): Benching

Add the following:

"All new road layerworks/courses adjoining existing roads and/or platforms shall be tied in together by means of proper benching techniques. The depth of benching shall equal the respective layer thicknesses and the width shall be at least 150mm."

PSDM-5.2.4.2: Placing and Compaction

PSDM-5.2.4.2.f): Compaction

Amend sub-paragraph 1) to read as follows:

"1) for material other than sand and rock fill……...as indicated in Table 17 overleaf."

Add the following new sub-clause:

"PSDM-5.2.9: Augered Holes for Conductive Concrete Applications

Where indicated on drawings or when instructed by the *Employer*, the *Contractor* shall auger or bore holes of size 400mm Ø and depths varying between 3.0m to 10.0m for the purpose of additional conductive concrete applications."

5.8.4 PSDM-6: TOLERANCES

Add the following:

"The dimensions and levels of the completed in-situ treated road-bed and selected subgrade layers shall conform to the requirements for selected layers as specified in Clause 6.3 (Degree of Accuracy II)."

5.8.5 PSDM-7: TESTING

Replace clause 7.2 and clause 7.3 with the following:

"PSDM-7.2: PROCESS CONTROL

The minimum testing frequency for process control by the *Contractor* shall not be less than the applicable frequency set out in Table 16 overleaf.

Table 16: Test Frequencies: Surface Preparation and Selected Layers

Test	Position in Layer	Minimum Testing Frequency
Density (Relative Compaction at OMC)	Roadbed preparation for roads and parking areas	1 test per 100m² of surface preparation
	In-situ surface preparation for platforms and other open areas	1 test per 200m² of surface preparation
	G5 subbase platform below the following footprints: • all substation buildings • hardstands surrounding the substation buildings • internal roads at Main Intake substation	1 test per 100m^2 of floor area per 150mm of G5 layer
	G5 subbase platform at Main Intake substation switchyard (outside of the building, hardstands and internal roads footprint)	1 test per 150m^3 of G5 materials placed
	Selected subgrade for Main Intake substation external roads and below the hardstand areas of substation M and substation N	1 test per 100m² of each selected subgrade layer
Grading and Indicator Tests & CBR	G5 subbase platform below the following footprints: • all substation buildings • hardstands surrounding the substation buildings • internal roads at the Main Intake substation • switchyard at the Main Intake substation	- 2 complete set of tests for G5 subbase material at each of substation M and substation N - 10 complete set of tests for G5 subbase layer at Main Intake Substation Note: Tests to be repeated if source of selected materials is changed
	Selected subgrade for Main Intake substation external roads and below the hardstand areas of substation M and substation N	- 2 complete set of tests for subgrade material at each of substation M and substation N - 5 complete set of tests for subgrade material at the Main Intake substation external roads
Soil Resistivity (for engineered fill)	G5 subbase material at source	1 test per lot (lot size = 150m x 150m)

The *Contractor* shall conduct the appropriate tests as given in TMH1 to check that the materials and workmanship comply with the applicable requirements given in this specification, SANS 1200 DM: Clause 3.2 and SANS 1200 ME: Clause 3.2. Should the average and minimum density of a test(s) carried out in accordance with Table 16 above be equal to or exceed the applicable values given in Table 17 below, the compaction shall be deemed to comply with the requirements for density.

Table 17: Compaction Requirements: Surface Preparation and Selected Layers

Layer	Density Specified (% of MOD AASHTO max density)	Average Density (%) of At Least 3 Positions Tested	Minimum Density for Any Single Test (%)
Roadbed preparation for roads and hardstands			
i. For materials other than cohesionless sand	93.0	93.7	90.4
ii. For cohesionless sand	100.0	101.0	98.0
iii. For G5 subbase	95.0	95.7	93.4

Layer	Density Specified (% of MOD AASHTO max density)	Average Density (%) of At Least 3 Positions Tested	Minimum Density for Any Single Test (%)
Surface preparation for platforms and other open areas			
i. For materials other than cohesionless sand	93.0	93.7	89.4
ii. For cohesionless sand	100.0	101.0	98.0
Selected subgrade for trafficked areas (roads and hardstands)	95.0	95.7	93.4
G5 layer below substation buildings and yard area at Main Intake Substation	95.0	95.7	93.4
Other selected subgrade layers for non-trafficked areas	93.0	93.7	90.4

The cost for all process control tests (as set out in Table 17 above) shall be included in the rates for supplying, processing, placing, water and compacting of the various layers."

5.8.6 PSDM-8: MEASUREMENT AND PAYMENT

PSDM-8.3: SCHEDULED ITEMS

PSDM-8.3.3: Treatment of Road-bed

Add the following new payment item:

"PSDM-8.3.3.c): Surface preparation and compaction of in-situ materials to minimum of 93% of MOD AASHTO maximum density (100% for sand) ..... Unit: m³

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for scarifying, watering, shaping and compacting the in-situ road-bed/surface material to the specified minimum compaction density, all in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*."

Add the following new payment item:

"PSDM-8.3.17: Imported 150mm gravel G7 selected layer compacted to 95% of MOD AASHTO maximum density (for road and hardstand layerworks)..... …Unit: m³

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for procuring, transporting, placing, watering, shaping, processing, compacting and testing on Site, all in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSDM-8.3.18: G5 subbase engineered fill for:

a) Substation M building platform..... Unit: m³
b) Substation N building platform ..... Unit: m³
c) Main Intake substation buildings, hardstands, internal roads and switchyard platform ..... Unit:m³

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for procuring suitable materials from commercial sources, including all testing at the source of the materials, as described under Clause PSDM-3.2.5, transportation, placing, watering, shaping, processing, compacting and testing of the materials on Site, all in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSDM-8.3.19: 400mm Ø Augured Holes for Conductive Concrete Applications, for:

a) 3.0m to 5.0m depth.....Unit: No.

b) 5.0m to 7.0m depth.....Unit: No.
c) 7.0m to 10.0m depth.....Unit: No.

The tendered rates shall cover all costs (auguring specialist, plant, equipment, material, labour, water, transport, etc.) for the coring of augured holes to the required depths as described under Clause PSDM-3.2.5), as instructed on Site by the *Employer* and in strict accordance with this specification and as shown on drawings, as well as carting away material within the freehaul distance.

The tendered rates shall further include the establishment and de-establishment of the piling plant and equipment on and from Site as well as the moving and setting up of the plant and equipment at each position of augering or boring.

PSDM-8.3.20: Imported 150mm gravel G7 selected layer compacted to 93% of MOD AASHTO maximum density (for road shoulders) ..... …Unit: m³

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for procuring, transporting, placing, watering, shaping, processing, compacting and testing on Site, all in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

5.9 PSG: CONCRETE (STRUCTURAL)

5.9.1 PSG-1: SCOPE

Add the following:

"These specifications cover the following concrete *works*:

a) Jointed concrete pavements.
b) Anchor/thrust blocks for pressurised water and foul sewer lines.
c) Reinforced foundation and cover slabs for manholes, catchpits, draw boxes, valve- and meter chambers and the like.
d) Concrete encasing of services.
e) Pre-cast reinforced concrete marker posts for cables, cable ducts and pipes.
f) Reinforced concrete stormwater grated channels.
g) Reinforced concrete required for cable trenches, transition units and cable/sleeve road crossings at the Main Intake Substation yard.
h) Reinforced concrete for wastewater drainage sumps and manholes.
i) Reinforced concrete for stormwater headwalls.
j) In-situ cast concrete as lining for V-drain stormwater channels.
k) Concrete foundations for fencing and gates."

5.9.2 PSG-2: INTERPRETATIONS

The requirements of Specification No. 1924701-2-300-B-SP-0001: Technical Specification: Tippler 3 - Structural Works shall apply to the *works* as listed under PSG-1 above, with additions and amendments as described below.

5.9.3 PSG-5: CONSTRUCTION

The following requirements, additional to or superseding the requirements included in Specification No. 1924701-2-300-B-SP-0001, shall apply to the *works* as listed in PSG-1 above.

PSG-5.1: REINFORCEMENT

PSG-5.1.3: Cover

Replace this sub-clause with the following:

"Minimum concrete cover to reinforcing shall be as follows:

Table 18: Minimum Concrete Cover

Concrete Structure	Cover (mm)
Surface beds for concrete roads/yards	40mm from top
Stormwater grated channels	50mm
Stormwater head wall	40mm
Scour valve chambers	50mm
Service sleeves draw boxes	50mm
Precast trench cover slabs	30mm to 40mm"

PSG-5.5: CONCRETE

PSG-5.5.1: Quality

PSG-5.5.1.5: Durability

Replace this sub-clause with the following:

"Table 19 overleaf indicates the maximum water/binder ratio and minimum cement content.

Table 19: Maximum Water to Binder Ratio and Minimum Binder Content

Item	Max. water to binder ratio	Min. binder content (kg/m^3)
Surface beds for concrete roads/yards	0.45	350
Stormwater grated channels	0.45	350
Stormwater head walls	0.45	350
Scour valve chambers	0.45	350
Service sleeves draw boxes	0.45	350
Precast trench cover slabs	0.45	350”

PSG-5.5.1.7: Strength Concrete

Add the following:

“Table 20 below indicates the minimum required cube strengths.

Table 20: Minimum Cube Strengths

Item	Cube strength (28 day, MPa) (Min)	Aggregate Size & Type
Surface beds for concrete roads/yards	40	19mm Granite or 19mm Greywacke
Stormwater channels	30	19mm Granite or 19mm Greywacke
Stormwater head wall	30	19mm Granite or 19mm Greywacke”
Scour valve chambers	30	19mm Granite or 19mm Greywacke
Service sleeves draw boxes	30	19mm Granite or 19mm Greywacke
Precast trench cover slabs	30	19mm Granite or 19mm Greywacke”

Add the following new clauses:

“PSG-5.6: JOINTS FOR CONCRETE ROADS/YARDS

Reference is made to the following drawings for jointing details for concrete pavements:

a) Drawing No. 1924701-2-510-C-LA-0047-01.
b) Drawing No. 1924701-2-510-C-LA-0052-02.
c) Drawing No. 1924701-2-510-C-LA-0056-04.

The above drawings provide details of the following joint types (of which their positions are indicated on the various layouts):

a) Construction joints (all longitudinal joints).
b) Saw cut joints (all transverse joints).
c) Isolation joints (between slabs and other structures).
d) Open ended joints.

PSG-5.7: JOINTS FOR CONCRETE LINED V-CHANNELS

Expansion joints for in-situ cast V-drain channels lining shall be made at 2.0m intervals.”

5.9.4 PSG-8: MEASUREMENT AND PAYMENT

Add the following new payment items:

"PSG-8.9: Concrete Surface Bed for Roads/Yards

a) As per Drawing Number 1924701-2-510-C-LA-0047-01 ..... Unit: m²
b) As per Drawing Number 1924701-2-510-C-LA-0052-02 ..... Unit: m²
c) As per Drawing Number 1924701-2-510-C-LA-0056-04 ..... Unit: m²
d) For reinstatement of road crossings ..... Unit: m²

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for the casting of 250mm thick 40MPa (19mm stone) dowel jointed concrete slabs with flexural strength of 3.8MPa, as directed on Site by the *Employer*, including (but not limited to) the following:

- all surface preparation
- designing, ordering and installation of formwork
- ordering and placement of reinforcing
- ordering and casting of concrete
- vibrating the concrete
- finishing (wood float with broom finish)
- jointing (where required and indicated)
- curing
- testing of concrete strength
- removal of formwork
- making neat

all in accordance with this specification, specification document no. 1924701-2-300-B-SP-0001 and the drawings."

5.10 PSL: MEDIUM PRESSURE PIPELINES

5.10.1 PSL-1: SCOPE

Replace this clause with the following:

"This specification covers the supply and installation of the following domestic and fire water infrastructure:

a) New external underground domestic, fire and HVAC water supply pipelines, including the new relocated section of the water main line at Substation N.
b) New internal domestic water pipework.
c) New internal HVAC water feed installed to a vertical level 2.0 m above final ground floor concrete level at each new substation building.
d) New external fire hydrants.
e) New pipe marker posts.
f) New external scour and isolation valves complete with valve chambers (domestic and fire).
g) New connections to existing water supply lines, including the new connections for the relocated section of the water main line at Substation N.
h) New internal combination pressure reducing and isolation valve set at each new substation building.
i) New internal isolation valves for the Eskom Ystervark building at the Main Intake Substation."

5.10.2 PSL-3: MATERIALS

PSL-3.1: GENERAL

Add the following:

"The *Contractor* shall provide adequate storage facilities for pipes, couplings and specials to conform to the following:

a) Couplings and Specials

Until required for use, the rubber rings shall be stored in a cool, dark place, away from grease, oil or harmful chemicals. If rubber rings have been tied together, they shall be separated a few days before they are required for use, in order to eliminate any impressions due to packaging.

Couplings, into which rubber rings have already been fitted, shall be stored under cover. All couplings and specials shall be stacked off the ground to ensure that the protective coatings are not damaged.

b) Stacking and Transportation of Pipes

The transportation and stacking of pipes shall be strictly in accordance with the manufacturer's requirements."

PSL-3.4: STEEL PIPES, FITTINGS AND SPECIALS

Add the following:

"All steel pipes, pipe specials, bends, reducers, T-pieces, couplings and other steel fittings shall be mild steel. Steel pipes of nominal bore up to and including 150mm shall comply with the applicable requirements of SANS 62: Medium Duty. Steel pipes of nominal bore above 150mm shall comply with SANS 719 Grade B.

All steel pipes shall be hot-dipped galvanised. Prior to galvanising, all pipes shall be thoroughly cleaned by means of grit- blasting to SA 2½ finish, in compliance with the requirement of SIS 05 59 00.

Pipes shall have a temperature range of 5^{o}C minimum to 35^{o}C maximum.

Pipes shall be butt-welded longitudinally.

Circumferential welds shall be by submerged arc welding process. Spirally-welded pipes will also be accepted. The welding processes and materials used for the fabrication of the pipes shall conform to

SANS 10044-1. The inside and outside of every weld of the steel specials shall be subjected to a dye-penetrant test, as specified in Clause 7.2.1 of SANS 1200 L and BS 4416.

10% of all welds for above ground steel pipes and pipe specials shall be subjected to radiographic testing. For steel pipes and pipe specials below ground, 100% of the welds shall be subjected to radiographic testing. All structural fillet welds shall be tested by means of magnetic particle testing (MPT).

The cost for all above-mentioned testing (dye-penetrant and radiographic) shall be included in the *Contractor*'s tendered rates.

The *Contractor* shall provide all quality assurance documentation, including quality control plans (QCP's), certificates to ASME 9, to include welding procedure specification (WPS), welder qualification documentation, welding inspection/testing certificates, material certificates, certificates for consumables and the like for all pipes, pipe specials and flanges, for the *Employer*'s approval. Payment for the quality assurance documentation shall be included in the scheduled rates for the pipes and specials.

All pipe specials to be installed within water retaining concrete structures (e.g. pump stations, water tanks) shall be cast in place. The pipe specials shall not be installed in a box-out left during the construction of the concrete structure."

Add the following new sub-clause:

"PSL-3.4.5: Quality Control of Manufactured Steel Items

Only welders who are qualified (certified) and coded shall be allowed to do welding of manufactured items. Examples of manufactured items include amongst others pipework items with flanges, pipe specials, pipe supports, structural steelwork and walkway structures. The manufacturer shall be in the possession of welding procedure specifications (WPS) and procedure quality records (PQR).

Prior to manufacturing, a quality control plan (QCP) shall be developed for each manufactured item, indicating the manufacturing process and the associated quality checks to be done. QCP's are to be signed off by competent persons (e.g. inspectors). Items to be included in the QCP shall typically include approval of drawings, welder's qualifications, assembly, welding procedures, cleaning and corrosion protection.

Payment for quality assurance shall be included in the scheduled rates for the manufactured items."

PSL-3.7: OTHER TYPES OF PIPES

PSL-3.7.1: uPVC Pipes

Replace this sub-clause with the following:

"uPVC pipework shall comply with SANS 966 and shall have a minimum working pressure of 16 bar, unless noted otherwise on the drawings. All uPVC bends shall be to SANS 966 and have a minimum working pressure of 16 bar, unless noted otherwise on drawings. All uPVC pipes and bends shall be of the spigot and socket type.

All uPVC pipes and bends shall be produced by a registered member of the South African Plastic Pipe Manufacturers Association (SAPPMA). The uPVC pipe manufacturer shall be ISO 9001:2000 accredited, certified as a mark holder of SANS 966 Part 1 and in possession of a valid permit to apply the SANS certification mark.

All reducers, T-pieces, end caps, couplings and other fittings for uPVC pipes shall be ductile iron (spheroidal graphite (SG) iron) complying with the requirements of BS EN 12842 and shall have a minimum working pressure of 16 bar, unless noted otherwise on drawings.

All steel pipe specials, bends, reducers, T-pieces, couplings and other fittings shall be ductile iron.

The materials and construction of all pipes, fittings, valves and specials shall comply with the appropriate SANS specification, whether explicitly stated or not, and shall be approved by the *Employer*. Cut pipes shall only be used at pipe junctions to position valves and specials as shown on the drawings and at connections to structures. When laying the pipes the markings shall be visible from above.

PSL-3.7.2: Polyethylene Pipes

Replace this sub-clause with the following:

“Polyethylene pipes shall be HDPE PE100 and comply with SANS 4427 and be PN12.5 (SDR 17), unless otherwise specified on the drawings, and shall be produced in a factory of a registered member of the South African Plastic Pipe Manufacturers Association (SAPPMA).

All HDPE pipe connections shall be electrofusion coupling connections, unless otherwise specified on the drawings. The HDPE pipe manufacturer shall be ISO 9001:2000 accredited, certified as a mark holder of SANS 4427 and in possession of a permit to apply the SANS certification mark.

Any HDPE pipe or pipe special with a notch or scratch damage of 10% or more of the pipe wall thickness shall be rejected and replaced by the *Contractor* at his cost.”

Add the following new sub-clause:

PSL-3.7.3: Polypropylene Pipes

“Polycop pipes shall be manufactured from polypropylene (PP) material and shall be type class 1 in accordance with SANS ISO 15874 and be of a design operation pressure rating of 10 bar, unless otherwise specified on the drawings, and shall be produced in a factory of a registered member of the South African Plastic Pipe Manufacturers Association (SAPPMA).”

PSL-3.8: JOINTING MATERIALS

PSL-3.8.2: Flexible Couplings

Add the following new sub-clauses:

“PSL-3.8.2.5: Detachable couplings shall be of the "Viking-Johnson" type or approved equivalent, without central register and to SANS 1808-2, BS 534, BS 4772 and AWWA C219, unless otherwise specified. Coupling flanges shall be designed to withstand the hydrostatic test pressures and all stresses due to tightening of the bolts. Rubber gasket shall be EPDM and comply with SANS 974 and BS 2494.

The bolts and nuts shall be Grade 4.8 and comply with SANS 1143 and BS 970. The bolts, nuts and washers shall be hot dipped galvanised to SANS 121, SANS 32 and BS 729. Detachable couplings shall suit the outside dimensions of pipework, complying with BS 2035.

The torque value recommended by the suppliers of flexible couplings for M12 bolts for flexible couplings up to 324mm outside diameter is 65Nm to 80Nm. The recommended torque value for M16 bolts for flexible couplings over 324mm outside diameter is 80Nm to 120Nm.

Bolts shall be tightened in a sequential criss-cross pattern. An approved lubricant or anti-seize compound (e.g. Copaslip) shall be used on the thread of the bolt and a multi-pass tightening sequence shall be followed. The multi-pass tightening sequence shall encompass the following:

a) All bolts are initially tightened to a torque value below the finally required torque.
b) A multi-pass tightening sequence shall be followed, in increments of no more than 50Nm.
c) Bolts are tightened in a final pass around the joint, to the final torque as specified.
d) Following the final tightening pass, a checking pass shall be carried out in which all the bolts are checked to the final torque value.

As a final check, each bolt shall be 'ringed' by tapping lightly with a lead or similar hammer, to ensure that the threads are not damaged. If any bolts are loose the tone of sound will be different to a tightened bolt. Further inspections shall be undertaken in such cases to identify and address any inadequacies.

The EPDM gasket shall be lubricated prior to fitting. Failure to apply lubricant can cause difficulty in fitting and may result in gasket creep under load. This may cause bolt torques to drop, thus necessitating re-tightening.

All flexible couplings shall be lined and coated with 300 micron DFT thermoplastic polymer Rilsan Nylon 11 to the manufacturer’s specification.”

PSL-3.8.3: Flanges and Accessories

Add the following:

"All flanges shall be weld-neck flanges to SANS 1123 Table 2500/2, unless otherwise specified or shown on the drawings. All flanges shall be forged. All puddle flanges shall be to SANS 50025.

All gaskets for steel to steel flanged joints shall be spiral wound inner (stainless steel grade 316) and outer (carbon steel) ring gaskets. Care shall be taken to ensure that all gaskets are packed properly and are not damaged by bending. For larger sizes (200mm+) the gaskets shall be suitably supported by wooden frames during transit and while in storage.

Where connections are made to existing pipes, the dimensions of existing flanges and pipes shall be verified by the *Contractor* prior to ordering of materials.

Any item of pipework, specials or valve, for which the flanges are incorrectly drilled, will be rejected. The reaming of bolt-holes to oversized dimensions to enable a particular item to fit will not be allowed.

All bolts, nuts and washers used with fittings, flanges and couplings shall be of grade 316 stainless steel. The bolts and nuts shall be hexagonal head type and comply with SANS 1700 and ISO 898.

All bolts must be of equal length. The length of each bolt shall be such that, after the nut has been tightened, the end of the bolt shall project above the nut by not more than six full threads and not less than one full thread. Two washers shall be used with every bolt connection to prevent damage to coatings.

Where used with belowground pipes, the connections shall be treated with an approved priming solution, packed with approved mastic and wrapped with an approved petrolatum tape with finishing layer by means of cling-wrapping.

The bolt torque requirements for bolted connections are as follows:

Table 21: Bolt Torque Requirements

Bolt Description	Torque Requirement	
	Gr 4.8	Gr 8.8
M12 x 1.75	35Nm	67Nm
M16 x 2	86Nm	167Nm
M20 x 2.5	168Nm	326Nm
M24 x 3	291Nm	563Nm

* Note: above torque requirements are based on using Copaslip as lubricant.

Bi-metal junctions shall be avoided or satisfactory steps shall be taken to prevent galvanic corrosion. Suitable isolation shall be provided between flanges, washers and bolts to prevent corrosion between dissimilar metals.

Prior to commencing tightening of a flanged joint, a check shall be performed to ensure that the flanges are parallel to each other. Flanged joints shall be tightened following the specified tightening sequence to achieve an even bolt loading and to eliminate elastic interaction.

Bolts shall be tightened as described in clause PSL-3.8.2.5 above.

Payment for protection of joints, isolation, bolts, nuts, washers and packings shall be included in the rates for the scheduled pipes, fittings, specials and valves."

Add the following new sub-clauses:

"PSL-3.8.8: Ductile Iron Fittings for PVC Pipes

All reducers, T-pieces, flange adaptors, couplings and other fittings for PVC pipe shall be socketed ductile iron (spheroidal graphite iron) fittings complying with the requirements of BS EN 12842 and have a minimum working pressure of 12 bar, unless indicated otherwise on the drawings.

PSL-3.8.9: HDPE Fittings

HDPE pipes and fittings shall be joined to each other by means of electrofusion couplers. Unless otherwise scheduled or shown on the drawings, HDPE pipes shall be joined to flanged valves, fittings and specials with backing rings and stubs."

PSL-3.9: CORROSION PROTECTION

Add the following:

"All underground saddles, cast iron detachable and flanged joints and galvanised fittings, including bolts, shall be protected by application of an approved protective paste, followed by a wrapping comprising of three layers of an approved impregnated tape, or by other means for inhibiting corrosion, as approved by the *Employer*. All bolts and flanges for valve and hydrant installations shall be protected in the same manner."

PSL-3.9.2: Steel Pipes

Replace this sub-clause with the following:

"Lined and coated pipes and specials shall be protected against damage at all stages, from manufacture to construction. Damages to the corrosion protection shall be repaired in accordance with the manufacturer's specifications. The cost of such repairs shall be to the *Contractor*'s account.

The *Contractor* shall develop a quality control plan (QCP), covering the control of coating operations, and shall appoint an independent coating inspector to conduct the following checks:

a) Random checks at different stages of the application of the corrosion protection, including surface preparation before application (sand blasting), humidity checks during application, proper use of application equipment, and the like.
b) DFT measurements for all coated steel pipes, specials and fittings, to be done at the various stages of application of the corrosion protection.
c) Pinhole testing of all the steel pipes and specials.
d) On completion of the inspection of all the steel pipes, specials and fittings, a certificate of conformance shall be issued to the *Employer* for approval.

Payment for corrosion protection and the independent coating inspection shall be included in the rates for the scheduled pipes, fittings and specials.

Coating shall include coating the full face of flanged ends.

The colour of all pipes for fire protection purposes shall be as follows:

i.	Water only piping	:	Signal red (SANS 1091 – A11).
ii.	Foam concentrate piping	:	White (RAL 9016)
iii.	Foam/water solution premix	:	Light blue

PSL-3.9.2.1: Internal Steel Pipe Corrosion Protection

a) Coating System A: Normal coating

All galvanised steel pipes, specials and fittings shall be lined internally with Corrocoat Zipcoat, or approved equivalent, at minimum 750 µm dry film thickness. Coating shall be applied in accordance with the manufacturer's specifications, unless otherwise specified or indicated on the drawings.

Pipe sections between ductile iron hydrant T-pieces and the hydrant valves shall be internally coated in accordance with the above specification.

PSL-3.9.2.2: External Steel Pipe Corrosion Protection

a) Coating System B: Above Ground Pipes

All above-ground galvanised steel pipes, specials and fittings shall be lined externally with Corrocoat Zipcoat, or approved equivalent, at minimum 500 µm dry film thickness. Coating shall be applied in accordance with the manufacturer's specifications, unless otherwise specified or indicated on the drawings.

b) Coating System C: Below Ground Pipes

All below ground galvanised steel pipes, specials and fittings shall be lined externally with Corrocoat Zipcoat, or approved equivalent, at minimum 750 µm dry film thickness. Coating shall be applied in accordance with the manufacturer's specifications, unless otherwise specified or indicated on the drawings.

All underground fittings, flexible and flanged joints, including bolts, shall be treated with an approved priming solution, packed with approved mastic and wrapped with an approved petrolatum tape with finishing layer by means of cling wrapping."

PSL-3.9.5: Joints, Bolts, Nuts and Washers

Substitute the sub-clause with the following:

"All bolts, nuts and washers used with fittings, flanges and couplings shall be of grade 316 stainless steel. The bolts and nuts shall be hexagonal head type and comply with SANS 1700 and ISO 898."

PSL-3.9.6: Corrosive Soil

Replace this sub-clause with the following:

"All underground connections of valves, steel or cast iron fittings shall be treated with an approved priming solution, packed with approved mastic, and wrapped with an approved petrolatum tape with finishing layer by means of cling wrapping."

PSL-3.10: VALVES

Replace this clause with the following:

"PSL-3.10.1: Valves – General

a) Valves shall be double-flanged, unless unavailable or otherwise specified.
b) All valves, including valves with gearboxes and valves with actuators, shall be provided with an indication of the current position as well as an indication of the closing and/or the opening direction.
c) Spindle covers shall be provided for valves with rising spindles.
d) Cast iron valve components, including valve bodies, shall be protected with a Fusion Bonded Epoxy or hot-applied thermoplastic coating system.
e) Metal plating of ferrous materials will not be accepted as an adequate corrosion protection system.
f) Lever handles on small bore valves and position indicator plates shall be of stainless steel.
g) Fasteners shall be of EN Grade 1.4401 (stainless steel grade 316), or better. This applies to all fasteners on the body of the valve and its gearbox. Pipework flange bolts are specified elsewhere.
h) Indelible body markings, as per SANS 1551-1, shall include the manufacturer's name, pressure rating (PN), nominal size (DN) and the direction of flow.
i) All isolating valves of size larger than 50mm up to and including 300mm diameter shall be of the sluice valve type and all isolating valves greater than 300mm diameter shall be of the butterfly type.
j) All isolating valves of size 50mm and less shall be bronze/brass lever arm ball valves or gate valves as indicated on the drawings or instructed by the *Employer*.
k) Brass gate valves shall comply with SANS 776 and brass ball valves shall comply with SANS 1056.
l) All scour valves shall be gate valves as specified under PSL-3.10.2.

PSL-3.10.2: Large Bore Gate Valves

All gate valves of size larger than 50mm up to and including 300mm shall be suitable for working pressure of 16 bar (i.e. PN16) and shall be double flanged cast iron, cast steel or spheroidal graphite iron wedge gate or RSV type according to SANS 664.

The valves shall have a brass gate and non-rising EN Grade 1.4401 stainless steel grade 316 spindle and brass or bronze guides. Non-rising spindle valves shall be fitted with indicators showing the valve opening position.

For RSV gate valves the body and bonnet shall be ductile iron grade GGG-50 to DIN 1693. The wedge shall be ductile iron grade GGG-50, fully encapsulated with EDK 70 rubber internally and externally so as to prevent corrosion and rubber failure. The wedge nut must be of the "fixed nut" type, press fit into the wedge, allowing no movement and manufactured from dezincification resistant high tensile navy brass. The wedge shall be supported by guides in the side of the valve body. No metal to metal contact between the gate and guides will be accepted.

All rubber shall be ozone stabilised and UV-resistant. The valve stem shall be stainless steel to DIN X 20 Cr 13. The primary seal shall be a NBR rubber hydraulic U seal (Manchette type). The secondary seal shall comprise of at least two NBR O-rings on the inside and two rings of nylon bush on the outside, for galvanic corrosion protection. The stem sealing arrangement shall include a wiper ring to prevent dirt ingress from the outside and shall be housed so as to protect it from UV radiation.

The thrust collar shall be dezincification resistant brass CZ 132 to BS 2874. The bonnet bolts shall be entirely sunk into the body casting, sealed and protected by hot wax melt. The bolts shall be grade 8.8 high tensile bolts and hot dip galvanised.

Gate valves shall be anti-clockwise closing, with direction of opening clearly marked on the valve body.

Gate valves shall be fitted with a square spindle, suitable for operating the valve by use of a valve key, held in the vertical position. The spindle shall be secured with retaining bolts.

All gate valves shall be drip-tight when tested in accordance with BS 5163. Pipes shall not be tested against a closed valve. Thrust blocks for test sections shall be approved by the *Employer* prior to testing of pipes.

Prior to coating, valves shall be cleaned by grit-blasting S15 standard. Coating shall comprise of a solvent-free sintered epoxy powder, applied in one coat by the use of arc-spray machines, to provide a dry film thickness of not less than 450 micron. The valves shall be externally coated for marine conditions.

PSL-3.10.3: Pressure Reducing Valves

a) Each substation building shall be fitted with a PN10 pressure reducing valve to regulate the building internal water pressures to suit the pipe fittings.
b) The pressure reducing valve shall be fitted with a 0.0kPa to 1,000kPa pressure gauge and shall comply with BS EN 1567. The pressure reducing valve shall consist of the following parts:

- Body from hot forged brass.
- Bonnet from hot forged brass.
- Pressure screw from hot forged brass.
- Nut cap from hot forged brass.
- Plug from hot forged brass.
- Disc from hot forged brass.
- Rectangular ring from hot forged brass.
- End cap from hot forged brass.
- Soring seat from hot forged brass.
- Compression spring from stainless steel.
- O-rings from nitrile rubber (NBR).
- Rectangular ring from nitrile rubber (NBR).
- O-ring from nitrile rubber (NBR).
- O-ring from nitrile rubber (NBR).

PSL-3.10.4: External Fire Hydrants

Fire hydrants shall be pillar type hydrants fitted with tamper proof quick coupling type hydrant outlet and shall be suitable for a working pressure of 1.6MPa.

Fire hydrants shall comply with the local fire department standard regulations and shall be approved by the relevant department head.

Fire hydrants pipework shall be 80mm Ø internal.

Hydrants shall be 80mm x 65mm right-angled, brass hand wheel hydrants with single lug outlets and shall be clockwise opening.

Fire hydrants shall comply with SANS 1128-1.

Backfill around fire hydrants shall be compacted in layers not exceeding 150mm to 95% of MOD AASHTO for G7 materials and to 100% of MOD AASHTO for sand.”

Add the following new clauses:

"PSL-3.12: SADDLES AND ADAPTORS

For each substation building, a saddle and male adaptor/threaded 90° bend shall be used to connect the building's water feed onto a new 110mm Ø fire water line feeding the relevant building's fire hydrant(s).

Saddles shall be of the type Magnum or approved equivalent type with a pressure rating of at least 16 bar.

Male adaptors shall be of the type Philmac or approved equivalent type with a pressure rating of at least 16 bar.

110mm saddles, with 1¼" female threaded inlets and 32mm adaptors with 1¼" threaded outlets, shall be used for the water connections of the various substation buildings.

PSL-3.13: BACKFILL MATERIAL

PSL-3.13.1: Backfilling of Pipes in General Landscaped/Non-surfaced Areas

Free draining granular material, obtained from stockpiled soft and intermediate excavated material, shall be used for backfilling of pipes up to the final landscaped surface level (at ground floor level).

PSL-3.13.2: Backfilling of Pipes in Areas Covered by Hard Surfacing and Buildings

The material to be utilised for backfilling of pipes up to the bottom of the layerworks within hard surfaced and building areas shall be selected, imported, non-cohesive, granular material (aggregate, sand or granular material), free of any organic material. The particle size distribution shall be such that 100% passes a 13.2mm sieve and not more than 5% passes a 0.075mm sieve.

PSL-3.14: BUILDING/INTERNAL COLD WATER PIPES AND FITTINGS

PSL-3.14.1: General

a) All copper pipework shall be Class 'O' (hard drawn) to SANS 460 with capillary fittings to SANS 1067 Part 2 with 97/3 tin/copper soldering to manufacturers specifications.
b) Brass gates valves shall be installed at all fittings for isolating purposes.
c) 15mm Ø copper pipes shall be chased into walls to a depth of at least 25mm. Clips to hold these pipes in place shall be fitted at 1.0m intervals.
d) 22mm Ø copper pipes shall be chased into walls to a depth of at least 30mm. Clips to hold these pipes in place shall be fitted at 1.0m intervals.
e) 28mm Ø copper pipes shall be chased into walls to a depth of at least 35mm. Clips to hold these pipes in place shall be fitted at 1.0m intervals.
f) All fittings and pipework shall be properly anchored prior to testing.
g) Testing of all piping shall be to 1.5 times working pressure. Each joint shall be inspected for leakage.
h) All copper pipework shall be cleaned with galvanised steel cleaner, followed by one layer Plascon Undercoat CHC 1 Chemcote, followed by one layer Plascon CHC 101 Chemcote, followed by one layer Plascon CHC 3810 Brilliant Green to SANS 1091 colour No. H10. Alternate product ranges will be considered, subject to approval by the *Employer.*
i) All portions of copper pipes passing through walls or floors shall be wrapped with 2 layers of building paper.
j) All copper pipework exposed to the outside on roofs and the like shall be insulated against freezing with 15mm thick pre-formed mineral wool insulation material with galvanised metal cladding (after corrosion protection).
k) All copper pipe fittings shall comply with Point 3.3.3: Table 2 of SANS 1067 Part 2.
l) Reference shall be made to the drawings for the pressure reducing valve and isolation valves combination set.

PSL-3.14.2: Fittings and Fixtures (at Eskom Ystervark Building)

a) Ablution basin cold water tap shall be in accordance with the Architect's sanitaryware schedule.
b) Ablution basin regulating valve with flexi hose shall be in accordance with the Architect's sanitaryware schedule.
c) Ablution toilet (WC) shall be fitted with angle valve with flexi hose in accordance with the Architect's sanitaryware schedule.

PSL-3.15: PRESSURE REDUCING VALVE AND VALVE COMBINATION SET

Each substation building shall be provided with a combination set consisting of a pressure reducing valve (PRV) and two (2) isolating gate valves, as indicated on the drawings or as instructed on Site by the *Employer*.

This combination set shall be installed within the ceiling space and/or ducting area of each building."

5.10.3 PSL-4: PLANT

PSL-4.3: TESTING

Add the following:

"The *Contractor* shall ensure that the test equipment is calibrated and in good working order."

5.10.4 PSL-5: CONSTRUCTION

PSL-5.1: LAYING

PSL-5.1.4: Depths and Cover

Replace sub-clause 5.1.4.1 with the following:

PSL-5.1.4.1: "Unless otherwise shown on the drawings or instructed by the *Employer*, the cover to all pipes, measured from below finished surface level, shall be not less than 1,000mm."

Add the following new sub-clause:

"PSL-5.1.5: Connection to Existing Pipelines

Where connections to existing pipelines are required, the *Contractor* shall excavate well in advance of the *works* being undertaken to expose the connection point and to verify that the assumed fittings are available on Site and that the connection as proposed can be made. It may be necessary to expose a full pipe length to verify the size and class of pipe in the ground or to locate an existing fitting.

The following shall apply:

a) Water supply disruptions shall be kept to a minimum.
b) Connections shall take place after the testing of the new pipeline(s) has/have been completed."

PSL-5.6: VALVE AND HYDRANT CHAMBERS

PSL-5.6.1: General

Substitute the first sentence with the following:

"The drawings of valve and hydrant chambers included with and appended to the Works Information supersede the corresponding drawings in the standardised specification."

PSL-5.6.2: Construction of Chambers

Substitute "Drawings L-1, L-2 and L-3" in the second sentence with "drawings included in the Works Information".

PSL-5.10: DISINFECTION OF POTABLE WATER PIPELINES

Add the following:

"The disinfection of the potable water pipelines shall be carried out by the *Contractor*."

Add the following new clauses:

"PSL-5.11: BACKFILLING OF WATER PIPELINES

PSL-5.11.1: Backfilling of Water Pipes in General Landscaped/Non-surfaced Areas

Backfilling of pipes up to final landscaped surface level shall be carried out with material described in clause PSL-3.13.1. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% Mod AASHTO maximum density, unless the material consists of cohesionless sand, in which case compaction shall be to 100% Mod AASHTO maximum density.

PSL-5.11.2: Backfilling of Water Pipes in Areas Covered by Hard Surfacing or Buildings

Backfilling of pipes up to the bottom of the layerworks of the hard surfaced or building areas shall be carried out with material described in clause PSL-3.13.2. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% Mod AASHTO maximum density, unless the material consists of cohesionless sand, in which case compaction shall be to 100% Mod AASHTO maximum density.

PSL-5.12: PIPE MARKERS

Pipe marker posts shall be pre-cast concrete posts constructed in strict accordance with details shown on the drawings."

5.10.5 PSL-7: TESTING

PSL-7.3: STANDARD HYDRAULIC PIPE TEST

PSL-7.3.1: Test Pressure and Time of Test

Add the following to sub-clause PSL-7.3.1.1:

"The *Contractor* shall undertake pressure testing of the pipeline in the presence of the *Employer* at convenient lengths not exceeding 500m, or in sections where the difference in static head does not exceed 25m.

Pipes shall not be tested against isolating valves. Special blank flanges or end caps, fully anchored, shall be provided for testing."

Substitute sub-clause PSL-7.3.1.2 with the following:

"The test pressure for field testing shall be 1.5 times the rated maximum working pressure of the pipe, e.g. Class 10 pipe (1.0MPa rated working pressure) shall be tested to 1.5MPa and Class 12 pipe (1.2MPa rated working pressure) to 1.8MPa."

Substitute sub-clause PSL-7.3.1.3 with the following:

"The test pressure applied according to PSL-7.3.1.2 must make allowances for any elevation difference along the pipe line, so that the pressure at any point in the pipe will be at least 1.25 times, and not more than 1.5 times, the rated working pressure of the pipe."

Replace sub-clause PSL-7.3.1.4 with the following:

"External underground uPVC, HDPE and Polycob pipelines shall be tested to the following pressures:

- Minimum test pressure = 1.25 times the rated pressure class of the pipe
- Maximum test pressure = 1.5 times the rated pressure class of the pipe"

PSL-7.3.3: Permissible Leakage Rates

Replace "cast iron" in sub-clause 7.3.3.b) with "ductile iron".

Add the following new clauses:

"PSL-7.5: HYDROSTATIC PRESSURE TESTING OF SPIGOT/SOCKET JOINTS

At least three spigot/socket joints per batch of uPVC pipes shall be subjected to a one-hour test as described in Section 5.8 of SANS 966 Part 1 at a laboratory approved by the *Employer*. The tests shall be witnessed by the *Employer*. Should any of the tests fail, the associated batch of uPVC pipe will be rejected.

Payment for this hydrostatic pressure testing shall be included in the scheduled rates for pipes.

PSL-7.6: PRESSURE TESTING OF PILLAR TYPE FIRE HYDRANTS

Refer to SANS 1128-1 (2010) for testing procedures and requirements. Payment for these tests shall be included in the scheduled rates for fire hydrants."

5.10.6 PSL-8: MEASUREMENT AND PAYMENT

PSL-8.2: SCHEDULED ITEMS

Replace payment item 8.2.1 with the following:

"PSL-8.2.1: Supply, handle, lay, bed (for flexible pipes), joint, test and disinfect pipes, complete with couplings (waste and cut lengths to be allowed for in these rates) ..... Unit: m

Pipelines will be measured by length over all lengths as laid. No deduction will be made for specials and valves. The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) related to the provision of pipes, complete with couplings, handling, inspecting, transporting, bedding, laying, jointing, cutting, hydraulic testing and disinfecting of the pipes and the joints, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*."

Replace payment item 8.2.2 with the following:

"PSL-8.2.2: Extra-over PSL-8.2.1 for supplying, laying, and bedding of fittings and specials complete with couplings, including cutting pipes to length where required, test and disinfect: .....Unit: No.

The tendered rate shall cover all extra-over costs (plant, equipment, material, labour, water, transport and the like) for the provision of each fitting and/or special, complete with couplings and the cost of handling, fixing, bedding, and testing of the fitting or special, as applicable, and the cutting of the pipes, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*."

Replace payment item 8.2.3 with the following:

"PSL-8.2.3: Extra-over PSL-8.2.1 for supplying, handling, fixing, bedding and commissioning of valves and flow meters complete with couplings (including bolts, nuts, washers and packings) .....Unit: No.

The tendered rate shall cover all extra-over costs (plant, equipment, material, labour, water, transport and the like) for the provision of each valve and/or flow meter, complete with couplings, and the cost of handling, fixing, bedding, and testing of the fitting or special, as applicable, and the cutting of the pipes, in strict accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*."

Replace payment item 8.2.11 with the following:

"PSL-8.2.11: Anchor/thrust Blocks and Pedestals (30MPa Concrete/19mm stone) ..... Unit: m^3

Anchor / thrust blocks and pedestals shall be measured per cubic metre concrete and the tendered rate shall include all excavation, trimming, formwork, reinforcement (where specified), placement of concrete and screeding of top surfaces to the required dimensions (as indicated on the drawings) and backfilling.

Separate payment will be made for hard rock excavation and for ready bars, nuts, washers and clamp with rubber lining, where applicable."

Replace payment item 8.2.13 with the following:

"PSL-8.2.13: Valve, hydrant and flow meter chambers, for: .....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the excavation and complete construction of chamber in accordance with the drawings, or as instructed on Site by the *Employer,* including all backfilling, backfilling compaction testing and finishing."

Add the following new payment items:

"PSL-8.2.16: Install internal cold water copper pipes for chiller plant with the following nominal diameters:

a) 32mm ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the manufacture, supply, transport, off-load, fixing, hanging, anchoring, chasing into walls, clipping (at 1.0m centres), strapping, installation of cold water copper pipes, complete with bends, reducers and other fittings, corrosion protection and insulation (where required), pressure testing, disinfection of pipes and complying with all requirements as set out in the specification, indicated on the drawings or as instructed on Site by the *Employer*.

PSL-8.2.17: Connecting to existing water mains

a) Connection of new 110mm Ø uPVC fire water pipe to existing 160mm Ø water main line (installed by Others) by means of "hot-tap" connection .....Unit: No.
b) Connection of new, re-routed 160mm Ø water line, to existing 160mm Ø water line .....Unit: No.
c) Connection of new 110mm Ø uPVC fire water pipe to new re-routed 160mm Ø water main line.....Unit: No.
d) Connection of new 110mm Ø uPVC fire water pipe to existing 160mm Ø water main line by means of "hot-tap" connection .....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the listed connections to be carried out in strict accordance with the procedure described in clause PSC-5.10.2: Relocation of Services in this specification, other relevant sections of this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSL-8.2.18: Install a combination set of 1 x pressure reducing valve and 2 x isolating valves in accordance with:

a) Detail LA-0048-01.C of drawing 1924701-2-510-C-LA-0048-01.....Unit: Set
b) Detail LA-0053-01.A of drawing 1924701-2-510-C-LA-0053-01.....Unit: Set
c) Section LA-0057-01.3 of drawing 1924701-2-510-C-LA-0057-01 .....Unit: Set

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the manufacture, supply, transport, off-load, fixing, corrosion protection, pressure testing and disinfection of the combination set and complying with all requirements as set out in this specification, the drawings, the manufacturers specification, or as instructed on Site by the *Employer*.

PSL-8.2.19: Install external standard pillar type fire hydrant in accordance with:

a) Detail LA-0048-01.D of drawing 1924701-2-510-C-LA-0048-01.....Unit: No.
b) Detail LA-0053-01.B of drawing 1924701-2-510-C-LA-0053-01.....Unit: No.
c) Section LA-0057-01.2 of drawing 1924701-2-510-C-LA-0057-01 .....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the manufacture, supply, transport, off-load, fixing, corrosion protection, pressure testing and disinfection of the pillar type fire hydrant and complying with all requirements as set out in this specification, the drawings, the manufacturers specification, or as instructed on Site by the *Employer*.

PSL-8.2.20: Pipe Markers

a) Marker posts.....Unit: No.
b) Kerb/edging marks .....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the manufacture, supply, transport, off-load and installation of marker posts or making kerb/edging marks, in accordance with this specification and the drawings, or as instructed on Site by the *Employer*.

PSL-8.2.21: Install internal cold water copper pipes at the Eskom Ystervark building at the Main Intake Substation, with the following nominal diameters:

a) 32mm..... Unit: m
b) 15mm..... Unit: m

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the manufacture, supply, transport, off-load, fixing, hanging, anchoring, chasing into walls, clipping (at 1.0m centres), strapping, installation of cold water copper pipes, complete with bends, reducers and other fittings, corrosion protection and insulation (where required), pressure testing, disinfection of pipes and complying with all requirements as set out in this specification or indicated on the drawings, or as instructed on Site by the *Employer*.

PSL-8.2.22: Install internal/building cold water brass shut-off gate valve at the Eskom Ystervark building at the Main Intake Substation, with the following nominal diameter:

a) 32mm.....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the manufacture, supply, transport, off-load, fixing of cold water brass shut-off gate valve complete with all fixtures and fittings, corrosion protection, pressure testing, disinfection and complying with all requirements as set out in this specification or indicated on the drawings, or as instructed on Site by the *Employer*."

5.11 PSLB: BEDDING (PIPES)

5.11.1 PSLB-1: SCOPE

Add the following:

"This specification also includes the supply and placement of bedding and padding materials required for the installation of belowground electrical and communication cables."

5.11.2 PSLB-3: MATERIALS

PSLB-3.1: SELECTED GRANULAR MATERIAL

Replace this clause with the following:

"Selected granular material shall be aggregate, sand or other non-cohesive, granular material, free of any organic material. The particle size distribution shall be such that 100% passes a 13.2mm sieve and not more than 5% passes a 0.075mm sieve.

The material shall comply with the compactability criteria as detailed under Clause PSLB-7.2."

PSLB-3.3: BEDDING

Add the following:

"The pipelines to be regarded as flexible are PVC, HDPE and Polycop pipes.

All other pipes shall be regarded as rigid and laid on Class B bedding."

PSLB-3.4: SELECTION

PSLB-3.4.1: Suitable Material Available from Trench Excavation

Replace this sub-clause with the following:

"No material from trench excavation shall be used as bedding material."

PSLB-3.4.2: Suitable Material Available Not Available from Trench Excavation

Replace this sub-clause with the following:

"All bedding material shall be imported material from commercial sources or borrow pits and shall be selected granular material according to clause PSLB-3.1."

Add the following new clause:

"PSLB-3.5: STONE BEDDING

"Should the *Contractor*, after having complied with all the requirements regarding de-watering of excavations, find that the conditions in the trench, open channel or open excavation bottom remain unstable due to the nature of the soil and the degree of saturation, the *Contractor* shall advise the *Employer,* who may instruct the *Contractor* to place a layer of stone bedding at the base of the trench in order to produce a more stable trench bottom.

Stone bedding shall consist of 13mm concrete aggregate to SANS 1083 (for waterlogged conditions). The 13mm stone shall be wrapped in 270g/m^2 needle-punched Bidim A5 (or approved equivalent) nonwoven polyester with minimum 500mm overlap."

5.11.3 PSLB-5: CONSTRUCTION

PSLB-5.1: GENERAL

PSLB-5.1.4: Compacting

Replace this sub-clause with the following:

“The degree of compaction attained for bedding (other than concrete and the backfill material above the pipe/sleeve/cable) shall be 93% of MOD AASHTO (100% for sand)."

Add the following new clauses:

“PSLB-5.5: STONE BEDDING

13mm Stone bedding shall be used where unstable waterlogged conditions prevail, despite reasonable steps having been taken by the *Contractor* to deal with the conditions.

PSLB-5.6: BEDDING AND PADDING FOR CABLE TRENCHES

Bedding and padding material for cable trenches shall be obtained from commercial sources and shall be crescent soil with low thermal resistivity, equal to or below 0.7K.m/W. The maximum allowable soil particle size shall be 12mm.

All bedding and padding materials shall be tested by an independent, *Employer*-approved testing facility/laboratory. All soil thermal resistivity measurements shall be made with the soil in a dry state, i.e. at very low moisture content.

The testing frequency shall be one test per every 100m³ of bedding and/or padding materials. Sample sizes shall be in accordance with the applicable test method or the recommendations of the selected laboratory. The results shall be furnished to the *Employer* for review and approval prior to dispatching bedding materials to Site.

No bedding or padding materials shall be placed on Site unless all test results have been submitted to the *Employer* for verification of compliance. Should the test results pass, approval will be furnished by the *Employer* to use the tested bedding and padding materials. If any of the test results fail, the materials shall be rejected for further use.

If the *Contractor* places any untested bedding or padding materials, or the tested materials fail to meet the abovementioned requirements, the *Contractor* shall remove all non-compliant materials as determined by the *Employer* and provide compliant materials as specified. All associated costs shall be to the *Contractor*’s account.

All soil testing and mixing of soil (where applicable) shall be in strict accordance with SANS 10198-5 and others applicable specifications.

The *Contractor* shall allow for all testing and procurement of special bedding and padding materials in the tendered rates.

A 150mm thick layer of bedding material shall be placed over the full width of the cable trench prior to the installation of cables. A further 150mm padding layer shall be placed over the full width of the cable trench after the installation of cables. Compaction shall be as specified under Clause PSLB-5.1.4.

The *Contractor* shall obtain the *Employer*’s approval after installation of bedding material and cables and prior to any further backfilling.”

5.11.4 PSLB-6: TOLERANCES

PSLB-6.1: MOISTURE CONTENT AND DENSITY

Degree of Accuracy II shall be applicable.

5.11.5 PSLB-7: TESTING

PSLB-7.2: COMPACTABILITY

Replace this clause with the following:

"The compactability test shall be carried out as follows:

Apparatus:

Cylinder	An open-ended cylinder of length approximately 250mm and nominal internal diameter 150mm.
Rammer	A metal rammer of mass approximately 1.0kg and having a striking face of diameter approximately 38mm.
Rule	A steel rule graduated in millimetres.

Procedure:

a) Obtain a representative sample of the material as follows:

   i. Heap about 160kg of the material on a clean surface, mix it thoroughly, divide it into two parts of approximately equal size, and discard one part.
   ii. Repeat the mixing, division, and discarding procedure until a sample of mass about 10kg is obtained. Ensure that the moisture content of the sample is approximately the same as that of the main body of bedding material at the time that it will be used in the trench.

b) Place the cylinder on a firm flat surface and gently pour the sample into it, taking care not to compact the material in any way. Strike off the top surface of the material level with the top of the cylinder and remove all surplus material from the flat surface. Lift the cylinder up clear of its contents and place it on a fresh area of the flat surface.

c) Return about one-quarter of the sample material to the cylinder and tamp vigorously until no further compaction can be obtained. Repeat this procedure with each of the other quarters, adding each, in turn, to the material in the cylinder and tamping the final surface as level as possible.

d) Measure the distance from the level of the compacted sample to the top of the cylinder and record this distance divided by the height of the cylinder as the compatibility factor of the bedding material.

Evaluation of Results:

Compactability Factor Evaluation

Up to and including 0.1	:	Material suitable for bedding
Over 0.1 up to and including 0.4	:	Material suitable (except for flexible pipes that may be subject to waterlogged conditions after laying) but requires extra care in compaction.
Over 0.4	:	Material unsuitable."

Add the following new clause:

"PSLB-7.3: PROCESS CONTROL

The minimum testing frequency for process control by the *Contractor* shall not be less than the applicable frequency set out in Table 22 overleaf.

Table 22: Testing Frequency: Bedding Materials

Test	Position in Layer	Testing Frequency
Compactability test	Bedding and padding layers	5 tests for each source of bedding/padding materials
Bedding material thermal resistivity test	Bedding and padding layers	1 test per 100m³ of bedding and padding material
Density (Relative Compaction at OMC)	Road crossings	Two tests per bedding/padding layer per road crossing
	Open Areas	One test per bedding/padding layer per 50m of trench
Indicator Tests, Grading	All areas	5 tests for each source of bedding/padding materials

The cost for all process control tests (as set out in Table 22 above) shall be included in the rates for supplying, processing, placing and compacting of the various bedding layers."

5.11.6 PSLB-8: MEASUREMENT AND PAYMENT

PSLB-8.1: PRINCIPLES

PSLB-8.1.3: Volume of Bedding Materials

Add the following:

"The volume of bedding material shall exclude the volume of the pipe."

PSLB-8.1.4: Separate Items for Cradle and Blanket

Replace this sub-clause with the following:

"Although distinctions may be made in terms of items for the bedding cradle and selected fill blanket, the material in both cases shall comply with the requirements for material for the bedding cradle."

PSLB-8.1.5: Disposal of Displaced Material

Add the following:

"It is the *Contractor*'s responsibility to find spoil sites at his cost, should this be necessary."

PSLB-8.2: SCHEDULED ITEMS

PSLB-8.2.1: Provision of Bedding from Trench Excavation

Replace this sub-clause with the following:

"All bedding material shall be imported material from commercial sources or borrow pits and shall be selected granular material according to clause PSLB-3.1."

PSLB-8.2.2: Supply only of Bedding by Importation

PSLB-8.2.2.3: From Commercial Sources

Add the following:

"PSLB-8.2.2.3.c): 13mm stone Bedding ..... Unit: m³

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the supply, transport, off-load, placement, compaction (by hand) and complying with all requirements as set out in this specification, as shown on the drawings or as instructed on Site by the *Employer.*

Payment for stone bedding shall only be made if the *Employer* has agreed in writing that the conditions on Site warrant the use of stone bedding."

Replace payment item 8.2.4 with the following:

"PSLB-8.2.4: Encasing of pipes and ducts in 30MPa (19mm stone) concrete..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for sourcing and supplying 30MPa concrete and encasing pipes and/or ducts at least 200mm all around the pipes and/or ducts, complying with all requirements as set out in this specification or as indicated on the drawings, or as instructed on Site by the *Employer.*"

Add the following new payment items:

"PSLB-8.2.6: Supply, handle and install nonwoven polyester geotextile ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for supplying, transporting, off-loading and installation of needle-punched nonwoven polyester geotextile (grade specified in the bill of quantities) and complying with all requirements as set out in this specification or as indicated on the drawings, or as instructed on Site by the *Employer.*

PSLB-8.2.7: Bedding and padding for underground cables ..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for sourcing, importation from commercial sources, supplying, transporting, off-loading and placing of bedding and padding materials for electrical cables, all as specified under Clause PSLB-5.6 and complying with all requirements as set out in this specification or as indicated on the drawings, or as instructed on Site by the *Employer.*

The quantity for payment purposes shall be the compacted volumes, determined from the actual lengths of cable installed and the thickness of the bedding and padding materials as specified in Clause PSLB-5.6."

5.12 PSLC: CABLE DUCTS

5.12.1 PSLC-1: SCOPE

Replace this clause with the following:

"This specification covers the supply, laying, bedding and proving of conventional and split type cable ducts (sleeves), the provisions and installing of cable markers, the closing and/or sealing of duct ends, the installation of underground danger tape and the construction of cable trenches at the new Main Intake Substation."

5.12.2 PSLC-3: MATERIALS

PSLC-3.1: DUCTS

Replace this clause with the following:

"All ducts/sleeves shall be double wall corrugated HDPE conduits of smooth bore of type Kabelflex or approved equivalent and shall be manufactured in accordance with BS EN 50086-2-4.

All ducts shall carry the SANS certification mark in respect of specification SANS 61386-24.

Ducts shall be installed according to the following colour coding:

a) Sleeves for electrical cables shall be black.
b) Sleeves for communication/data cables shall be green."

PSLC-3.2: BEDDING

Replace this clause with the following:

"Bedding material shall be aggregate, sand or other non-cohesive, granular material, free of any organic material. The particle size distribution shall be such that 100% passes a 13.2mm sieve and not more than 5% passes a 0.075mm sieve.

The material shall comply with the compactability criteria as detailed under Clause PSLB-7.2."

PSLC-3.3: BACKFILL

Replace this clause with the following:

"PSLC-3.3.1: Backfilling of Cable Ducts in General Landscaped/Non-surfaced Areas

Backfilling of cable ducts up to final landscaped level shall be carried out with material described in Clause PSL-3.13.1. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% Mod AASHTO maximum density, unless the material consists of cohesionless sand, in which case compaction shall be to 100% Mod AASHTO maximum density.

PSLC-3.3.2: Backfilling of Cable Ducts in Areas Covered by Hard Surfacing and Buildings

Backfilling of cable ducts up to the bottom of the layerworks of the hard surfaced and building areas (at ground floor level), shall be carried out with material described in clause PSL-3.13.2. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% MOD AASHTO."

5.12.3 PSLC-5: CONSTRUCTION

PSLC-5.1: EXCAVATION OF TRENCHES

PSLC-5.1.1: Trench Widths and Depths

Replace sub-clause PSLC-5.1.1.1 with the following:

“Trench widths shall be as per drawing LC-1 of caluse 5.1.1.1 of SANS 1200 LC unless otherwise indicated on the contract drawings referenced in the Works Information and associated specifications.”

Replace sub-clause PSLC-5.1.1.2 with the following:

“All trenches shall be excavated to a depth so that, after the duct or nest of ducts has been laid, there is a minimum cover of 1,000mm over the ducts, unless otherwise shown or drawings or instructed on Site by the *Employer*.”

PSLC-5.3: DUCT LAYING

PSLC-5.3.3: Draw Wire

Replace this sub-clause with the following:

“Draw wires shall be installed in each duct (one single strand of draw wire per duct). A 2.0m free length shall be provided beyond the ends of the duct, to be neatly coiled and left in the draw boxes at each end of the ducts. The draw wires shall be made of 3.2mm Ø Class B galvanised mild steel.”

Add the following new sub-clauses:

"PSLC-5.3.5: Closing/Sealing of Sleeve/Duct Ends

The ends of all ducts/sleeves shall be closed/sealed as follows:

a) Where the ducts/sleeves enter a building, manhole or the like inside a building etc. (i.e. duct/sleeve opening is exposed), it shall be sealed with an approved fire retardant material, irrespective of whether the duct contains electrical and/or electronic cables or not. The opposite duct end shall be sealed in the same way.
b) Ducts/sleeves in the ground, i.e. at road crossings and the like, containing electrical and/or electronic services, shall be sealed with expanded foam to avoid the ingress of water, soil, vermin and the like.
c) Unused ducts/sleeves in the ground, i.e. at road crossings and the like, shall be sealed with plastic end caps.

PSLC-5.3.6: Clearances

Minimum vertical and horizontal clearances/spacing between electrical and electronic services ducts, measured between the outer wall of the ducts, shall be 300mm. This shall apply in all cases where ducts are installed next to each other, above each other or where ducts cross each other.

Minimum vertical and horizontal clearances/spacing between electrical and electronic services ducts and other services, measured between the outer wall of the duct and the exterior surface of the service, shall be 300mm. This shall apply in all cases where ducts and services are installed next to each other, above each other or where ducts cross each other.

The *Employer* may at his discretion specify higher clearances/spacing. Reference shall also be made to other associated contract documentation and the drawings for further details on minimum clearances between electrical, electronic and other services.

Where specified or instructed by the *Employer*, the *Contractor* shall install protective concrete slabs, additional sleeves and/or cover tiles at the positions specified by the *Employer*. Examples of such positions may be where electrical and electronic cables enter and/or exit the dedicated ducts.”

PSLC-5.8: ROAD CROSSINGS

Replace this clause with the following:

“Ducts shall extend a distance of 1.0m beyond the paved sidewalks or 1.0m beyond the kerb where there is no sidewalk.

Where ducts cross asphalt and gravel roads, clause PSC-5.9: ROAD CROSSINGS shall apply.”

PSLC-5.10: POSITION TO BE MARKED

Replace this clause with the following:

"The *Contractor* shall mark the position of a cable duct/group of cable ducts crossing a road with a 5mm deep groove into the upper surface of the kerb/concrete edging by means of an angle grinder. The grooves and 20mm of the concrete surface either side of it shall then be painted with an approved paint using the following engraved letter and colour coding:

a) Electrical : letter “E”, colour red
b) Communication : letter “C”, colour green

Where there are no kerbs/concrete edgings installed at a road crossing, a marker post shall be installed at either side of such a road crossing.

Pipe marker posts shall be pre-cast concrete posts constructed in strict accordance with the details indicated on the drawings.”

PSLC-5.11: REPAIRS AND REINSTATEMENT OF SURFACES

Add the following:

“Refer to clause PSC-5.9: ROAD CROSSINGS for all details, requirements and specifications regarding road crossings of new sleeves and the reinstatement of these road crossing surfaces.”

Add the following new clause:

“PSLC-5.12: DANGER TAPE

The *Contractor* shall install PVC electrical danger warning tape within the general backfill material 300mm below finished ground level above all cable ducts, even where the cable ducts are covered by hardened surfaces. Where hardened surfaces impede these installation requirements, the *Contractor* shall consult the *Employer* for a ruling on the matter.

The danger tape shall be at least 450mm wide and 150 micron thick and shall consist of black thunder flash symbol on orange background with the wording “DANGER/INGOZI/GEVAAR”.”

5.12.4 PSLC-8: MEASUREMENT AND PAYMENT

PSLC-8.2: SCHEDULED ITEMS

Replace payment item 8.2.5 with the following:

"PSLC-8.2.5: Supply, lay, bed and prove ducts/sleeves including draw wires.
Ducts to be "Kabelflex" or approved equivalent ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for sourcing, supplying, laying, jointing, bedding, building into draw boxes (where required), proving and providing draw wires, as described in this specification, as shown on the drawings, or as instructed on Site by the *Employer.*”

Replace payment item 8.2.8 with the following:

"PSLC-8.2.8: Cable and Cable Duct Markers

a) Route markers (marker posts).....Unit: No.
b) Kerb/edging marks .....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the manufacture, supply, transport, off-load and installation of marker posts or making kerb/edging marks, as described in this specification, as shown on the drawings or as instructed on Site by the *Employer*."

Add the following new payment items:

"PSLC-8.2.10: Closing and/or sealing of sleeve/duct ends

a) Sleeve/duct ends sealed with approved fire retardant material .....Unit: No.
b) Sleeve/duct ends sealed with builders expander foam.....Unit: No.
c) Sleeve/duct ends closed with plastic end caps.....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, transport and the like) for sourcing, transport, off-loading and installation (sealing /closing) of sleeve/duct ends as per sub-clause PSLC-5.3.5, as described in this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSLC-8.2.11: Supply, lay, bed and prove split sleeve/duct ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for sourcing, supplying, splitting, laying, jointing, bedding, building into draw boxes (where required), proving and providing draw wires (if required), as described in this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSLC-8.2.12: Cable Trenches

a) Install brick cable service trench complete with precast concrete cover slabs, and the like in accordance with Section LA-0057-03.1 of Drawing Number 1924701-2-510-C-LA-0057-03..... Unit: m

b) Install cable trench/sleeve transition units complete with precast concrete cover slabs, and the like in accordance with Section LA-0057-03.2 and Section LA-0057-03.3 of Drawing Number 1924701-2-510-C-LA-0057-03.....Unit: No.

c) Install cable/sleeve road crossing Type 1 complete in accordance with Section LA-0057-03.4 of Drawing Number 1924701-2-510-C-LA-0057-03..... Unit: m

d) Install cable/sleeve road crossing Type 2 complete in accordance with Section LA-0057-03.5 as well as Details LA-0057-03.A and LA-0057-03.B of Drawing Number 1924701-2-510-C-LA-0057-03.....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for excavation, construction and backfilling of the above listed cable trenches in accordance with the drawings listed above, disposing of all excess material to the designated stockpile area as indicated in Part C.4: Site Information.

PSLC-8.2.13: Installation of Danger Tape ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for sourcing, supplying, loading, off-loading and installation of danger tape as per clause PSLC-5.12, as described in this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSLC-8.2.14: Installation of Precast Concrete Cover Slabs..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for sourcing of material, precast on site (or at a suitable approved manufacturer) 230mm x 450mm x 50mm thick 20MPa concrete slabs, supplying, loading, transportation, off-loading and installation of these precast concrete cover slabs, as described in this specification, as shown on the drawings or as instructed on Site by the *Employer*."

5.13 PSLD: SEWERS

5.13.1 PSLD-1: SCOPE

Replace this clause with the following:

"This specification covers the supply and installation of the following foul sewer and waste water infrastructure:

a) Foul Sewer

i. At the Eskom Ystervark Building at the Main Intake Substation

1) New external underground gravity uPVC foul sewer pipeline.
2) New internal foul sewer pipework and vents.
3) New foul sewer manholes.
4) New conservancy tank.
5) New pipe route marker posts.

ii. At Substation N

1) New external scour valve complete with valve chamber.
2) New relocated section of the foul sewer rising main line.
3) New foul sewer connections for the relocated section of the foul sewer rising main line.
4) New pipe route marker posts.

b) Waste Water

i. At the Main Intake Substation

1) New external underground gravity concrete waste water pipeline.
2) New external waste water concrete sumps and manholes.
3) New external waste water concrete oil dam.
4) New external waste water concrete oil trap."

5.13.2 PSLD-3: MATERIALS

PSLD-3.1: PIPES, FITTINGS AND PIPE JOINTS

PSLD-3.1.5: uPVC Pipes

Replace this sub-clause with the following:

"All uPVC pipes shall be produced in a factory of a registered member of the South African Plastic Pipe Manufacturers Association (SAPPMA). The uPVC pipe manufacturer shall be ISO 9001:2000 accredited and shall be a certified mark holder of SANS 966 Part 1, in possession of a permit to apply the SANS certification mark.

All underground foul sewer soil water (SP) gravity pipes shall be uPVC Class 34 Solid Wall (heavy duty) pipe (300kPa pipe stiffness), in accordance with SANS 791, unless indicated otherwise on the drawings.

Exposed foul sewer waste and vent pipes shall be uPVC (white pipes), in accordance with SANS 967."

Add the following new sub-clause:

"PSLD-3.1.8: Concrete Pipes

All waste water pipes shall be shall be reinforced concrete spigot and socket pipes class 100D in accordance with SANS 677.

PSLD-3.1.9: Jointing of Pipes

a) uPVC underground pipe joints shall be concrete encased 200mm all around and 200mm to either side of the joints."

PSLD-3.4: BEDDING

Replace this clause with the following:

"Bedding shall be aggregate, sand or other non-cohesive, granular material, free of any organic material. The particle size distribution shall be such that 100% passes a 13.2mm sieve and not more than 5% passes a 0.075mm sieve.

The material shall comply with the compactability criteria as detailed under Clause PSLB-7.2."

PSLD-3.5: MANHOLES, CHAMBERS, ETC.

PSLD-3.5.4: Concrete

Add the following:

"Only granite aggregate shall be used in concrete."

PSLD-3.5.7: Step Irons

Replace this sub-clause with the following:

"Step irons shall be installed in all manholes deeper than 1.0m. Step irons shall consist of polypropylene-coated 12mm high tensile steel, such as Calcamite or approved equivalent. The installation of the step irons shall be in accordance with the specification of the manufacturer."

Add the following new sub-clause:

"PSLD-3.5.9: Backfill

PSLD-3.5.9.1: Backfilling of Sewer Pipes in General Landscaped/Non-surfaced Areas

Backfilling of sewer pipelines up to final landscaped surface level shall be carried out with material described in Clause PSL-3.13.1. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% Mod AASHTO maximum density, unless the material consists of cohesionless sand, in which case compaction shall be to 100% Mod AASHTO maximum density.

PSLD-3.5.9.2: Backfilling of Sewer Pipes in Areas Covered by Hard Surfacing and Buildings

Backfilling of sewer pipes up to the bottom of the layerworks of the hard surfaced and building areas shall be carried out with material described in clause PSL-3.13.2. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% Mod AASHTO maximum density, unless the material consists of cohesionless sand, in which case compaction shall be to 100% Mod AASHTO maximum density."

Add the following new clause:

"PSLD-3.7: INTERNAL/BUILDING SEWER PIPES AND FITTINGS

PSLD-3.7.1: General

a) All above ground waste water pipes (WP) shall be uPVC Freeflo sewer and drain systems, or approved equivalent, to SANS 967.
b) All underground waste water pipes (WP) shall be uPVC Class 34 Solid Wall (heavy duty) pipe (300kPa pipe stiffness), in accordance with SANS 791, unless indicated otherwise on the drawings.
c) All vent pipes (VP) shall be uPVC Freeflo sewer and drain systems (white pipes), or approved equivalent, to SANS 967.
d) All anti-siphonage pipes (ASP) shall be uPVC Freeflo sewer and drain systems, or approved equivalent, to SANS 791.
e) All waste fittings shall be fitted with approved anti-siphon traps or valves.
f) Waste fittings shall have 65mm deep seal traps and be individually anti-siphoned.
g) Paint colours for pipes shall be in accordance with SANS 1091.

PSLD-3.7.2: Fittings and Fixtures (at Eskom Ystervark Building)

a) Ablution hand wash basin shall be in accordance with Architect's sanitaryware schedule.
b) Ablution toilet (WC) shall be in accordance with Architect's sanitaryware schedule."

5.13.3 PSLD-5: CONSTRUCTION

PSLD-5.4: CONNECTIONS TO MANHOLES

Add the following:

"If the gradient of a pipe section approaching a manhole is more than 1:10, a set of vertical bends may be used to make the connection to the manhole, provided that no low points are formed in the pipe as a result of the bend. The configuration of pipes and bends will be subject to approval by the *Employer*."

PSLD-5.6: MANHOLES, INSPECTION CHAMBERS, ETC.

PSLD-5.6.1: General

Replace the contents of this sub-clause with the following:

"a) The foul sewer rising main line scour valve chamber at Substation N shall be constructed in accordance with section LA-0050-01.A of drawing 1924701-2-510-C-LA-0050-01.
b) Manholes for gravity foul sewer lines shall be brick manholes constructed in accordance with detail LA-0057-02.B of drawing 1924701-2-510-C-LA-0057-02.
c) Waste water drainage sumps shall be reinforced concrete manholes constructed in accordance with detail LA-0057-02.C of drawing 1924701-2-510-C-LA-0057-02.
d) Waste water drainage manholes shall be reinforced concrete manholes constructed in accordance with detail LA-0057-02.D of drawing 1924701-2-510-C-LA-0057-02.
e) The 44,000ℓ oil dam shall be a reinforced concrete structure constructed in accordance with drawings 1924701-2-510-C-LA-0057-02 and 1924701-2-510-B-DE-0023-01.
f) The oil trap shall be a double chamber brickwork structure constructed in accordance with drawing 1924701-2-510-C-LA-0057-02."

Add the following new clause:

"PSLD-5.11: MANUFACTURE, SUPPLY, DELIVER AND INSTALL 6,000ℓ CONSERVANCY TANK FOR ESKOM YSTERVARK BUILDING

The conservancy tank system shall be constructed and installed as per the detail drawings, to include, but not limited to, the following items:

a) 1 x 6,000ℓ horizontal tank (Nel tank or similar approved).
b) Incoming soil pipe system.
c) Suction pipe system.
d) Vent pipe system.
e) Extraction manhole chamber with heavy duty cover and frame.
f) Tank access manhole chamber with heavy duty cover and frame.
g) 3 x 50mm wide galvanised mild steel straps.
h) 3 x concrete anchor pedestals whereon tank shall be strapped with the 3 x galvanised straps.

After excavations for the tank system have been completed, the tank shall be placed on top of the three mass concrete anchor pedestals and a 1:6 cement/sand mix bedding layer, as indicated in the drawings.

After final installation of the conservancy tank, the tank shall be fixed with three straps and the required pipework shall be installed. The complete system shall be backfilled with a 1:6 cement/sand mix (with the tank full of water), placed in loose layers of 150mm thickness and compacted to 95% MOD AASHTO."

5.13.4 PSLD-7: TESTING

PSLD-7.1: GENERAL

Add the following to sub-clause PSLD-7.1.5:

"All foul sewer pipe pressure tests shall be repeated after the completion of backfilling of pipe trenches and the conservancy tank."

PSLD-7.2: TESTS AND ACCEPTANCE/REJECTION CRITERIA

PSLD-7.2.6: Water Tightness of Manholes

Add the following:

"A water tightness test shall be undertaken by the *Contractor* on the following underground structures:

a) Conservancy tank.
b) All wastewater manholes.
c) All foul sewer manholes.
d) All wastewater sumps.
e) 44,000 ℓ oil dam.
f) Oil trap structure.

A thorough inspection shall be done to ensure that all joints are properly sealed and that all inlet and outlet pipes are closed. The structure shall be filled to the top with water. If there are no immediately evident leakages, the structure shall remain filled for a saturation period of at least two weeks or such longer time as may be required, to permit complete saturation of the structure. The level of the water shall be carefully noted and recorded in the presence of the *Employer*.

If any leakages are visible, the water test shall be aborted. The source of the leaks shall be identified and, where possible, these shall be repaired in a method to be approved by the *Employer*. The test shall then be repeated.

At the end of the saturation period more water shall be added, if necessary, to bring the water level back to the maximum operating level. The water levels in the structure shall then be monitored daily for a period of seven days. The structure shall be deemed watertight if:

i. No visible leakage or obvious damp spots are apparent on the outside of the structure; and
ii. The drop in water level during the 7-day test period does not exceed 1/500 of the water height or 6mm, whichever is the smaller.

If the structure fails the water tightness test the *Contractor* shall determine the cause of the leakage. The leakage shall be repaired on the inside of the structure after the water has been drained. Thereafter the structure shall again be subjected to a complete water test as described above.

Payment for water tightness testing shall be included in the tendered rates for the construction of the various structures."

5.13.5 PSLD-8: MEASUREMENT AND PAYMENT

PSLD-8.2: SCHEDULED ITEMS

Replace payment item 8.2.1 with the following:

"PSLD-8.2.1: Supply, handle, lay, joint, bed and test pipelines

a) 160mm Ø uPVC class 16 sewer rising main pipe (new relocated line)..... Unit: m
b) 110mm Ø uPVC class 34 heavy duty foul sewer gravity pipes..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the provision of pipes, complete with couplings, handling, inspecting, transporting, bedding, laying, jointing, cutting, making connections into manholes and testing of the pipes and the joints, in strict accordance with this specification, as shown on the drawings and typical details or as instructed on Site by the *Employer*.

The pipeline will be measured linearly, taking account of the grade to which the pipeline is laid, and not in the horizontal plane. No deductions will be made for specials. Deductions will be made for the internal length of manholes. Separate items will apply for pipes of different materials, diameters, and classes.

The rate shall exclude the construction of the bedding cradle and selected fill blanket around and over the top of the pipes. This item is covered under SANS 1200 LB."

Replace payment item 8.2.2 with the following:

"PSLD-8.2.2: Extra-over PSLD-8.2.1 for the supplying, fixing, and bedding of valves.....Unit: No.

The tendered rate shall cover all extra-over costs (plant, equipment, material, labour, transport and the like) for the provision of each valve, complete with couplings, and the cost of the handling, fixing, bedding, and testing of the fitting or special, as applicable, and the cutting of the pipes, in accordance with this specification, as indicated on the drawings or as instructed on Site by the *Employer.*"

Replace payment item 8.2.3 with the following:

"PSLD-8.2.3: Foul Sewer Manholes

a) Scour valve manhole .....Unit: No.
b) 450mm x 450mm brick manhole.....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the excavation and complete construction of the manholes, backfilling, testing of backfilling compaction, disposing of all excess material to the designated stockpile area, as indicated in Part C.4: Site Information and finishing, in strict accordance with this specification, as shown on the drawings and typical details or as instructed on Site by the *Employer*.

The rate shall further include the leak proof testing and commissioning as per clause PSLD-7.2.6. "

Replace payment item 8.2.8 with the following:

"PSLD-8.2.8: Anchor/thrust Blocks and Pedestals (30MPa concrete/19mm stone) ..... Unit: m^3

Anchor/thrust blocks and pedestals shall be measured per cubic metre concrete. The tendered rate shall include all excavations, trimming, formwork, reinforcement (where specified), placement of concrete and screeding of top surfaces and backfilling, in strict accordance with this specification, as shown on the drawings and typical details or as instructed on Site by the *Employer* to the required dimensions as indicated on the drawings."

Replace payment item 8.2.9 with the following:

"PSLD-8.2.9: Pipe Markers

a) Marker posts.....Unit: No.
b) Kerb/edging marks.....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the manufacture, supply, transport, off-load and installation of marker posts or making kerb/edging marks, in accordance with this specification, as shown on the drawings or as instructed on Site by the *Employer*."

Replace payment item 8.2.11 with the following:

"PSLD-8.2.11: Connection to Existing Sewer

a) Newly re-routed 160mm Ø sewer pipe to existing sewer line.....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the connection to be carried out in strict accordance with the procedure described in clause PSC-5.10.2: Relocation/Removal of Services in this specification, other relevant sections of this specification, as shown on drawings or as instructed on Site by the *Employer*."

Add the following new payment items:

"PSLD-8.2.13: Installation of 6,000ℓ conservancy tank system complete with all fittings, manholes, strapping, and the like in accordance with detail LA-0057-02.A of Drawing Number 1924701-2-510-C-LA-0057-02.....Unit: Sum

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for manufacturing, supplying of all material, delivery, off-loading, excavation into soft and intermediate soil, casting of concrete anchors, placing of 1:6 cement/sand mix bedding material, installation of 6,000ℓ tank onto concrete anchors and bedding material, inter-connecting of all upstream and downstream pipework, supplying of galvanised straps, strapping of tank to concrete anchors, backfilling of tank with 1:6

cement/sand mix and testing the compaction of the backfilling, in accordance with clause PSLD-5.11 and the relevant detail drawings.

The rate shall further include the leak proof testing and commissioning as per clause PSLD-7.2.6.

PSLD-8.2.14: Install uPVC sewer vent pipes with the following nominal diameters:

a) 110mm..... Unit: m
b) 50mm..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the manufacture, supply, transport, off-load, fixing, anchoring, clipping (at 1.0m centres), installation of pipes, bends, reducers and other fittings, painting, pressure testing, disinfection, in accordance with this specification, as shown on the drawings and as prescribed in the manufacturer's specification.

PSLD-8.2.15: Install uPVC sewer waste water pipes with the following nominal diameters:

a) 50mm..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the manufacture, supply, transport, off-load, fixing, anchoring, clipping (at 1.0m centres), installation of pipes, bends, reducers and other fittings, painting, pressure testing, disinfection, in accordance with this specification, as shown on the drawings and as prescribed in the manufacturer's specification.

PSLD-8.2.16: Supply, handle, lay and bed spigot and socket wastewater pipes

a) 300mm Ø class 100D concrete wastewater pipes..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the provision of the spigot and socket pipes, complete with rubber rings, handling, inspecting, transporting, bedding, laying, jointing, cutting, making connections into manholes, sumps and the oil dam and testing of the pipes and the joints, in accordance with this specification, as shown on the drawings and as prescribed in the manufacturer's specification.

The rate shall exclude the construction of the bedding cradle and selected fill blanket around and over the top of the pipes. This item is covered under SANS 1200 LB.

PSLD-8.2.17: Wastewater Manholes/Structures

a) 600mm x 600mm (internal size) wastewater drainage sump .....Unit: No.

b) 600mm x 600mm (internal size) wastewater drainage manhole .....Unit: No.

c) 44,000ℓ oil dam .....Unit: No.

d) Oil trap .....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the excavation, complete construction of the manholes/structures/sumps as described in clause PSLD-5.6.1 above (including all fitting, covers, frames, pipes, access ladders, etc.), backfilling, testing of backfilling compaction, disposing of all excess material to the designated stockpile area as indicated in Part C.4: Site Information and finishing, in strict accordance with this specification, as shown on the drawings and typical details or as instructed on Site by the *Employer*.

The rate shall further include the leak proof testing and commissioning as per clause PSLD-7.2.6.

PSLD-8.2.18: Install one-way vent valves with the following nominal diameters:

a) 110mm.....Unit: No.
b) 50mm.....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the manufacture, supply, transport, off-load, fixing, anchoring, clipping (at 1.0m centres), installation of one-way vent valves and painting, in accordance with this specification, the project drawings and the manufacturer's specifications."

5.14 PSLE: STORMWATER DRAINAGE

5.14.1 PSLE-1: SCOPE

Replace this clause with the following:

"This specification covers the supply and installation of the following stormwater and subsoil infrastructure:

a) New underground concrete stormwater pipe lines.
b) New underground uPVC stormwater pipe lines.
c) New underground HDPE subsoil drainage systems.
d) New underground reinforced concrete stormwater grated channels.
e) New augured stormwater soak away drains.
f) New stormwater reinforced concrete head walls.
g) New detention pond lining and overflow structures.
h) New lined V-drain channels.
i) New stormwater manholes and catch pits.
j) New stormwater harvesting tank for the Eskom Ystervark building at the Main Intake Substation."

5.14.2 PSLE-3: MATERIALS

PSLE-3.1: CULVERT UNITS AND PIPES

Add the following:

"All underground stormwater pipes smaller than 300mm diameter shall be uPVC class 34 solid wall (heavy duty) pipe (300kPa pipe stiffness), in accordance with SANS 791 or HDPE PE100 PN9 (SDR 17) pipe, unless indicated otherwise on the drawings.

All pipes 300mm Ø and larger shall be reinforced concrete spigot and socket pipes class 100D in accordance with SANS 677.

Subsoil pipes shall be perforated HDPE pipes (Drainex or approved equivalent)."

PSLE-3.3: BEDDING MATERIALS

PSLE-3.3.1: Bedding Cradle and Selected Fill Blanket

Replace this sub-clause with the following:

"Bedding cradle and selected fill blanket material shall be aggregate, sand or other non-cohesive, granular material, free of any organic material. The particle size distribution shall be such that 100% passes a 13.2mm sieve and not more than 5% passes a 0.075mm sieve. The material shall comply with the compactability criteria as detailed under Clause PSLB-7.2."

PSLE-3.4: MANHOLES, CATCHPITS AND ACCESSORIES

PSLE-3.4.4: Step Irons

Replace this sub-clause with the following:

"Step irons shall be installed in all manholes deeper than 1.0m. Step irons shall consist of polypropylene-coated 12mm high tensile steel, such as Calcamite or approved equivalent. The installation of the step irons shall be in accordance with the specification of the manufacturer."

Add the following new clauses:

"PSLE-3.6: BACKFILL

PSLE-3.6.1: Backfilling of Pipes, Channels and Other Stormwater Structures in General Landscaped/ Non-surfaced Areas)

Backfilling of pipes up to final landscaped surface level shall comprise of material as described in Clause PSL-3.13.1. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% Mod AASHTO maximum density, unless the material consists of cohesionless sand, in which case compaction shall be to 100% Mod AASHTO maximum density.

PSLE-3.6.2: Backfilling of Pipes, Channels and Other Stormwater Structures in Areas Covered by Hard Surfacing

Backfilling of pipes up to the underside of the layerworks of the hard surfaced areas shall be carried out with material as described in Clause PSL-3.13.2. This material shall be mixed with the correct quantity of water, placed in layers not exceeding 150mm thickness and compacted by means of approved compaction plant to a minimum of 93% MOD AASHTO.

PSLE-3.7: SUBSOIL DRAINAGE STONE

All subsoil drainage stone shall consist of 19mm clean washed single-sized crushed concrete stone aggregate with a minimum 10% fines value of 150kN. The stone shall conform to the grading analysis for a 19mm Grade 1 single-sized crushed stone aggregate given in Table 1 of SANS 1200 M.

PSLE-3.8: SUBSOIL DRAINAGE GEOTEXTILE

The subsoil drainage geotextile shall be a continuous filament non-woven needle-punched geotextile (Kaytech A2 or approved equivalent).

To ensure proper coverage, adjacent sections of geotextile shall have an overlap of 300mm and shall be joined by one of the following methods:

a) Sewing with polyester thread.
b) Blanket stitching with galvanised wire or polyester thread.
c) Stapling with rods or wire."

5.14.3 PSLE-5: CONSTRUCTION

Add the following new clauses:

"PSLE-5.8: MANUFACTURE, SUPPLY, DELIVER AND INSTALL GRATED CHANNEL COVERS

All new underground channels and grid inlet structures shall be covered by a Mentis RS40 Rectagrid B60 type Gripweld grating cover (hot-dipped galvanised), fixed on top of hot-dipped galvanised 45x45x5 RSA's, welded back to back to 75x75x6 RSA's with Y10 fishtail lugs at 300mm centres (120mm long each). The covers shall be supplied with saddle clips placed at the spacing as recommended by manufacturer.

Prior to galvanising, all RSA and Mentis Grating shall be thoroughly cleaned by means of grid blasting to SA 2½ finish, in compliance with the requirement of SIS 05 59 00.

PSLE-5.9: MANUFACTURE, SUPPLY, DELIVER AND INSTALL ARMORFLEX BLOCKS FOR THE LINING OF STORMWATER V-CHANNELS, DETENTION POND, HEAD WALL OUTFLOW AREA AND OVERFLOW AREA

All sloped sides/banks of stormwater V-channels, as well as the bottom beds of these V-channels, detention ponds and other areas indicated on the drawings shall be lined with the Armorflex system, or an equivalent system as approved by the *Employer*. The minimum specifications for the Armorflex system shall be the following:

a) Blocks shall be precast Technicrete Armorflex 140 open blocks, or approved equivalent.
b) Blocks shall be laid in stretcher bond pattern to achieve mechanical interlock.
c) 3.1mm Ø galvanised fencing wire or 5mm Ø polyester rope shall be used to interlink the blocks by

pushing the wire/rope through the cable ducts inside the blocks.

d) Block placement, wiring up, anchoring and finishing shall be strictly to the manufacturer's specifications and details.
e) Blocks shall be placed on A2 Kaytech Bidim (or approved equivalent) and bedded on 50mm clean sand bedding. The bedding sand shall conform to the requirements of Sub-clause PSLB-3.1.
f) Blocks shall be filled with clean sand stabilized with 3% cement.

PSLE-5.10: GROUTED STONE PITCHING ON A CONCRETE BED

PSLE-5.10.1: Stone for Pitching

Stone for the pitching shall be sound, tough and durable, with stones being no larger than 200mm and no smaller than 150mm (for medium pitching) in minimum dimension, except that smaller pieces or spalls may be used for filling spaces between the larger stones. The rocks or stones shall be shaped and placed to form a stable protective layer of the required thickness.

PSLE-5.10.2: Placing of Stone Pitching

The area shall be prepared by excavating, shaping and trimming as necessary for pitching, and by thoroughly compacting the area to at least 93% MOD AASHTO (100% for sand) by hand-ramming to prevent subsequent settlement.

Where stone pitching is to be placed along steep embankments, the *Employer* may instruct the *Contractor* to strengthen the toe of the stone pitching by increasing the depth along the base.

A 100mm thick concrete bed (20MPa/19mm stone) shall be placed on the prepared surface. The stone pitching shall be laid while the concrete is still fresh. Joints between stones shall be filled with cement grout. Care shall be taken not to spill grout onto the finally exposed surfaces of the stones. Grout spillage onto the exposed surfaces of the stones shall be removed before the grout has set. All joints between stones shall be neatly finished.

The mortar for grouting shall be mixed and placed in a continuous operation to provide a uniform finish. The grout shall be worked into the pitching to ensure that all spaces or voids between the stones will be completely filled with grout to the full depth of the stone pitching.

The grouted pitching shall be cured with wet sacking or other approved wet cover for a period of not less than four days after grouting and shall not be subjected to loading until adequate strength has been developed. Where required, weep holes shall be formed in the pitching.

The completed pitching shall have a uniform, compacted appearance. The level of the finished surface shall not deviate by more than 25mm from the specified lines and grades.

PSLE-5.11: AUGERED HOLES FOR DRAINAGE APPLICATIONS

Where indicated on drawings or when instructed by the *Employer*, the *Contractor* shall auger or bore holes of size 400mm Ø and depths of at least 10.0m, for the purpose of soakaway drainage.

Each hole shall be filled with imported coarse sand (selected granular material) to be aggregate, sand or other non-cohesive, granular material, free of any organic material and of which the particle size distribution shall be such that 100% passes a 13.2mm sieve and not more than 5% passes a 0.075mm sieve."

5.14.4 PSLE-8: MEASUREMENT AND PAYMENT

PSLE-8.2: SCHEDULED ITEMS

Replace payment item 8.2.1 with the following:

"PSLE-8.2.1: Supply, handle, lay and bed spigot and socket stormwater pipes ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the provision of pipes, complete with couplings, handling, inspecting, transporting, bedding, laying, jointing, cutting, making connections into manholes and testing of the pipes and the joints. The pipeline will be measured linearly, taking account of the grade to which the pipeline is laid, and not in the horizontal plane. No deductions will be made for specials. Deductions will be made for the internal length of manholes. Separate items will apply for pipes of different materials, diameters, and classes. The rate

shall exclude the construction of the bedding cradle and selected fill blanket around and over the top of the pipes. This item is covered under SANS 1200 LB."

PSLE-8.2.8: Supply and Install Manholes, Catch pits, and the Like

Insert after "brickwork (if any)", the words "step irons,".

Add the following:

"Notwithstanding the provisions of Sub-Clause 8.2.8.c), manholes, catch pits, and the like will be scheduled by means of separate items for various categories of depth (increasing by increments) and type. For measurement and payment purposes the depth of a manhole is defined as the depth from the top of the cover to the invert level of the manhole."

Add the following new payment items:

"PSLE-8.2.14: Supply and lay pipe inside concrete encasement
(encasement measured elsewhere) ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the provision of pipes complete with couplings, handling, inspecting, transporting, laying, jointing, cutting, concrete encasing and testing of pipes and the joints, in strict accordance with this specification, the drawings and the manufacturer's specification.

PSLE-8.2.15: Reinforced concrete (40MPa/19mm stone) stormwater grated channel (900mm wide), complete with heavy duty hot dipped galvanised grating, benching and isolation joints all around, in accordance with detail:

a) LA-0048-01.E of Drawing Number 1924701-2-510-C-LA-0048-01 ..... Unit: m
b) LA-0053-01.C of Drawing Number 1924701-2-510-C-LA-0053-01 ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the complete construction of the reinforced concrete stormwater grated channels, in strict accordance with this specification, the drawings or as instructed on Site by the *Employer.*

PSLE-8.2.16: 400mm Ø x 10m deep augured stormwater soak away vertical drain filled with clean coarse graded sand in accordance with detail:

a) LA-0048-01.K of Drawing Number 1924701-2-510-C-LA-0048-01 .....Unit: No.
b) LA-0053-01.G of Drawing Number 1924701-2-510-C-LA-0053-01.....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the complete construction of the stormwater soakaway vertical drains, including, but not limited to, the drilling of 10m deep augured holes and filling them with clean, coarse sand, in strict accordance with this specification and the drawings, or as instructed on Site by the *Employer.*

The tendered rates shall further include the establishment and de-establishment of the piling plant and equipment on and from Site as well as the moving and setting up of the plant and equipment at each position of augering or boring.

PSLE-8.2.17: Supply, handle, lay, joint and bed spigot and socket HDPE perforated
subsoil pipes ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the provision of perforated HDPE subsoil pipes, complete with couplings, handling, inspecting, transporting, bedding in 19mm concrete stone (in accordance with PSLE-3.7), laying, jointing, cutting, making connections into manholes, wrapping trench in geotextile (in accordance with PSLE-3.8) and testing of the pipes and the joints, in strict accordance with this specification and the drawings, or as instructed on Site by the *Employer.*

PSLE-8.2.18: 30MPa (19mm stone) concrete stormwater headwalls complete as per the following details:

a) LA-0053-01.H of Drawing Number 1924701-2-510-C-LA-0053-01 ..... Unit: m
b) LA-0055-03.A of Drawing Number 1924701-2-510-C-LA-0055-03 ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the excavation, complete construction of the stormwater headwall in accordance with this specification and the drawings, or as instructed on Site by the *Employer,* backfilling, disposing of all excess material to the designated stockpile area as indicated in Part C.4: Site Information and finishing, in strict accordance with this specification and the drawings, or as instructed on Site by the *Employer.*.

PSLE-8.2.19: Lining of detention pond base, headwall outflow area and pond overflow area with Armorflex blocks (or equivalent approved) ..... Unit: m²

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the manufacture, supply, delivery, off-loading, bedding preparation, placement and filling of blocks with cement stabilised sand, in strict accordance with this specification, the drawings and the manufacturer's details, as described in Clause PSLE-5.9, in strict accordance with this specification and the drawings, or as instructed on Site by the *Employer.*

PSLE-8.2.20: Lining of open V-drain channels, with:

a) 1,200mm wide x 200mm thick 30MPa (19mm stone) in-situ cast concrete ..... Unit: m
b) 4,000mm wide x 800mm deep precast concrete Armorflex blocks (or equivalent approved) in accordance with section LA-0055-03.2 of drawing 1924701-2-510-C-LA-0055-03..... Unit: m

The tendered rate for item a) shall cover all costs (plant, equipment, material, labour, transport and the like) for casting of the concrete slabs, in strict accordance with this specification, as shown on the drawings, or as instructed on Site by the *Employer,* including, but not limited to, the surface preparation, formwork, placement of reinforcing, jointing (transverse, longitudinal and isolation joints), casting of concrete, vibrating of concrete, curing, finishing, testing, and the like.

The tendered rate for item b) shall cover all costs (plant, equipment, material, labour, transport and the like) for the manufacture, supply, delivery, off-loading, bedding preparation, placement and filling of blocks with cement stabilised sand, in strict accordance with this specification, the manufacturer's details, as shown on the drawings or as instructed on Site by the *Employer*.

PSLE-8.2.21: Supply, handle, place on pedestal (measured elsewhere) an external 2,500ℓ horizontal stormwater harvesting tank (Jo-Jo tank or similar/equivalent approved) complete with fittings, lid and the like.....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the sourcing, supply, delivery, off-loading, installation, fixing to building wall with 2 x 50mm wide galvanised mild steel straps (fixed to the building with suitable sized chemical anchors) and connecting all incoming downpipe and outgoing water supply pipes, complete with bends, reducers and the like, in strict accordance with this specification, the manufacturers specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSLE-8.2.22: Grouted Stone Pitching on a Concrete Bed..... Unit: m²

The tendered rate shall include full compensation for furnishing all materials, making all excavations, compacting and trimming the excavated surfaces, placing stones and grouting, as well as all other *works* necessary for completing the pitching as specified. The tendered rate shall also include full compensation for the concrete bed.

PSLE-8.2.23: Drainage Dish behind Kerb Line..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the creating dished drainage channels behind kerb lines as indicated on the drawings or as instructed on Site by the *Employer*.

PSLE-8.2.24: Connection of 110mm Ø Drainage Pipes to Sleeve Trenches .....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the construction of the 110mm Ø drainage pipes into the brick walls of the sleeve trench and closing all openings between the pipe and the brick wall with a suitable cementitious grout, to be carried out as shown on drawings or as instructed on Site by the *Employer*."

5.15 PSM: ROADS (GENERAL)

5.15.1 PSM-5: CONSTRUCTION

Add the following:

"The following types of surfacing and layerworks will typically be used for the *works*:

PSM-5.1: ROAD CROSSINGS

a) Asphalt Road Crossings

- 30mm to 70mm continuously graded asphalt surfacing and base with modified binder (type A-E2).
- 150mm G1 crushed stone base layer, compacted to 88% of apparent relative density.
- 150mm C3 stabilized subbase layers (constructed from G5 quality material 3% cement stabilised) and compacted to 98% MOD AASHTO.
- 150mm C4 stabilized subbase layers (constructed from G5 quality material 3% cement stabilised) and compacted to 98% MOD AASHTO.
- 150mm G7 selected layer compacted to 97% MOD AASHTO.
- 150mm in-situ roadbed preparation compacted to 93% MOD AASHTO (100% for sand).

b) Concrete Road Crossings

- 250mm Reinforced 40MPa jointed concrete surface bed with flexural strength of 3.8 MPa.
- 150mm C2 cement stabilised subbase layer (constructed from G3 quality material 3% cement stabilised) and compacted to 98% MOD AASHTO.
- 150mm G7 selected subgrade layer compacted to 95% MOD AASHTO (100% MOD AASHTO for sand).
- 150mm in-situ roadbed preparation compacted to 93% MOD AASHTO (100% for sand).

c) Segmental Block Paved Road Crossings

- 80mm heavy duty 35MPa block pavers laid in herringbone pattern.
- 20mm bedding sand.
- 150mm C3 cement stabilised subbase layer (constructed from G5 quality material 3% cement stabilised) and compacted to 98% MOD AASHTO.
- 150mm G5 subbase layer compacted to 95% MOD AASHTO.
- 150mm G7 selected subgrade layer compacted to 97% MOD AASHTO.
- 150mm in-situ roadbed preparation compacted to 93% MOD AASHTO (100% for sand).

d) Gravel Service Road Crossings

- 150mm Subbase gravel wearing course compacted to 97% MOD AASHTO.
- 150mm imported gravel G7 selected subgrade layer compacted to at least 95% MOD AASHTO.
- 150mm in-situ roadbed preparation compacted to 93% MOD AASHTO (100% for sand).

PSM-5.2: NEW ROADS AND SURFACING

PSM-5.2.1: Substation M and N

a) New Concrete Roads/Yards

- 250mm concrete slab with 28-day cube strength of 40MPa (19mm stone) and design flexural of 3.8MPa.
- 150mm C3 cement-stabilized subbase, compacted to 97% MOD AASHTO.
- 150mm imported gravel G7 selected subgrade layer compacted to at least 95% MOD AASHTO.
- 150mm in-situ roadbed preparation compacted to 93% MOD AASHTO (100% for sand).

PSM-5.2.2: Main Intake Substation

a) External Gravel Access Roads

i. Access Road 1 and 2

- 200mm gravel wearing course compacted to at least 98% MOD AASHTO.
- 150mm G5 subbase compacted to at least 95% MOD AASHTO.
- 150mm imported gravel G7 selected subgrade compacted to at least 95% MOD AASHTO.
- 150mm in-situ roadbed preparation compacted to 93% of MOD AASHTO (100% for sand).

ii. Access Road 3 and 4

- 150mm gravel wearing course compacted to at least 98% MOD AASHTO.
- 150mm imported gravel G7 selected subgrade compacted to at least 95% MOD AASHTO.
- 150mm in-situ roadbed preparation compacted to 93% of MOD AASHTO (100% for sand).

b) Internal Block Paved Access Roads

- 80mm S-A Interlocking concrete heavy duty pavers on 20mm bedding sand placed in herringbone pattern.
- 150mm C3 cement-stabilized subbase compacted to 97% MOD AASHTO.
- 150mm rip and re-compact imported G5 subbase platform to 95% MOD AASHTO.

c) Transformer Delivery Road and Area Surrounding Substation

- 250mm Concrete slab with 28-day cube strength of 40MPa (19mm stone) and design flexural of 3.8MPa.
- 150mm C3 cement-stabilized subbase compacted to 97% MOD AASHTO.
- 150mm rip and re-compact imported G5 subbase platform to 95% MOD AASHTO.

d) Substation Yard

- 100mm thick 37.5mm clean single-sized crushed concrete stone aggregate drainage layer (yard stone).
- Kaytech A4 Bidim or approved equivalent geofabric.
- 1.15m thick G5 subbase platform placed in 150mm layers and each layer compacted to at least 95% MOD AASHTO.”

5.16 PSME: SUBBASE

5.16.1 PSME-1: SCOPE

Add the following:

"This specification shall also cover the following:

a) The minimum required specifications for the placement and compaction of the new 100mm thick drainage layer/wearing course (also referred to as yard stone) on top of a nonwoven polyester geotextile on top of the G5 subbase engineered platform at the new Main Intake Substation yard.
b) The minimum required specifications for the placement of new road crossing subbase layers (stabilized and unstabilized)."

5.16.2 PSME-3: MATERIALS

PSME-3.2: PHYSICAL PROPERTIES

PSME-3.2.1: Subbase Material

Add the following:

"The material standards shall also comply with the relevant provisions of SANS 1200 M for stabilised materials.

The *Contractor* shall obtain all new subbase material from an approved commercial source. All haulage shall be included in the rates."

Add the following new sub-clauses:

"PSME 3.2.3: Drainage Layer/Wearing Course (Yard Stone)

A drainage layer ('yard stone') of minimum thickness of 100mm, consisting of 37.5mm clean (washed) single-sized crushed stone, shall be constructed on top of the G5 subbase platform at the Eskom and Transnet yards located at the main intake substation.

The drainage stone shall conform to the grading analysis for a 37.5mm single-sized crushed stone aggregate given in Table 2 of SANS 1083.

PSME 3.2.4: Drainage Layer Geotextile

Prior to the placement and compaction of the drainage stone layer, a needle-punched nonwoven polyester geotextile of type Kaytech A4 Bidim (or approved equivalent) shall be placed on top of the G5 subbase platform.

To ensure proper coverage, adjacent pieces of geotextile shall have an overlap of 300mm and joined by one of the following methods:

a) Sewing with polyester thread.
b) Blanket stitching with galvanised wire or polyester thread.
c) Stapling with rods or wire.

The geotextile shall further extend vertically up against all foundations within the substation platform up to the top of the stone drainage layer (i.e. 100mm vertically extended).

The *Contractor* shall allow in his tendered rates for all overlapping and vertical extensions of the geotextile. The Contractor will only be renumerated for the quantity of geotextile placed (and measured) in plan."

5.16.3 PSME-5: CONSTRUCTION

PSME-5.4: PLACING AND COMPACTION

Add the following new sub-clause:

"PSME-5.4.5: Benching

All new road or platform layerworks/courses adjoining existing roads and/or platforms shall be tied in together by means of proper benching techniques. The depth of benching shall equal the respective layer thicknesses and the width shall be at least 150mm."

5.16.4 PSME-7: TESTING

PSME-7.2: PROCESS CONTROL AND ROUTINE INSPECTION AND TESTING

PSME-7.2.1: Process Control

Replace Table 2 with the following:

Table 23: Testing Frequency: Subbase Materials

Test	Position in Layer	Testing Frequency
Density (Relative Compaction at OMC)	C3 subbase for Substation M and N concrete yard, Main Intake Substation internal block paved access roads and Main Intake Substation concrete paved transformer road and building surrounds	1 test per 200m² of 150mm C3 subbase layer placed
	G5 subbase for Main Intake Substation external gravel access roads	1 test per 200m² of 150mm G5 subbase layer placed
	Gravel wearing course for Main Intake Substation access roads	1 test per 200m² of gravel wearing course layer placed
	Road crossings	- Two tests per subbase layer (G5, C2, C3 or C4) per road crossing - Two tests per gravel wearing course layer per road crossing
Indicator Tests, Gradings and CBR	C3 subbase for Substation M and N concrete yard, Main Intake Substation internal block paved access roads and Main Intake Substation concrete paved transformer road and building surrounds	1 test per 100m³ of C3 subbase material placed
	G5 subbase for Main Intake Substation external gravel access roads	1 test per 100m³ of G5 subbase material placed
	Gravel wearing course for Main Intake Substation access roads	1 test per 200m³ of gravel wearing course material placed
	Road crossings	One test for each source of subbase or gravel wearing course material used for road crossings
UCS/ITS	C3 subbase for Substation M and N concrete yard, Main Intake Substation internal block paved access roads and Main Intake Substation concrete paved transformer road and building surrounds	1 test per 100m³ of C3 subbase material placed
	Road crossings	One complete set of UCS and ITS tests per source of material used for road crossings

Add the following:

"The cost for all process control tests (as set out in Table 23 above) shall be included in the rates for supplying, processing, placing and compacting of the various layers."

PSME-7.2.2: Routine Inspection and Testing

Replace this sub-clause with the following:

The *Contractor* shall conduct the appropriate tests as given in TMH1 to check that the materials and workmanship comply with the applicable requirements given in this specification. Should the average and minimum density of a test(s) carried out in accordance with Table 23 above be equal to or exceed the applicable values given in Table 24 below, the compaction shall be deemed to comply with the requirements for density.

Table 24: Compaction Densities for Subbase Materials

Specified Density (% of modified AASHTO maximum density)	Average Density % (of at least 3 positions tested)	Minimum density for any single test
95.0	95.7	92.4
97.0 (stabilised)	97.5	94.5"

5.16.5 PSME-8: MEASUREMENT AND PAYMENT

Add the following new payment items:

"PSME-8.3.11: Tie new C3 subbase layer in with existing road layerworks by means of benching..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the proper benching (minimum 150mm wide) of the new C3 subbase layer to tie in with existing adjoining road or platform layers as indicated on the drawings or as instructed on Site by the *Employer*.

PSME-8.3.12: Tie new G5 gravel subbase layer in with existing road layerworks by means of benching..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the proper benching (minimum 150mm wide) of the new G5 subbase layer with existing adjoining road or platform layers as indicated on the drawings or as instructed on Site by the *Employer*.

PSME-8.3.13: Tie new G7 gravel selected layer in with existing road layerworks by means of benching..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, water, transport and the like) for the proper benching (minimum 150mm wide) of the new G7 gravel layer with existing adjoining road or platform layers as indicated on the drawings or as instructed on Site by the *Employer*.

PSME-8.3.14: Construct 100mm thick drainage layer/wearing course from 37.5mm clean (washed) single-sized crushed concrete stone aggregate compacted until stone interlocking is achieved..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for procuring, transporting, stockpiling, washing, placing, shaping, processing and compacting the stone layer to the applicable minimum degrees of compaction, in accordance with PSME 3.2.3 or as instructed on Site by the *Employer.*

PSME-8.3.15: Supply, handle and install nonwoven polyester geotextile ..... Unit: m^2

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for procuring, transporting, placing, overlapping, extending up against foundations and joining of the geotextile, in accordance with PSME 3.2.4 or as instructed on Site by the *Employer."*

5.17 PSMF: BASE

5.17.1 PSMF-1: SCOPE

Add the following:

"This specification shall also cover the following:

a) The minimum required specifications for the placement of new road crossing base layers (unstabilized)."

5.17.2 PSMF-3: MATERIALS

PSMF-3.3: PHYSICAL AND CHEMICAL PROPERTIES

PSMF-3.3.2: Graded Crushed Stone

Replace sub-clause 3.3.2.a) with the following:

"PSMF-3.3.2.a): The maximum size of the crushed stone shall be 37.5mm"

Add the following new sub-clause:

"PSMF-3.3.2.d): The CBR at the specified density shall be at least 80%."

5.17.3 PSMF-7: TESTING

PSMF-7.2: PROCESS CONTROL

Replace this sub-clause with the following:

"Table 25: Testing Frequency: Base Materials

Test	Position in Layer	Testing Frequency
Density (Relative Compaction at OMC)	Road crossings (G1 base material)	Two tests per base layer per road crossing
Indicator Tests, Gradings and CBR	Road crossings (G1 base material)	One test for each source of base material used for road crossings
ACV, 10% FACT, Flakiness Index	Road crossings (G1 base material)	One test for each source of base material used for road crossings

The cost for all process control tests (as set out in Table 25 above) shall be included in the rates for supplying, processing, placing and compacting of the various layers."

PSMF-7.3: ROUTINE INSPECTION AND TESTING

Replace this sub-clause with the following:

"The *Contractor* shall conduct the appropriate tests as given in TMH1 to check that the materials and workmanship comply with the applicable requirements given in this specification. Should the average and minimum density of a test(s) carried out in accordance with Table 25 above be equal to or exceed the applicable values given in Table 26 below, the compaction shall be deemed to comply with the requirements for density.

Table 26: Compaction Densities for Subbase Materials

Specified Density (% of apparent relative density)	Average Density % (of at least 3 positions tested)	Minimum density for any single test
88	88.5	86.0

5.18 PSMH: ASPHALT BASE AND SURFACING

5.18.1 PSMH-1: SCOPE

Add the following:

"This specification shall also cover the following:

a) The minimum required specifications for the placement of new road crossing Asphalt surfacing in accordance with clauses PSC-5.9: ROAD CROSSINGS and PSM: ROADS (GENERAL)."

5.18.2 PSMH-3: MATERIALS

PSMH-3.4: BITUMINOUS BINDER

Replace this clause with the following:

"The binder to be used for the asphalt base and surfacing shall be a polymer-modified binder (Modified Binder Class A-E2), manufactured from 50/70 penetration grade bitumen complying with the requirements of SANS 4001-BT1. The polymers to be used to modify the bitumen shall be styrene butadiene styrene (SBS). The modified bitumen shall conform to the requirements for Binder Class A-E2 as set out in Table 27 below.

Table 27: Properties of Polymer Modified AE-2 Binder for Hot-Mix Asphalt

Property	Unit	Test Method	Specified Values
Before Ageing			
Softening Point[1]	°C	MB-17	65-85
Elastic Recovery @ 15 °C	%	MB-4	>60
Force ductility @ 5°C	N	**DIN EN 13703**	report[3]
Dynamic viscosity @165°C	Pa.s	MB-18	≤ 0.6
Storage stability @160°C	°C	MB-6	≤ 5
Flash Point	°C	ASTM D93	≥ 230
After Ageing (RTFOT)			
Mass change	%	MB-3	≤1.0
Difference in Softening point	°C	MB-17	-2 to +8
Elastic Recovery @ 15 °C	%	MB-4	>50
Dynamic viscosity @165°C	Pa.s	MB-18	report[2]

Notes:

1. The prescribed test method is based on not using stirrers.
2. No limits are given and the values should be recorded for reporting purposes only as they may be used in future specifications
3. No values given but the test can be used to rank various binders according to their low temperature cohesion properties."

5.18.3 PSMH-8: MEASUREMENT AND PAYMENT

Add the following new payment item:

"PSMH-8.5.9: Extra over items 8.5.4 for the transportation cost of bitumen binder supplied by a refinery outside the Western Cape Province.....Unit: ton (t)

Where bitumen that meets the requirements of the specification is not available from a refinery in the Western Cape Province, the *Employer* may agree that material be imported from other sources.

The unit of measurement shall be the ton of net cold bituminous binder and shall be calculated from the average binder content of the asphalt placed for a day's work or the actual volume of prime, tack and binder sprayed.

The tendered rate shall include full compensation for the additional cost of transporting bituminous binder which meets all the requirements of the specification from a refinery outside the Western Cape Province. Any difference in the "ex refinery" price of bitumen shall be compensated for by means of the special material adjustment formula."

5.19 PSMK: KERBING AND CHANNELLING

5.19.1 PSMK-1: SCOPE

Add the following:

"This specification shall also cover the following:

a) The trimming of trench excavations for concrete and precast concrete lined V-drains and open drains."

5.19.2 PSMK-8: MEASUREMENT AND PAYMENT

PSMK 8.2: SCHEDULED ITEMS

Change the heading of payment item 8.2.1 to read as follows:

"PSMK 8.2.1: Concrete kerbing, edging and channelling ..... Unit: m"

Change the heading of payment item 8.2.7 to read as follows:

"PSMK 8.2.7: Trimming of excavations for concrete-lined open drains in soft and intermediate material, for: ..... Unit: m"

5.20 PSMM: ANCILLARY ROADWORKS

5.20.1 PSMM-8: MEASUREMENT AND PAYMENT

Add the following new payment items:

"PSMM 8.6: BOLLARDS

PSMM 8.6.1: Supply and install bollards in accordance with detail LA-0047-01.A of Drawing Number 1924701-2-510-C-LA-0047-01 .....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for sourcing, supply, excavation, complete construction and installation of the bollard, backfilling, disposing of all excess material to the designated stockpile area as indicated in Part C.4: Site Information and finishing, in accordance with the specifications and drawings, or as instructed on Site by the *Employer.*

PSMM 8.7: SIGNAGE

PSMM 8.7.1: Road signs with painted background and symbols and with signboard constructed from aluminium sheeting (2mm thick) complete and in accordance to class III of SANS 1519 .....Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for sourcing, supply, fabrication, excavation, complete construction and erection of the road signs, backfilling, disposing of all excess material to the designated stockpile area as indicated in Part C.4: Site Information and finishing, in accordance with the specifications and drawings, or as instructed on Site by the *Employer."*

5.21 PSQ: STEEL PALISADE FENCING AND GATES

5.21.1 PSQ-1: SCOPE

This specification covers the requirements for the design, supply and installation of galvanized steel palisade fencing. This specification shall be read in conjunction with drawings 1924701-2-510-C-LA-0056-03, 1924701-2-510-C-DE-0011-01 and 1924701-2-510-C-DE-0011-02.

5.21.2 PSQ-2: DESIGN AND CONSTRUCTION

PSQ-2.1: FENCE POSTS

a) The main fence posts (items 8) shall be constructed of I.P.E. sections of size 100mm x 55mm x 2,990mm long with a maximum spacing between posts, centre to centre, of not more than 3,000mm.
b) The corner posts (items 9) shall be constructed of I.P.E. sections of size 100mm x 55mm x 2,990mm long with 2 x Flat sections (items 17) of size 40mm x 8mm x 206mm each.
c) The posts for the 2.4m fence shall have a minimum height of 3,050mm.
d) All fence posts shall be fitted with 2 x connector straps of size 40mm x 8mm x 140mm each, of which 1 is at the top and 1 at the bottom of the post.
e) All posts shall conform to SANS 10162. The grade of steel shall be 300WA as defined in SANS 50025. All steel shall be thoroughly cleaned by means of grid blasting to SA 2½ finish, in compliance with the requirement of SIS 05 59 00, and then hot dip galvanised to SANS 121, unless otherwise specified, after welding has been completed. All marks stamped into the steel shall be visible after galvanizing.
f) All welding shall conform to BS 5135.
g) The height of the planted posts shall be the same height as the adjacent pales.
h) None of the posts may be joined on Site by welding to achieve the specified height.

PSQ-2.2: FENCE PALES

a) The minimum height of the pales above ground shall be 2.400mm.
b) The pales (items 6) shall be constructed of 3mm x 65mm x 22mm “Classic Palisade” D-sections or 40mm x 40mm x 3mm angle iron sections (RSA).
c) All pales shall conform to SANS 10162. The grade of steel shall be 300WA as defined in SANS 50025. All steel shall be thoroughly cleaned by means of grid blasting to SA 2½ finish, in compliance with the requirement of SIS 05 59 00, and then hot dip galvanised to SANS 121, unless otherwise specified, after welding has been completed. All marks stamped into the steel shall be visible after galvanizing.
d) All welding shall conform to BS 5135.
e) The top of the pales shall have a spearhead shape.
f) No vertical pales may be joined by welding to achieve the specified height.

PSQ-2.3: FENCE PANELS

a) The panels shall be constructed of pales as specified in sections PSQ-2.2 and PSQ-2.4 of this specification.
b) All pales shall be completely welded on both sides to the horizontal rails. All welding flux shall be removed prior to galvanizing. Cold galvanizing shall be used for touching up if remedial welding is done on Site, subject to the approval of the *Employer*.
c) The maximum gap distance between the pales shall not exceed 155mm.
d) The maximum distance from the top rail to the top of the pale shall not exceed 300mm.
e) The maximum distance from the bottom rail to the bottom of the pale shall not exceed 130mm.

PSQ-2.4: FENCE TOP AND BOTTOM HORIZONTAL PANEL FIXING RAILS

a) Horizontal rails (items 1 to 3) shall be 50mm x 50mm x 6mm angle iron sections (RSA) - (2 per fence panel).

PSQ-2.5: GATEPOSTS AND GATES

PSQ-2.5.1: General

a) Anti-tamper facilities shall be provided for each gate locking mechanism.

b) The design for the anti-tamper facility shall be submitted to the *Employer* for approval prior to placement of orders.
c) The maximum distance from the top rail of the gate panel to the top of the pale shall not exceed 300mm and from the bottom rail of the gate panel to the bottom of the pale shall not exceed 130mm.
d) All welding on the gates and panels shall be full-depth, i.e. no tack welding will be allowed.
e) All gate posts, gate frames and gate pales shall be thoroughly cleaned by means of grid blasting to SA 2½ finish, in compliance with SIS 05 59 00, and then hot-dip galvanised to SANS 121.

PSQ-2.5.2: 1.0m Pedestrian Gates

a) Gateposts (items 10) shall be constructed of I.P.E. sections of size 100mm x 55mm x 2,990mm long with 2 x flat sections of size 40mm x 8mm x 68mm long each.
b) The gate frame/fixing rail (items 4) shall be constructed from the following material:

- 50mm x 50mm x 3mm square tubing.
- 2 x flat sections of size 40mm x 20mm x 50mm long each.
- 4 x flat sections of size 100mm x 8mm x 100 long each.
- 2 x 20mm Ø x 133mm long round bars.
- 2 x 40mm Ø x 100mm long round bars.

c) The in-fill for the gate frame shall be pales made of 3mm x 65mm x 22mm “Classic Palisade” D-sections or 40mm x 40mm x 3mm angle iron sections (RSA).

PSQ-2.5.3: Swing Gates

a) Gateposts (items 11) shall be constructed of I.P.E. sections of size 140mm x 73mm x 2,984mm long with 2 x flat sections of size 40mm x 8mm x 68mm long each and 1 x plate of size 250mm x 250mm x 6mm.
b) The gate frame/fixing rail (items 5) shall be constructed from the following material:

- 50mm x 50mm x 3mm square tubing
- 2 x flat sections of size 40mm x 20mm x 50mm long each.
- 4 x flat sections of size 100mm x 8mm x 100 long each.
- 2 x 20mm Ø x 133mm long round bars.
- 2 x 40mm Ø x 100mm long round bars.

c) The in-fill for the gate frame shall be pales made of 3mm x 65mm x 22mm “Classic Palisade” D-sections or 40mm x 40mm x 3mm angle iron sections (RSA).

PSQ-2.5.4: Sliding Gates

a) Gateposts (items S1) shall be constructed of I.P.E. sections of size 140mm x 73mm x 2,984mm long with 2 x flat sections of size 68mm x 40mm x 2.5mm each and a base plate of size 250mm x 250mm x 6mm.
b) The gate frame/fixing (item S3) rail shall be constructed from the following material:

- 100mm x 50mm x 3mm rectangular hollow sections.
- 8 x 300mm x 300mm x 6mm triangular gussets.
- 2 x 5,500mm x 50mm x 50mm x 5mm rear angle iron sections (RSA).
- 2 x 120mm Ø x 30mm wide standard wheels with ball bearing axle in frame.
- 42mm x 42mm x 2.5mm x 5,500mm long Unistrut channel and trolley wheel unit.

c) The in-fill for the gate frame shall be pales (items S2) made of 3mm x 65mm x 22mm “Classic Palisade” D-sections or 40mm x 40mm x 3mm angle iron sections (RSA).
d) The gate rear support post (items S4) shall be constructed from the following material:

- 76mm x 76mm x 3mm x 2,750mm long square tubing.
- 250mm x 250mm x 6mm base plate.
- 76mm x 76mm x 3mm top plate.
- 105mm x 105mm x 6mm angle iron section (RSA).

PSQ-2.6: FOUNDATIONS

a) Concrete foundations for the various gate posts and sliding gates shall be as indicated on drawings 1924701-2-510-C-DE-0011-01 and 1924701-2-510-C-DE-0011-02.

PSQ-2.7: KERBING

a) The precast concrete kerbing (base at the bottom of the fence) shall have the following dimensions:

- Width = 75mm.
- Height = 300mm.
- Length = 1,000mm.

b) The kerbing shall be cast in-situ in a foundation of size 300mm wide by 300mm high as indicated on drawing 1924701-2-510-C-DE-0011-01.

PSQ-2.8: CONCRETE

a) The minimum strength of all concrete used shall be as follows:

i. for fence post foundations and kerbing: not less than 15MPa after 28 days.
ii. for the pedestrian gate foundations: not less than 20MPa after 28 days.
iii. for the swing gate foundations: not less than 30MPa after 28 days.
iv. for the sliding gate ramp: not less than 30MPa after 28 days.
v. for the sliding gate rail: not less than 20MPa after 28 days.

b) The *Contractor* shall arrange for sampling and testing of all concrete used and shall submit full records to the *Employer*. The method of sampling shall comply with SANS 1200 G.
c) If ready mix concrete is used, the *Contractor* shall submit certificates confirming the strength of the concrete to the *Employer*.
d) No water may be added to the concrete mix once a sample has been taken.
e) Only mechanically mixed concrete is acceptable. Hand mixed concrete will not be acceptable.

5.21.3 PSQ- 3: MEASUREMENT AND PAYMENT

PSQ-3.1: Clearing the fence line, 2.0m wide strip ..... Unit: m

The tendered rate shall include all plant, labour and the like for clearing of the fence line to a width of 1.0m to each side of the centre line of the fence, including removal of trees, stones, and other obstructions and the disposal of all waste material as per clause PSC-3.1.

PSQ-3.2: Supply and erect new 2.4m high steel palisade fencing in accordance with Drawing Numbers 1924701-2-510-C-LA-0056-03, 1924701-2-510-C-DE-0011-01 and 1924701-2-510-C-DE-0011-02 ..... Unit: m

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for the supply of all materials (as indicated on the drawings), welding and connecting of all materials, galvanising of the materials, construction of the fencing, including all excavations, backfilling, planting and concreting of fence poles, the construction of in-situ kerbing, etc. in accordance with the specifications, drawings and the manufacturer's requirements.

PSQ-3.3: Extra over item PSQ-3.2 for supplying and erecting new fencing for corners .....Unit: No.

The tendered rate shall cover all extra-over costs (plant, equipment, material, labour, transport and the like) for construction of fencing corners in accordance with the drawings or as instructed on Site by the *Employer.*

PSQ-3.4: Extra over item PSQ-3.2 for supplying and erecting new 5.0m long removable palisade fence panels .....Unit: No.

The tendered rate shall cover all extra-over costs (plant, equipment, material, labour, transport and the like) for installation of the fence panels in accordance with the drawings or as instructed on Site by the *Employer.*

PSQ-3.5: Supply and erect new steel palisade gates in accordance with Drawing Numbers 1924701-2-510-C-LA-0056-03, 1924701-2-510-C-DE-0011-01 and 1924701-2-510-C-DE-0011-02, for:.....Unit: No.

The tendered rate shall cover all extra-over costs (plant, equipment, material, labour, transport and the like) for to the procurement of all materials and construction of each gate type, including all excavations, backfilling and disposing of all excess material to the designated stockpile area as indicated in Part C.4: Site Information and finishing, in accordance with the specifications, drawings and manufacturer's requirements.

PSQ-3.6: 30MPa (19mm stone) Concrete gate ramp in accordance with section LA-0056-01.6 of drawing 1924701-2-510-C-LA-0056-01 to be constructed with the 5.5m sliding gate.....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for the casting of the reinforced 30MPa (19mm stone) concrete gate ramp, as directed on Site by the *Employer*, including (but not limited to) the following:

- all surface preparation
- designing, ordering and installation of formwork (where required)
- ordering and placement of reinforcing
- ordering and casting of concrete
- vibrating the concrete
- finishing (wood float with broom finish)
- jointing (where required)
- curing
- testing of concrete strength
- removal of formwork
- making neat

all in accordance with this specification.

5.22 PSR: HORIZONTAL DIRECTIONAL DRILLING

5.22.1 PSR-1: SCOPE

The *works* as covered in this specification include the installation of new underground 160mm HDPE ducts using horizontal directional drilling (HDD), or approved equivalent methods of installation. The scope of the *works* shall include the provision of all services, equipment, materials, labour and the like for the complete and proper installation and testing of the new underground 160mm HDPE ducts.

5.22.2 PSR-2: APPLICATION

The *Contractor* shall follow all procedures and undertake all precautions that are necessary to ensure that the directional drilling installations are adequately controlled. Adherence to these specifications or the *Employer's* approval of the methods used by the *Contractor* shall not relieve the *Contractor* of his responsibility for the satisfactory completion of the *works*.

The *Contractor* shall appoint an experienced specialist subcontractor, to be approved by the *Employer*, to execute all horizontal directional drilling.

5.22.3 PSR-3: DEFINITIONS

The following words and expressions shall have the meanings assigned to them below.

a) Intermediate Drilling Points

Excavations at either end of the boring operation from and between which boring and pipe installation are carried out.

b) Horizontal Directional Drilling (HDD)

The action of drilling a hole and pullback of a pipeline into position.

c) Directional Drilling Rig

Directional drilling equipment of sufficient capacity to perform the bore and pullback of a pipe in-situ.

d) Pilot Hole

A hole with a maximum diameter of 50mm (or as determined by specialist), drilled to ensure that a subsequently bored, larger hole, will be properly aligned.

e) Entry and Exit Points/Pits

An excavated or levelled Site located at the start or end of a drilling section of a pipeline, from which the drilling is being done.

f) Thrust Block

A temporary structure constructed inside the launch or receiving pit for the purpose of transferring the forces to the adjacent soil.

5.22.4 PSR-4: MATERIALS

PSR-4.1: DUCTS

Unless otherwise specified, the ducts to be used shall be orange HDPE PE100 SDR11 PN16 pipes or approved equivalent, complying with SANS 4427 and capable of withstanding an internal water pressure of 16 bar. The diameter of the ducts not be less than the nominal diameter (ND) shown on the drawings or stated in the bill of quantities.

5.22.5 PSR-5: PLANT

PSR-5.1: GENERAL

The directional drilling equipment to be provided by the *Contractor* shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback of the pipe, a drilling fluid mixing and delivery system of sufficient capacity to successfully complete the crossing and/or alignment, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials, and spare parts on hand to maintain the system in good working order for the duration of the *works*.

PSR-5.2: DETECTION EQUIPMENT

The *Contractor* shall provide and use detection equipment that is suitable for the location of underground services, pipes, and cables without the disturbance of the surface. The *Contractor* shall provide proof that the proposed equipment is capable of executing the *works* as required.

PSR-5.3: DRILLING RIG

The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurised fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing, and rotating pressure required to complete the crossing and/or alignment of the pipeline. The hydraulic power system shall be self-contained with sufficient pressure and volume to power the drilling operations. The hydraulic system shall be free of leaks. The rig shall have a system to monitor and record maximum pullback pressure during pullback operations.

A machine with an impact/hammer action for use in rocky terrain may be required.

PSR-5.4: SURVEYING OF OPERATION

The *Contractor* shall provide and use surveying equipment that is suitable for the technology that is to be employed. The *Contractor* shall provide proof of capability of proposed equipment.

PSR-5.5: LIGHTING

The *Contractor* shall provide adequate lighting for the execution of the *works* where required.

PSR-5.6: DRILL HEAD

The drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.

PSR-5.7: MUD MOTORS

Mud motors shall be of adequate power to turn the required drilling tools.

PSR-5.8: GUIDANCE SYSTEM

The guidance system shall be of a proven type and setup and shall only be operated by personnel that are trained and experienced in the guidance system. The operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system.

PSR-5.9: GUIDES

Where necessary, guides shall be provided within the access points to facilitate the initial directional control of the pipes.

PSR-5.10: VENTILATION

Sufficient ventilation shall be provided to remove dust and to ensure safe working conditions.

PSR-5.11: PIPE ROLLERS

Pipe rollers, if required, shall be of sufficient size to support the weight of the pipe while being hydro-tested and during pullback operations. Sufficient number of rollers must be used to prevent excess sagging of the pipe.

5.22.6 PSR-6: CONSTRUCTION

PSR-6.1: GENERAL

The *Employer* must be notified 48 hours in advance before commencing any HDD operations. The directional drilling shall not begin until the *Employer* has approved the preparations for the drilling operations. The *Employer*'s approval for the installation shall in no way relieve the *Contractor* of the ultimate responsibility for the satisfactory completion of the *works*.

Where possible, the vertical alignment of the pipeline will have a minimum fall of 0.2% in the vertical plain between drilling or access points. Low or sagged points between intermediate points shall not be allowed.

HDPE Pipes for jacking will be butt-welded or equivalent approved prior installation.

PSR-6.2: PERSONNEL REQUIREMENTS

All personnel shall be fully trained in their respective duties as part of the trenchless technology drilling crew. This includes all safety aspects.

PSR-6.3: SITE PREPARATION

PSR-6.3.1: Entry and Exit Points/Pits

Prior to any alterations to the Site, the *Contractor* shall photograph or video tape the entire *works* area, a copy of which shall be given to the *Employer* and a copy to remain with the *Contractor* for a period of one year following the completion of the project.

The Site as indicated on the drawings or proposed by the *Contractor* and approved by the *Employer* shall be graded or filled to provide a level working area. No alterations beyond what is required for operations shall be made. The *Contractor* shall confine all activities to the designated *works* areas. The *Contractor* will determine how many access areas are necessary to complete the drilling process successfully.

PSR-6.4: GENERAL CONSIDERATIONS FOR HDPE PIPES

The maximum bend radius for HDPE pipeline is the diameter x 160. During the welding process of HDPE pipe products, a beading is formed on the outside and the inside of the product, which is dependent on the class of product used. The *Contractor* shall check that the mandrel is able to bend the radius of the pipe, taking account of the beading.

PSR-6.5: BACKFILLING AND DISPOSAL OF EXCAVATED MATERIAL

After completion of the installation of the ducts, all open excavations shall be backfilled in 150mm layers and compacted to 93% Mod AASHTO density or as directed on Site by the *Employer*. Surplus excavated material shall be disposed of at an approved dumpsite.

PSR-6.6: DESIGN

The *Contractor* shall furnish a detailed design, specifications and working drawings to explain his method of installation before drilling commences.

The design and method statements shall be done by a professional engineer with adequate experience in this field. Calculations, specifications and drawings shall be signed by the *Contractor*'s engineer and shall be subject to approval by the *Employer.* The *Contractor* shall also produce, for approval, a drawing indicating all access points.

PSR-6.7: DRILL PATH SURVEY

The entire drill path shall be accurately surveyed with entry and exit stakes placed in the appropriate locations within the areas indicated on the approved *Contractor*'s drawings. If the *Contractor* is using a

magnetic guidance system, the drill path will be surveyed for any surface geo-magnetic variations or anomalies.

PSR-6.8: PILOT HOLE

The launch angle of the directional drill must be at an appropriate angle to allow for the applicable depth of the duct within the permissible bending radius of the specific duct. The selection of the drill must suit the specific ground conditions.

Pilot holes drilled along the drill path shall not have any deviations greater than 5% of the specified depth over a length of 40m. In the event that the pilot hole deviates from the bore path by more than this distance, the *Contractor* shall notify the *Employer* and the *Employer* may require the *Contractor* to pullback and re-drill the pilot hole.

In the event that inadvertent returns or returns losses of the drilling fluid occurs during the pilot hole drilling operation, the *Contractor* shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds (as measured by a March funnel) and then wait another 30 minutes. If mud fracture or return loss continues, the *Contractor* will cease operations and notify the *Employer*.

PSR-6.9: REAMING

Upon successful completion of the pilot hole, the *Contractor* shall ream the hole to a minimum of 25% greater than the outside diameter of the specified duct, using the appropriate tools. The *Contractor* will not attempt to drill/ream at output levels that are higher than the allowable equipment specifications for the rig.

PSR-6.10: PULL BACK

After reaming the borehole to the required diameter, the *Contractor* will pull the duct through the borehole. In front of the pipe will be a swivel. Once the pullback operation have commenced, the operation must continue without interruption, until the duct is completely pulled through the borehole. During the pullback operation, the *Contractor* will not apply more than the maximum safe duct pull pressure at any time.

In the event that a duct becomes stuck, the *Contractor* will cease pulling operations to allow any potential hydro-lock to subside and thereafter will commence pulling operation again. If the duct remains stuck, the *Contractor* will notify the *Employer*.

PSR-6.11: SITE RESTORATION

After the drilling operations, the *Contractor* will de-mobilise the equipment and restore the *Site* to its original condition. All excavations shall be backfilled and compacted to 93% Mod AASHTO density or as directed by the *Employer* on Site. Landscaping shall be restored to its original state. The *Contractor* shall dispose of all drilling mud at an approved, registered waste disposal site.

PSR-6.12: RECORD KEEPING (AS-BUILT)

The *Contractor* shall maintain a daily project log of drilling operations and a guidance system log. A copy shall be handed to the *Employer* upon completion of the *works*.

5.22.7 PSR-7: SAFETY

PSR-7.1: GENERAL

The *Contractor* shall at all times maintain adequate safety precautions on the Site. Permission to proceed with the *works* shall not in any way detract from the obligations and liabilities of the *Contractor* in this regard.

PSR-7.2: SAFETY OF EXISTING *WORKS*

Where applicable, the duct shall be directional drilled through under the relevant road, railway or other service or structure without disrupting the traffic and without disturbing the alignment or levels of the road surface, the tracks, or other adjoining services or structures, or impair the safety of persons, traffic, services or structures.

Before commencing the *works* in the vicinity of any structure, the *Contractor* shall undertake a detailed examination of the structure, record its condition, and submit a copy of such records to the *Employer.*

PSR-7.3: CHECKING THE ALIGNMENT OF THE DUCT

The *Contractor* shall check the line and the level of the duct at least once during the installation of each duct length and shall take such corrective action as may be necessary. A copy of the results of all checks and details of any corrective measures shall be available for inspection on Site. A copy of these records shall be given to the *Employer* on the same day.

PSR-7.4: ACCOMMODATION OF TRAFFIC

The *Contractor* shall at all times institute adequate safety precautions on Site. Permission to proceed with the *works* shall in no way detract from the obligations and liabilities of the *Contractor*. The accommodation of traffic shall be in accordance of the relevant technical specifications in this document and SANS 1200 clauses.

5.22.8 PSR-8: SOIL CONDITIONS

Refer to Part C4: Site Information for current soil conditions at certain locations on the Site.

The *Contractor* shall report immediately to the *Employer* any circumstance which indicates that, in the *Contractor*'s opinion, the ground conditions differ from the descriptions provided in the above-mentioned report or inferred from these reports.

The *Contractor* may perform additional subsoil investigations to verify the subsoil conditions.

No blasting will be allowed.

5.22.9 PSR-9: AS-BUILT DRAWINGS

The *Contractor* shall, on completion of the *works* and before the final payment is made, supply the *Employer* with drawings showing full details of the completed duct. Each such drawing shall be certified by the *Contractor* to be an accurate reflection of the *works* as constructed.

5.22.10 PSR-10: TOLERANCES

The ducts shall be positioned within the tolerances given below.

- In plan ± 100mm
- Vertical ± 50mm

Should the difference between the actual and the specified position or alignment of the finished duct exceed the value of the above tolerance, the *Employer* reserves the right to accept or reject such ducts at his sole discretion. The *Employer* shall be indemnified from bearing any costs attached to non-adherence to the above tolerance requirements.

Adjustment to line or level or both shall be gradual, and the pipe manufacturer's permissible angular deflection of the ducts shall not be exceeded at any point.

5.22.11 PSR-11: MEASUREMENT AND PAYMENT

PSR-11.1: Site Establishment ..... Unit: Sum

The rate shall include full compensation for the establishment on Site and the subsequent removal of all special equipment and plant for directional drilling, including the thrust block when applicable, for maintaining the safety of existing structures, services, roads, railways and the like, for bracing, lighting, watching, dewatering and surveying and for maintaining all temporary *works* until the *works* is completed.

PSR-11.2: Accommodation of Traffic for:

a) HDD Entry Pits .....Unit: No.
b) HDD Exit Pits.....Unit: No.

The rate shall include full compensation for the accommodation of traffic at all *works* areas, including the provision and maintenance of access roads to the entry and exit points, erection and maintenance of temporary gates, fences and road signs where applicable and for the removal and reinstatement of the access roads and temporary *works* on completion of the drilling operations to the satisfaction of the *Employer* and affected landowners.

PSR-11.3: Excavation for entry and exit pits

a) Excavations in soft and intermediate material .....Unit: m^3
b) Extra-over item a) above for excavating in hard rock material.....Unit: m^3

The rate shall include full compensation for all *works* necessary for excavating the points to suit the *Contractor*'s horizontal drilling rigs/equipment, for excavating by hand where applicable, for shoring the sides of the excavation and for stockpiling the excavated material at predetermined locations. The *works* shall be carried out as described in the specifications.

PSR-11.4: Backfilling for entry and exit pits

a) Available from trench excavations .....Unit: m^3
b) G4 imported material from commercial sites .....Unit: m^3

The unit of measurement for sub item a) shall be the cubic metre of suitable excavated material used for backfilling the entry and exit points, to the extent indicated on the drawings or as directed by the *Employer*.

The rates shall include full compensation for loading, transporting and offloading of approved material that was previously excavated or obtained from approved borrow pits.

The rate shall also include full compensation for compacting the material in 150mm thick layers to 93% MOD AASHTO for trench materials and 98% MOD AASHTO for G4 imported material.

Material shall be imported only on the instructions of the *Employer.* Overhaul on imported materials will not be payable.

PSR-11.5: Supply, handle, join, insert and test pipe to be pulled back for horizontal directional drilling, for the following:

a) 160mm Ø HDPE pipe (set of 4) ..... Unit: m
b) 160mm Ø HDPE pipe (set of 8) ..... Unit: m

The unit of measurement shall be the metre of completed installed pipelines, measured between the ends of the completed pipeline. The rate shall also include welding and/or couplings where required.

The tendered rate shall allow for the supply, handling, joining, inserting, proving, delivery and storing of the ducts, for rubber rings and/or for welding.

PSR-11.6: Horizontal Drilling of Ducts Through:

a) Soft and intermediate material..... Unit: m
b) Hard rock material ..... Unit: m

The unit of measurement shall be the linear metre of drilling, measured from the start to end of the drilled portion of the duct.

The tendered rates shall include full compensation for the hire, positioning and operation of the drilling rig, for all drilling and pull-back of the pipes, all lubrication of drilled holes and all ancillary equipment, including the disposal of all materials removed along the drill path.

5.23 PSS: SOIL AND VEGETATION REHABILITATION

5.23.1 PSS-1: SCOPE OF *WORKS*

This specification covers the minimum requirements for the following soil and vegetation rehabilitation activities:

a) Appointment of nominated soil and vegetation conservation specialist.
b) Topsoiling.
c) Mulching.
d) Fertilising.
e) Hydroseeding.
f) Erosion matting.
g) Herbicide application.
h) Watering/irrigation.
i) Weed removal."

5.23.2 PSS-2: SEARCH AND RESCUE

PSS-2.1: NOMINATED SOIL AND VEGETATION CONSERVATION SPECIALIST

The *Employer* will nominate a soil and vegetation conservation specialist to report and provide guidance to the *Employer;* and undertake the *works* that are required for the removal, preservation, transplanting and re-establishment of selected plant species within the Site, in accordance with the requirements of the DEA-approved environmental management programme.

The *Contractor* shall, upon further instruction by the *Employer*, appoint and make payment to the specialist, in accordance with the further terms and conditions as advised by the *Employer*. The specialist will not be authorized or empowered to issue any instructions to the *Contractor*. Any instructions relating to these *works* will be issued by the *Employer* only.

The scope of services to be provided by the specialist will include the following:

a) Conduct a field inspection of the Site prior to Site clearance to identify plant species that are to be conserved, including the location of such species.
b) Identify suitable areas for the conservation or transplantation of such selected species.
c) Provide method statements for the removal, relocation, conservation and transplanting of such selected species, including in particular measures for the preservation of plants to be re-used for the final restoration of the Site.
d) Undertake search and rescue operations prior to Site clearance operations, to include removal of identified plants, seed, bulbs and the like, which shall either be transplanted to other areas as identified by the *Employer*, or stored in a temporary nursery, for later use for rehabilitation purposes.
e) Be responsible for constructing and maintaining the temporary nursery for the storing of plants to be conserved, and for re-planting and re-establishing such plants species on Site after completion of re-topsoiling by the *Contractor*. The specialist will also be responsible for the de-establishing and removal of such nursery after the soil and vegetation rehabilitation phase is complete and in strict accordance with this specification or as instructed on Site by the *Employer*.
f) Witness the removal and stockpiling of topsoil and other organic matters retrieved from Site, for later re-use for the restoration of the Site, and advise the *Employer* on the appropriateness and potential improvements to the methods employed by the *Contractor.*
g) Review the methods used for the temporary storage of topsoil and mulch in separate stockpiles and advise on further steps required for the preservation and/or enrichment of topsoils.
h) Review the *Contractor's* method statements and practices for the reinstatement of sections of the Site that are to be re-vegetated and advise the *Employer* on the appropriateness and potential improvements to the methods employed by the *Contractor.*
i) Undertake tests on the recovered topsoil and provide further guidance on the type and application rates of fertilizers and herbicides.
j) Oversee the topsoiling and revegetation of areas that are to be restored by the *Contractor* and advise the *Employer* of methods to be used to effectively revegetate and rehabilitate such areas.
k) Monitor the re-establishment of vegetation and provide guidelines to the *Employer* on further measures to be taken to ensure the successful re-establishment of vegetation after initial restoration has been undertaken by the *Contractor.*

The specialist may also be instructed to collect and harvest seeds or seedlings from adjoining areas, to be used for the restoration of vegetated areas.

A provisional sum is provided for the costs attached to the appointment of the soil and vegetation specialist."

5.23.3 PSS-3: TOPSOILING

Restoration of exposed embankments, including topsoil placement and re-establishment of vegetation, shall be done as soon as practical after substantial, continuous sections of the cut and fill slopes or trench backfilling have been completed.

The *Contractor* shall be responsible for the prevention of erosion at all areas impacted upon by the *Contractors* activities. All erosion repairs must be implemented at the first signs thereof and no erosion shall be allowed to develop on a large scale.

The *Contractor* shall plan all final earthworks shaping and trimming operations to allow for topsoil application. Final, trimmed levels for the bulk earthworks must make provision for the specified depth of reapplied topsoil.

All areas where rehabilitation is required shall be scarified and/or ripped prior to the application of topsoil, to ensure a uniform level of compaction for vegetation growth. This operation shall be restricted to a depth of 150mm. Care shall be taken to avoid soil inversion where the topsoil has not been removed.

At all completed, exposed cut and fill slopes, or other areas where topsoil was removed, topsoil shall be uniformly spread to a depth of approximately 200mm and re-contoured over the full extent of such areas. Compaction of topsoil shall be kept to a minimum.

Ripping and/or scarifying shall not be undertaken under wet conditions.

5.23.4 PSS-4: MULCHING

PSS-4.1: MATERIALS

Mulch shall primarily be obtained from the stockpiles retained on Site following the clearance of shrubs and trees, as described under Clauses PSC-5.3.2 and PSC-8.2.2.

Provision is made for supplementing the quantities of mulch obtained from Site with mulch to be procured by the *Contractor* from commercial sources. The specification for such imported mulch shall be as follows:

a) The chips shall be no longer than 50mm in length or breadth and shall be free of alien invasive seed.
b) The wood shall be chipped during winter.
c) Chips shall not be made from wood treated with preservatives.
d) Half-composted chips shall be utilised in preference to non-composted chips.

PSS-4.2: CONSTRUCTION

Following topsoiling, as described above, the mulch shall be spread over the re-contoured areas. Mulch shall be applied by hand to achieve a layer of uniform thickness of approximately 25mm, at a coverage rate of around 100kg per 250m^2. The mulch shall be rotovated or mixed by hand with the upper 100mm layer of topsoil. These *works* shall not be undertaken under conditions of high wind strength.

In very rocky areas the *Employer* may instruct the *Contractor* to apply the mulch prior to placement of the topsoil.

Following mixing of the mulch with the topsoil, further scarifying shall be undertaken to create contoured furrows of approximately 100mm depth at horizontal spacings of between 300mm and 400mm, to provide for the establishment of vegetation.

5.23.5 PSS-5: FERTILIZER

The nominated soil and vegetation specialist will undertake tests on the recovered topsoil, to determine the type and application rate for fertilizers to be applied to the prepared surfaces. The specialist shall

also advise on the methods of application for such fertilizers, which may include mixing and application as part of the hydroseeding operations.

All fertilizers shall be safely stored in plastic bags, labelled to indicate the weight and content of each bag, including the proportion of each constituent. Fertilizer shall not be directly exposed to adverse weather conditions, such as harsh sun, rain, wind and the like. Fertilizer shall be dry, free-flowing and free from lumps.

A provisional sum has been provided for the procurement of fertilizer. The tendered rate for hydroseeding shall make provision for the addition and distribution of fertilizer, if so required.

5.23.6 PSS-6: HYDROSEEDING

PSS-6.1: MATERIALS

The final mix to be used for hydroseeding will be confirmed in conjunction with the recommendations of the nominated soil and vegetation specialist, as described under Clause PSS-2.1 above.

A provisional sum has been allowed for the procurement of further proprietary products that may have to be added to the hydroseed mix, together with the fertilizer. The tendered rate for hydroseeding shall include mixing-in of such additional products with the hydroseed mix.

The following further provisions shall apply:

a) Seed shall only be purchased from South African National Seed Organisation (SANSOR) accredited dealers; or hand collected from the site prior to the commencement of site clearance.
b) Seed shall be labelled in accordance with the Government Seed Act (Act 28 of 1961), as amended. The *Contractor* shall provide signed certification from the seed merchants to the *Employer*, confirming that each container of seed as delivered is labelled and the content is in accordance with the provisions of this act.
c) Each lot of commercial seed shall be subject to sampling and testing at the discretion of the *Employer*. Sampling and testing shall be in accordance with the latest rules and regulations of the Government Seed Act.
d) All seed shall be transported in 50kg hessian bags and kept dry at all times.
e) All seed shall be stored in a facility that is cool (between 7° and 10°C), dry, damp proof and rodent free.

PSS-6.2: CONSTRUCTION

The soil and vegetation conservation specialist shall provide a hydroseeding machine capable of dispensing a uniform solution of seed, anti-erosion compound, fertiliser and water. The hydroseeding machine shall be thoroughly cleaned after each application and before a different seed mix is introduced into it to prevent contamination of the project specific seed mix with alien seed stock that could potentially become invasive.

The seed mix shall be dispensed at a rate of not less than 20 kilolitres of water per hectare.

Hydroseeding should only be carried out after the first good rains (minimum of 5mm) have fallen during the winter rainfall period. Watering shall commence and continue until after the seeds have germinated and growth begins. The *Contractor* shall continue watering as required until the vegetation is able to survive independently, as instructed by the *Employer*.

PSS-6.3: HYDROSEEDING PLANT

The hydroseeder shall be capable of pumping the specified seed mix, fertiliser, soil stabiliser, aqueous smoke solution, mulch and wetting agent (mixed in water) at the specified rates over the areas to be seeded. The hydroseeder shall have an agitation system, which shall be sufficient to agitate, suspend and homogeneously mix the specified slurry.

The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles suitable for the even distribution of the slurry on the various slopes to be seeded.

The slurry tank shall be mounted on a travelling unit, either self-propelled or drawn by a separate unit. The travelling unit shall be capable of placing the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded to provide uniform distribution without waste.

The *Contractor* may be called upon to demonstrate to the *Employer* by way of a trial section that the application of the hydroseeding mix meets the requirements of this specification.

5.23.7 PSS-7: EROSION MATTING

PSS-7.1: MATERIALS

The minimum requirements for the erosion matting shall be as follows:

a) The netting/matting shall be biodegradable and made from coir or similar material.
b) The netting/matting shall be sufficiently robust to last for a period of not less than 5 years under normal service conditions.
c) Holes in the netting/matting shall have a minimum size of 400mm² and a maximum size of 900mm² and be made from at least 4.0mm to 6.0mm thick cord.

A 1.0m² sample of the geofabric or geogrid fabric shall be submitted to the *Employer* for approval prior to procurement.

PSS-7.2: CONSTRUCTION

The *Contractor* shall place a biodegradable netting/matting for slope stabilisation and erosion prevention, as directed by the *Employer*. The substratum shall be levelled to ensure that there are no intrusions or depressions within the area where the matting is to be placed, to prevent erosive damage.

The matting shall be staked to the ground and shall be placed with fish-scale pattern overlaps from the bottom of the slope upwards to prevent water from undermining the matting and undercutting the embankments.

5.23.8 PSS-8: RE-ESTABLISHMENT OF RECOVERED VEGETATION

The nominated soil and vegetation specialist, as described under Clause PSS-2.1 above, will be responsible for planting recovered species, temporarily held at the nursery, as well as bulbs and seeds collected from other parts of the Site.

The timing and sequencing of these revegetation activities will be determined in conjunction with the nominated soil and vegetation specialist.

5.23.9 PSS-9: WEED CONTROL

The *Contractor* shall implement a weed control programme covering all disturbed areas before and after rehabilitation, as described above, extending up to the expiry of the defects liability period.

All weeds shall be removed before hydroseeding and the reestablishment of vegetation and taken to a registered landfill site. The handling and transportation of such weeds may not give rise to the spread of weed species along public or private roads.

The cost of the above *works* shall be covered under the scheduled payment item.

5.23.10 PSS-10: WATERING/IRRIGATION OF RE-VEGETATED AREAS

The *Contractor* shall provide all watering to re-vegetated areas, as required to ensure the proper reestablishment of such vegetation. The *Contractor* shall use a fine nozzle spray to prevent the scouring of stabilised soils, resulting in erosion. Water used for the irrigation of re-vegetated areas shall be free of chlorine and other pollutants that will have a detrimental effect on the plants and shall be free of Phytophthora.

The *Contractor* shall supply all water and provide all pipe-work, pumps, irrigation equipment and other plant as necessary, which shall be approved by the *Employer* and remain available until the end of the defects liability period.

All watering required up to and including the hydroseeding operations shall be deemed to be included in the *Contractor's* rates for topsoiling and hydroseeding. Watering to be provided after hydoroseeding until the end of the defects liability period shall be paid for under the scheduled rate, based upon the *Employer's* further instructions for such watering.

5.23.11 PSS-11: HERBICIDE

The *Employer* may instruct the *Contractor* to apply selected herbicides to rehabilitated areas. All precautionary measures for the handling and application of such herbicides shall be strictly adhered to, including, but not limited to, the manufacturer's specifications and guidelines.

Payment for the supply and application of such herbicides will be made under the provisional sum allowed for these *works*.

5.23.12 PSS-12: MEASUREMENT AND PAYMENT

PSS-12.1: Nominated Soil and Vegetation Conservation Specialist..... Unit: Provisional Sum

A provisional sum has been included in the bill of quantities to cover the cost of the nominated soil and vegetation specialist consultant for the services as described under Clause PSS-2.1.

The amounts payable under Item a) above shall be the invoice value as submitted by the specialist consultant to the *Employer* and as certified by the *Employer.* All such invoices shall be forwarded by the *Employer* to the *Contractor* for payment of the specialist consultant. No payments shall be made under this item unless such invoices have been duly certified by the *Employer.*

Payment of invoices shall be made within 30 calendar days of receipt by the *Contractor* of the invoice as certified by the *Employer*.

PSS-12.2: Topsoiling ……Unit: m²

The tendered rate shall cover all costs (plant, equipment, material, labour, transport, etc.) for taking topsoil from the stockpile on Site, transporting it within the freehaul distance, spreading and placing it to a thickness of 200mm on all areas requiring rehabilitation in accordance with Clause PSS-3 of this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSS-12.3: Mulching

a) Application of mulch from stockpiles on Site..... Unit: m²
b) Procurement and application of mulch from commercial sources..... Unit: m²

The tendered rates for Item a) above shall cover all costs (plant, equipment, material, labour, transport, etc.) for loading mulch from the stockpile on Site (as described under Clause PSC-5.3) and for transporting, offloading, spreading and mixing the mulch as described under Clause PSS-4 above, or as directed by the *Employer* on Site.

The tendered rates for Item b) above shall cover all costs (plant, equipment, material, labour, transport, etc.) for procuring mulch from a reputable commercial source, and for off-loading, spreading and mixing the mulch as described under Clause PSS-4 above, or as directed by the *Employer* on Site.

PS-12.4: Hydroseeding

a) Procure hydroseed mix ..... Unit: Provisional Sum
b) Application of hydroseeding ..... Unit: m^2

The tendered rate for Item a) shall include the cost of procuring, handling, storage on Site and certification for the hydroseed mix, as described under Clause PSS-6.1.

The tendered rate for Item b) shall include all costs (plant, equipment, material, labour, transport, etc.) for the distribution of the hydroseed mix, including mixing and agitating the seed, fertiliser and further agents required in the seed-cocktail, applying the mixture, initial watering, weeding and re-hydroseeding bare patches, as described under Clause PSS-6.2.

PSS-12.5: Erosion Matting ..... Unit: m²

The tendered rate shall cover all costs (plant, equipment, material, labour, transport, etc.) for procuring and placing the erosion matting, as described under Clause PSS-7 of this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSS-12.6: Watering after hydroseeing ..... Unit: ℓ

The tendered rate shall cover all costs (plant, equipment, material, labour, transport, etc.) for watering of revegetated and rehabilitated areas after completion of hydroseeding, as described under Clause PSS-10 of this specification, as shown on drawings or as instructed on Site by the *Employer*. The tendered rate shall be valid until the expiry of the defects liability period.

PSS-12.7: Provisional Sums

a) Fertilizer ..... Unit: Provisional Sum
b) Herbicide ..... Unit: Provisional Sum
c) Other proprietary products ..... Unit: Provisional Sum

The provisional sums shall cover the cost of procuring additional proprietary products that are required for the rehabilitation, revegetation and protection of disturbed areas, not covered by other scheduled rates.

5.24 PST: LATERAL SUPPORT

5.24.1 PST-1: SCOPE

This specification covers the installation of the support measures to be installed for the construction of the Substation M and Substation N building platforms and yards. These support measures shall comprise of primary soil and rock anchorage support (if required) as well as secondary support, comprising of mesh-reinforced shotcrete.

The *Contractor* shall construct the items as described herein with the types of materials, to the dimensions, quality standards and standards of workmanship as described herein, and as shown on the drawings and bill of quantities. Any conflicts between the documentation shall be brought to the immediate attention of the *Employer*.

These specifications cover the construction of lateral support systems forming part of the civil *works,* including, but not limited to, the following:

a) Substation M

i. A 200mm thick 30MPa shotcrete wall constructed 70° to the horizontal, including mesh reinforcing, two rows of self-drilling soil nails and vertical geodrains.

b) Substation N

i. A ± 550mm thick slurry wall constructed with a Cutter-Soil-Mixer (CSM) or trench mixer to a depth of at least 2.5m below the adjacent bulk earthworks excavation level, with a minimum strength of 3.0MPa and a maximum permeability of 1 x 10^{-8} m/s.
ii. A 200mm thick 30MPa shotcrete wall constructed 90° to the horizontal, including mesh reinforcing, four rows of self-drilling soil nails and vertical geodrains.

IMPORTANT NOTE:

The *Contractor* shall inform the *Employer*'s design engineer of his intent to commence with the excavation work on the lateral support walls (at substation M and N) 7 days in advance.

The *Employer*'s design engineer shall witness the excavation of these lateral support walls from the start and the *Contractor* shall allow the *Employer*'s design engineer to sample and/or profile the excavation as it continues.

The *Contractor* shall under no circumstances carry out excavations for the lateral support walls unless witnessed by the *Employer*'s design engineer or instructed to continue with such excavation by the *Employer*'s design engineer.

5.24.2 PST-2: DEFINITIONS

The following definitions shall apply:

Drain holes means 50mm diameter holes, with or without PVC pipe, required to relieve water pressure from behind the slope face or rock wedge. The length varies according to the design intent.

Infill/keystone block means shotcrete infill where overhangs or voids have been formed in the slope during excavation or resulting from adverse jointing. Localised dowels may be required to integrate the block with the rock mass to form a "keystone".

Wickdrain means geotextile layer, working in conjunction with weepholes, to ensure efficient relief of water pressure from behind the shotcrete cover on the slope.

Overspray means sprayed concrete placed outside of the intended receiving surface.

Rebound means sprayed concrete material that ricochets off the receiving surface and falls to accumulate on the ground or other surface.

Rock pins means rock dowel pins (Y12, 500mm long, L shape) installed at appox.1.5m c/c, where dowels are not present, to tie the mesh reinforced shotcrete to the rock slope face.

Sloughing or sagging means subsidence of sprayed concrete, due generally to excessive water in the mix, or placing too great a thickness of sprayed concrete in a single pass.

Sprayed concrete or shotcrete means concrete projected pneumatically onto a receiving surface to produce a dense, homogeneous mass. Sprayed concrete normally incorporates admixtures and may also include additions of fibres, or a combination of these.

Tensioned rock bolt or rock bolt means a high-yield deformed bar of specified diameter (generally 25mm) and length, which is end anchored with resin grout, fully column bonded with resin or cement grout, equipped with a faceplate, hemispherical washer and nut and tensioned to a specified load. The use of resin or cement grout for column bonding shall be at the *Contractor*'s discretion, unless specifically detailed on the drawings. The rock bolt may also be anchored by friction in lieu of grout.
Self-drilling nail means a high-yield threaded steel bar, which has a hollow centre of specified inside and outside diameter, fitted with a drill bit at the drill end to enable self-drilled installation that can be grouted through the centre of the bar. The protruding portion is equipped with a face plate, bevelled washers (if necessary) and nut, which is hand tensioned once the grout has reached a minimum strength.

Untensioned rock bolt or dowel means a high-yield deformed steel bar, of specified diameter (generally 25 mm) and length, for which the protruding portion will be straight and which is full-column grouted with pumped cement grout into predrilled holes. Untensioned rock bolts will not be tensioned. The straight protruding portion will be equipped with a face plate, hemispherical washer (if necessary) and nut, and hand-tensioned once the grout has reached a minimum strength.

Weepholes means 50mm diameter PVC pipe projecting from wickdrain/netlon strips (or similar), depending on the Site conditions, placed against the rock face to relieve water pressure from behind the covering shotcrete.

Weld mesh means galvanised, welded mesh reinforcement for the shotcrete.

Wet mix process means a mixing process in which all the constituent materials of sprayed concrete, including water, but excluding accelerators and pressurised air, are mixed before introduction into the delivery hose.

Wet-mix sprayed concrete means the constituent material of cement, sand/aggregate, water and admixtures that are premixed and delivered to the application nozzle as wet-mix before being sprayed to the receiving surface.

5.24.3 PST-3: MATERIALS

PST-3.1: SELF-DRILLING NAILS

The self-drilling, hollow-bar system comprises of a fully-threaded steel bar, which is drilled and grouted into loose or collapsing soils without a casing. The bar features a hollow centre for simultaneous drilling and grouting and a rope thread for connection to standard drill tooling equipment.

The face comprises a bearing plate with bevelled washers for angle compensation. For confinement of the face between the bearing plates, mesh reinforced shotcrete shall be provided to offer the necessary restraint.

The drill hollow bars are typically installed into the 'soft' and 'intermediate' excavation zones, which generally comprise of sand, calcrete and completely weathered (residual) granite.

PST-3.2: ROCK DOWELS OR UNTENSIONED ROCK BOLTS

Where dowels or untensioned rock bolts are used, they shall consist of hot-rolled, continuously threaded, high tensile steel bars (typically Thread Bar 500 – TB500), which should be of the "Duraset" type or approved equivalent.

The rock bolts shall have a minimum yield stress of not less than 500MPa. The TB500 bars typically have a diameter of 32mm and a length of 5.0m. The length of the rock bolt could change depending on the conditions encountered on Site.

The length of bolts shall be the length of bar that is bonded into rock. A minimum threaded length of 150mm shall be allowed beyond the face plate and nut, to allow for hand- tensioning of the dowel. A coarse-cut thread should be provided, which shall not reduce the overall specified bar diameter by more than 3mm. The installed end shall be chamfered.

Typical face plates shall be 300mm x 300mm x 10mm thick. The face plates should deform at minimum 80% of the specified working load of the rock dowel/bolt. Performance of the plates shall be verified by means of Site trials, as directed by the *Employer,* prior to the commencement of excavations. Installation and testing of rock dowels/bolts during such trials shall be carried out using the same equipment, including a hydraulic tensioning device, as will be used in the surface *works*. The face plates should be fitted with a hemispherical washer to permit seating of the face plate at inclinations up to 30º from normal to the bolt.

Face plates, hemispherical washers and nuts for straight-end threaded dowels shall be manufactured to suit the loading requirements, in compliance with SANS 1408. Threaded parts of bars, nuts and seatings shall comply with the requirements of SANS 1556-2 and shall be coated at the factory with an approved grease, of a type that will facilitate ease of installation, as recommended by the dowel manufacturer. The remaining portions of the dowels shall be clean and free of any deleterious materials such as grease, paint, dirt and scale.

PST-3.3: TENSIONED ROCK BOLTS

Where tensioned rock bolts are used, they shall consist of the “DSI” thread bar system, or approved equivalent.

Threadbar rock anchors are post-tensioned tendons, installed in drilled holes for which the entire bond length is located in rock. The anchor force is transmitted to the rock by bond between the grout body and the rock. The free-stressing length of the anchor shall remain unbonded, to allow the anchor to be checked and re-tensioned at any time. Adequate corrosion protection for the stressing anchorage and the free stressing length shall be provided.

In highly corrosive environments, the free stressing length shall be coated with a corrosion inhibitor and covered with smooth sheathing. Spacers shall be installed over the bond length to allow full grout cover, in order to provide bond to the surrounding drilled hole. The entire length shall be covered with cement grout.

The anchorage shall be capable of holding the bolt at a tension equal to the yield load of the bolt, or as directed by the *Employer*. Each bolt shall be provided with suitable nuts, washers, washer plates and bolt thread to carry the yield load of the bolts. The washers and washer plates shall be of a pattern that permits close contact with the concrete base at inclinations of up to 15 degrees from normal to the concrete base.

PST-3.4: CEMENT GROUT

The cement used in the manufacture of cement grout shall meet the requirements of SANS 50197.

Only Portland cement complying with SANS 50197 CEM-I-52.5N and which is less than one month old shall be used in the cement grout.

Water used for cement grout mixing shall conform to SANS 1200 G.

Fine aggregate, if used in the mix, shall consist of siliceous granules or very fine sand, to be approved by the *Employer*. The particle size shall be such that 100% of the material will pass the 0.6 mm sieve. The aggregate content in the grout shall not exceed 30% of the mass of the cement. The cement grout shall be screened to remove lumps or other oversized solids.

Admixtures used for the grout shall be subject to approval by the *Employer*. Admixtures shall be free of deleterious materials that may damage the steel or impair the effectiveness of the grout. Admixtures shall be free of halides, nitrates, sulphides, sulphates and the like. The amount of admixture to be used shall be in accordance with the manufacturer’s instructions.

Cement grout may include an expanding agent, to be approved by the *Employer* and applied in accordance with the manufacturer’s recommendations.

A fluidising admixture may be added to improve workability, subject to approval by the *Employer*.

The mixed grout shall have the following properties:

a) C1-ions content shall not exceed 750mg per litre.
b) Viscosity shall be measured in a standard CSRA flow cone or similar approved. Flow shall not be less than 12 seconds and not more than 30 seconds. Any other approved cone shall be calibrated against the CSRA cone.

c) Bleeding at 20°C shall not exceed 2% by volume 3 hours after mixing and the maximum bleeding shall not exceed 4%. After the initial grouting of the bolts, any bleed shall be compensated for by topping up the hole.

d) The required unconfined compressive strength of the cement grout shall not be less than 5MPa at 24 hours and 30MPa at 28 days. The compressive strength of 100mm cubes made of the grout and cured in a moist atmosphere for the first 24 hours and thereafter in water at 20°C shall exceed 15MPa at 7 days.

The water:cement ratio by weight will generally be between 0.30 to 0.35. This may be adjusted, subject to the mix design that is adopted and approved by the *Employer*.

Cement grout that is not used shall be discarded if more than one hour has elapsed after first mixing.

Testing of cement grout cubes and cores of grout shall be undertaken in accordance with Clause PST-6.4. Tests shall be conducted by an approved laboratory and the results shall be submitted to the *Employer* for his approval. The cost of all such tests shall form part of the *Contractor's* normal process control and shall be deemed to be included in his tendered rates.

PST-3.5: SPRAYED CONCRETE (SHOTCRETE)

PST-3.5.1: Cement

Cement used in sprayed concrete shall be ordinary Portland cement, either Cem I (42.5) or Cem II (42.5) or better, or sulphate resisting cement complying with the requirements of SANS 50197-1.

The partial replacement of Portland cement with silica fume shall be subject to the *Employer*'s written approval.

PST-3.5.2: Aggregate

All aggregates shall comply with the requirements of SANS 1083.

Fine aggregates shall contain no soft particles and shall be uniformly graded within the grading limits of Table 28.

Table 28: Grading Limits for Aggregates

Sieve Size (mm)	% Passing (By Mass)
10.00	100
5.00	95-100
2.36	80-90
1.18	50-85
0.60	25-60
0.30	10-30
0.15	2-10

The sand aggregate shall be washed, cleaned and sharp, with a moisture content of between 4% and 6%. The optimum moisture content shall not exceed 8%.

The fineness modulus shall be approximately 2.5 and shall not exceed 3.2.

Aggregate for premixed sprayed concrete shall be delivered in bags or stored in silos and shall be kiln-dried.

No coarse aggregate (>5mm) shall be used unless approved by the *Employer* in writing.

PST-3.5.3: Water

Water to be used for mixing and curing sprayed concrete shall comply with the requirements for potable water.

PST-3.5.4: Admixtures

Admixtures shall not be used without the written approval of the *Employer*. Should the use of admixtures or air-entraining agents be considered necessary, the *Contractor* shall submit a full report prepared by an approved laboratory, giving the results of tests on sprayed concrete using the constituent materials with and without the admixtures, to indicate the influence of the admixture on the initial and final setting time and early strength development of the sprayed concrete.

PST-3.5.5: Deteriorated Material

Materials that have been contaminated or rejected subsequent to initial approval on delivery to the Site shall be removed from the Site at the *Contractor*'s expense.

PST-3.6: CUTTER-SOIL-MIXER SLURRY SPECIFICATION

The main components of the binders for the slurry mix shall be the following:

a) Cement (OPC or Blast furnace cement CEM III/B 32.5).
b) Bentonite.
c) Water.

If required, additives (e.g. plasticizers and/or retarders) or admixtures (e.g. fly-ash) can be used as part of the slurry mix design, subject to the approval of the *Employer*.

The *Contractor* shall, prior to the commencement of the *works*, prove to the satisfaction of the *Employer* that the correct mix design has been obtained by the testing of various mix design samples.

The minimum requirements for the slurry wall mix design shall be as follows:

i. A minimum design strength of 3.0MPa at 28 days.
ii. A maximum permeability of 1×10^{-8} m/s.

5.24.4 PST-4: PLANT

PST-4.1: PLANT FOR SPRAYED CONCRETE

PST-4.1.1: General

All plant used for the sprayed concrete application shall be based on proven technology within the industry and shall be in good working order. The plant shall be inspected, serviced and calibrated at regular intervals and tested to ensure that the system functions efficiently and accurately, all to the satisfaction of the *Employer*.

PST-4.1.2: Mixing and Delivery Plant

The type and capacity of the mixing plant, delivery hoses and nozzles shall ensure a uniform mix and supply of the dry-mix ingredients to the mixing nozzle, thereby obtaining the correct consistency and a uniform discharge rate from the nozzle.

The air operating pressure supply at the gun outlet shall not be less than 240kPa in order to maintain a discharge nozzle velocity of between 90m/s to 120m/s.

The water pressure supply at the nozzle shall be not less than 400kPa.

PST-4.2: CUTTER SOIL MIXING (CSM) PLANT AND EQUIPMENT

The type, size and capacity of the CSM or trench mixer plant and equipment shall be in accordance with the guidelines and requirements of the relevant manufacturer/supplier and shall suit the conditions and available free moving space on the Site.

5.24.5 PST-5: CONSTRUCTION

PST-5.1: METHOD STATEMENTS

The *Contractor* shall provide method statements for installation of all lateral support elements to the *Employer* for approval. Method statements shall be issued to the *Employer* at least 28 days prior to the start of lateral support installation work.

The method statements shall cover the following:

a) Details of plant to be used for the construction of the slurry wall, drilling, soil nail fixing and shotcreting.
b) Details and test results confirming that the minimum requirements for the CSM mix design, as stated in clause PST-3.6: CUTTER-SOIL-MIXER SLURRY SPECIFICATION has been achieved.
c) Details of the dowels to be used. Samples of materials proposed shall be supplied to the *Employer* if so requested.
d) Details of any proprietary rock support systems proposed, with supporting test data.
e) Details of the method of corrosion protection.
f) Details of drilling methods and equipment.
g) Details of all equipment and accessories to be used for rock bolts installation.
h) Details of the proposed grouting procedures and admixtures and, if so requested, samples of the proposed grouting admixtures.
i) Details of equipment and methods to be used for pull-out testing of dowels, with calibration certificates attached.
j) Details of movement monitoring during excavation and during the various stages of support measure installation.
k) Step by step procedures for the following:

    i. Construction of the slurry wall, including construction of temporary platform for CSM plant and equipment.
    ii. 1.5m incremental excavations for the shotcrete.
    iii. Placement of geodrains and welded mesh within the 1.5m incremental shotcrete section, including all required overlapping.
    iv. Placing of sprayed concrete (shotcrete).
    v. Drilling for soil nails.
    vi. Fixing and tightening of soil nails.

PST-5.2: DRILLING

PST-5.2.1: Self-drilling Nails

When installing the hollow stem self-drilling nails, the drilling and installation shall be done simultaneously in the upper calcrete/sand horizons. This simultaneous installation is a unique feature of the self-drilling nail in that the bar is utilized as a grouting annulus, eliminating the need for insertion of the bar and the removal of the drilling rod and casing to keep the drill hole open.

PST-5.2.2: Rock Bolts (TB500) – If Required

For the rock anchors, all holes shall be drilled using pneumatic-powered drilling rigs. After each hole has been drilled to its full length and flushed out by compressed air and/or water, to remove all loose materials, the hole shall be probed to ensure that no collapse has occurred and that it has been cleaned over its full length. The hole shall be plugged immediately after drilling to prevent debris from entering.

Due to the hardpan calcrete and strength of the rock, percussion drilling techniques shall be used. The drill hole diameter shall typically vary between 75mm to 100mm, or as specified by the *Employer.*

The following further requirements shall be met for drilling of the nails/bolts:

a) Holes shall be drilled straight and to an accuracy of ± 5 degrees.
b) Holes shall not be more than 100mm longer than the required grouted length of the dowel, unless instructed otherwise by the *Employer*.
c) Where holes are cleaned by flush water, the amount of water employed shall be kept to an absolute minimum.
d) Holes drilled into the vertical rock face shall, as a general rule, be at an inclination of 15 degrees downwards from the horizontal.

e) Holes drilled vertically, into the flat bed of the rock, shall, as a general rule, be perpendicular to the horizontal surface.
f) The *Employer* may also instruct the *Contractor* to adjust the alignment of the drilled holes, as dictated by conditions on Site.
g) The exact position of the bolts shall be marked on Site by the *Contractor* for the approval of the *Employer*.

PST-5.3: SELF-DRILLING NAIL INSTALLATION IN CALCRETE/SAND HORIZONS

The hollow stem self-drilling nail system shall be installed using rotary percussive drilling. Rotation speeds shall be sufficient to cut a true borehole (120 RPM to 150 RPM), as opposed to displacement of the soil with the drill bit through percussion and heavy feed pressures (driven installation).

Drilled boreholes are required to ensure enlarged grout bodies and to allow proper permeation of the grout into the surrounding ground. Feed pressures on the drill rods shall be regulated in accordance with the cutting performance of the drill bit. Boreholes may collapse in fine sand formations. The drilling and grouting operations shall therefore be performed simultaneously, using a grout swivel, grout pump and drilling head, to ensure that grout is injected over the full length of the hole to ensure stability of the drill hole.

PST-5.4: UNTENSIONED ROCK DOWEL INSERTION

The method of installation of dowels shall be approved by the *Employer*. Manufacturer's instructions for the use of proprietary components shall be followed wherever applicable.

The capacity, number, location, lengths and angle of dowel installation shall be commensurate with ground conditions, as shown on the drawings or as directed by the *Employer*. The dowels shall be fitted with centralisers at spacings of no more than 1.5m along the length of the dowel, to home the dowels centrally within the holes.

A minimum of two centralisers shall be provided for dowels shorter than 2.0m, with centralisers 300mm from the near and far ends of the dowel respectively.

After complete installation, trimming and finishes, the dowel shall not protrude more than 100mm from the rock face.

PST-5.5: TENSIONED ROCK BOLT INSERTION

The method of installation and tensioning of bolts shall be to the approval of the *Employer*. Manufacturer's instructions for the use of proprietary components shall be followed wherever applicable.

Installation of tensioned rock bolts shall only be undertaken by suitably qualified and experienced operators.

The lengths, diameters and spacing of the bolts shall be as shown on the drawings or as instructed by the *Employer*.

The rock bolt shall be installed so that the steel bar is located at the centre of the hole and the bonded length is located within competent bedrock.

Bars may have to be shortened, depending upon prevailing Site conditions. The *Contractor* shall ensure that all equipment required to trim and re-thread bars is available on Site at all times.

Tensioning of the rock bolts shall be by means of a suitable direct-pull device, e.g. torque wrench with dynamometric key, which shall be calibrated in accordance with the design requirements and the *Employer*'s instructions.

The bolts shall be tensioned in accordance with the SAICE Code of Practice on Lateral Support in Surface Excavations. The effectiveness of the installation procedure shall be determined by the installation of a test bolt and testing this bolt to yield load.

Should the assembly fail at a tension less than the proof load, the *Contractor* shall investigate the cause and provide remedial measures, to be documented and submitted to the *Employer* for his review and approval.

The procedure for the test bolt shall then be repeated until the *Employer* is satisfied that the specified requirements can be met.

PST-5.6: GROUTING PROCEDURE

The *Contractor* shall provide a method statement, in compliance with these specifications, covering the methods of grouting. The *Contractor* shall also conduct field tests to demonstrate the effectiveness of his proposed methods. These field tests shall include a pull-out test of the rock bolt.

Approval of the grouting procedure by the *Employer* will be subject to acceptance of the method statement and successful completion of the field tests.

In areas where the bolt face plate cannot be placed in direct contact with the rock over the full area of the face plate, a quick setting grout, to be approved by the *Employer*, shall be applied to the face plates before installation, such that the grout fills any gaps between the face plate and rock after tensioning.

PST-5.7: SPRAYED CONCRETE (SHOTCRETE)

PST-5.7.1: Mix Design

The sprayed concrete mix shall be designed and tested by the *Contractor* and a report submitted to the *Employer* for approval. The mix ingredients and material source shall not be altered during the course of construction without prior approval of the *Employer*. Such approval may be subject to an approved laboratory test report. The sprayed concrete mix shall be designed to yield a 28-day compressive strength as shown on the drawings.

No admixtures shall be used for structural repair work, unless required in special circumstances, in which case special approval will be required by the *Employer*.

PST-5.7.2: Batching

All batching of materials shall be by mass rather than by volume. Generally the sand aggregate may have a moisture content not exceeding 8% when batching. When kiln-dry sand is used, allowance shall be made for the lack of moisture content in order to maintain the required consistency.

The batching proportions shall allow for the loss of material due to rebound.

The ingredients shall be mixed not more than 1 hour before being loaded into the placer.

PST-5.7.3: Mixing

The materials shall be mixed thoroughly for a period of at least 90 seconds, ensuring the complete coating of the sand particles with cement.

Powder admixtures, if approved, shall be added to the mix in the gun while liquid admixtures shall be added through the nozzle.

Any batch of wet-mix sprayed concrete or any batch of dry-mix sprayed concrete using moist sand shall be used within one hour after mixing and shall be discarded after such elapsed period.

Rebound material shall not be used in sprayed concrete for lateral support.

In temporary *works*, or for concrete strength less than 15MPa, rebound material may be used if approved by the *Employer.* Rebound material shall not be used in a batch without being subjected to an approved preparation procedure. The cleaned and accepted rebound aggregate may be mixed with the fine aggregate as partial replacement thereof. Such a mix shall be deemed to be a new mix design and shall be tested and a report submitted to the *Employer* for approval.

The mix shall be screened prior to loading the gun to prevent the inclusion of stones, cement bag scraps or other foreign materials in the mix.

Sprayed concrete mixes using moist sand (<8% moisture) shall be mixed on Site due to the time limitations on the use of the batch.

Dry mixes using kiln-dried sands may be premixed, transported and stored in an approved manner on Site prior to use. Premixed mixes shall be used with plant that prevents excessive cement dust generation and aggregate separation.

PST-5.7.4: Placing/Shooting

The *Contractor* shall use experienced, skilled operators. The nozzle operator shall have adequate experience of work of a similar nature to that required for the particular application and the crew shall be familiar with the plant and equipment being used. The crew shall consist of at least the nozzle operator, a blowpipe operator, a machine operator and two rebound clearing men, all of whom shall be present during the application of sprayed concrete.

Shotcrete may be applied to both clear and meshed faces. Before starting the shotcreting operation, the exposed surface shall be cleaned by means of well-saturated compressed air, care being taken to avoid deposition of any oil or other deleterious materials.

While the surface is still moist, the shotcrete shall be shot into place pneumatically at right angles to the face being covered. The nozzle shall be held in the optimum position for placement, generally 0.6m to 1.2m from and perpendicular to the receiving surface. Care shall be taken to ensure full coverage of exposed reinforced mesh surfaces and to prevent the formation of voids or sand pockets. All voids and sand pockets formed during the application of sprayed concrete shall be cut out and made good during the course of the *works* while the sprayed concrete is still plastic.

Care shall be taken to avoid segregation of the material and, to ensure adhesion of the coating to the excavated surface and between successive layers of shotcrete. Any area of lean or separated shotcrete or areas that loosen under blows by hand held hammer shall be cut out and replaced with sound shotcrete.

All vertical surfaces shall be worked from the bottom upwards.

The *Contractor* shall provide on Site a standby hose of capacity similar to the one in use to maintain continuity of work in case of a hose blockage. Hoses shall be blown clean before any work is stopped.

PST-5.7.5: Test Panels

The *Contractor* shall provide test panel formers of at least 1000mm x 1000mm in size and 200mm thick and with sides splayed outwards at 45° to prevent the entrapment of rebound. Test panels shall be sprayed in the presence of the *Employer* for each mix design, using the same technique as for application of shotcrete onto the retaining structure. The test panels itself shall be protected by means of a suitable template and left to cure alongside the work.

Each test panel shall represent the section of work executed over the period agreed to by the *Contractor* and the *Employer* in advance. For the first 50 cubic metres of shotcrete applied, test panels shall be prepared and tested for each 10 cubic metres applied.

PST-5.7.6: Construction Joints

Once a section of work has commenced the application of the sprayed concrete shall be continuous up to construction joints or up to approved locations. Construction joints shall be formed where there is a stoppage in the work exceeding 1.5 hours, by cutting back the previous shotcrete layer to form a face at not less than 45° to the surface of the exposed face. Feathered joints will not be permitted.

Irregular edges shall be cut back to straight lines before commencing with further *works*.

PST-5.7.7: Curing and Protection

The finished surfaces shall be protected from drying out and direct sunlight, as well as from rain and frost, by whatever means, subject to the *Employer*'s approval.

The exposed surfaces shall be cured over a period of at least seven days by one of the following procedures:

a) Spraying the sprayed concrete with continuous uniform water spray commencing eight hours after placement.
b) Applying a full coat of an approved curing membrane as soon as practicable after placement, but not later than eight hours thereafter.

Rapid drying of the sprayed concrete at the end of the curing period must be prevented.

PST-5.7.8: Surface Finish

The finished surface shall have a neat, smooth, even and uniform finish free from rebound pockets or other defects.

The general procedure for achieving the required finish shall be as follows:

a) Undisturbed Nozzle Finish / Off the Gun Finish (GU)

The sprayed surface shall be brushed with a soft plasterer's brush approximately one hour after placement to remove adhering rebound dust and to prevent surface crazing.

PST-5.7.9: Surface Preparation

Immediately prior to the application of sprayed concrete, all surfaces shall be thoroughly cleaned and all loose ground shall be removed. This may be achieved by barring down, jetting with a mixture of water and air applied at high pressure and/or other appropriate means as approved by the *Employer*. Where soft material is to be covered, only obviously loose material shall be removed and boulders shall be thoroughly cleaned with compressed air. All surfaces to receive sprayed concrete shall be moist and free of all traces of dirt, oil, rebound or other deleterious material. The jetting equipment used shall allow for air and water in any combination to be available for cleaning of surfaces and/or of finished work.

PST-5.7.10: Reinforcement

At the time of application of the sprayed concrete, the reinforced steel (mesh) shall be free from loose or powdery rust, mill-scale, hardened rebound or any other coating which may reduce the bond strength or have a deleterious effect on the steel or sprayed concrete.

PST-5.7.11: Drainage Behind Shotcrete

Where groundwater inflows could interfere with the application of sprayed concrete or cause a reduction in the quality of sprayed concrete, the *Contractor* shall take action to control such groundwater inflows. Such action shall include the channelling of water by means of pipes and chases.

Where sprayed concrete is applied after completion of the drainage holes, the drainage holes shall be extended through the sprayed concrete with suitable formers or similar approved method. Plastic pipes or tubes used for this purpose may be left in holes drilled into the rock and embedded in sprayed concrete.

Geodrains shall be installed on the exposed soil surface prior to the application of shotcrete. These drains are to be continuous and all captured groundwater is to be led to drainage holes at the base of the shotcrete wall.

5.24.6 PST-6: TESTING

PST-6.1: GENERAL

The cost of all tests as described below, including any further quality control activities as covered in these specifications or as required to perform the *works* as described herein, shall be included in the tendered rates for the *works* as installed and constructed.

PST-6.2: TRIAL TESTING

Prior to the installation of soil nails or rock bolts, the *Contractor* shall carry out tests on Site to demonstrate and prove the ability and capacity of the systems to meet the requirements set forth in the method statements submitted by the *Contractor.*

The tests on nails and bolts shall demonstrate the following:

a) The strength of the cement grout required to fully anchor the nails/bolts up to the specified characteristic strength of the support.
b) The capacity of the equipment to be used to install the longest fully grouted nail/bolt required.
c) The capability of the crew to correctly install the support.
d) The design assumptions.

The *Contractor* shall undertake the tests with the equipment to be used in the *works.* The equipment shall be capable of installing test soil nails/rock bolts in slope faces at inclinations greater than 60°.

The *Contractor* shall provide a suitably calibrated hydraulic direct tensioning jack and load cell with a capacity in excess of 1.5 times the maximum characteristic strength of the nails/bolts to be used in the *works*, for use during the trial testing described above. Loads applied and dowel elongations shall be recorded during the tests.

PST-6.3: WORKS TESTING

The *Contractor* shall carry out in-situ tests on soil nail and rock bolts as the *works* progress. Testing shall be in accordance with recognized procedures given in the standards and codes of practice listed under section 3.0 of this specification.

The *Contractor*, in the presence of the *Employer*, shall carry out regular calibration of hydraulic tensioning devices. The *Contractor* shall provide the necessary testing equipment as required.

The *Contractor* shall check the effectiveness of the dowel installation procedures by testing a minimum of 1 in 50 units installed to a test load in accordance with the SAICE Code of Practice on Lateral Support in Surface Excavations

Installed support shall be tested after the grout has achieved its design strength. Nails/bolts to be tested shall be selected by the *Employer*.

Any nail/bolt that fails at a tension of less than or equal to the required test/proof load shall be replaced. In the event of such a failure, the end anchorage zone of the ground support for the 50 nail/bolt units installed prior to the test shall be considered unbonded.

The *Contractor* shall investigate the cause of such failure and submit proposed amendments to the installation procedure, as may be necessary. The spacing, length, diameter and type of additional support shall be approved by the *Employer*. The *Contractor* shall install any additional support as may be required prior to advancing the excavation any further.

Tests shall continue thereafter at a rate of 1 in 25 units installed until the *Employer* is satisfied that the cause of the failure has been overcome. Should any nails or bolt units tested still fail at tensions of less than the required test/proof load, the *works* shall be suspended. The *Contractor* shall install trial nails/bolts and conduct further pull-out tests on trial nails/bolts installed outside that area of the *works*, as directed by the *Employer*, until the *Contractor*'s method of support installation proves satisfactory to the *Employer*.

Should the failure be assessed to have been due to the *Contractor's* neglect in adhering to the specifications and approved method statements, or taking insufficient account of the prevailing rock or soil conditions, rectification of such defects and any associated additional costs shall be to the *Contractor's* account.

PST-6.4: TESTING OF SHOTCRETE

A trial panel of shotcrete, with a thickness of no less than 250mm and an area of at least 1.0m², shall be constructed on a representative section of the surface that is to be treated. The average percentage rebound shall be estimated for each trial panel.

The panel shall be constructed by spraying concrete into a mould at the same time as the concrete is applied to the surface. The test panel shall be cured by the same method as the sprayed concrete.

The strength of sprayed concrete shall be determined from concrete cores cut from a test panel constructed at the same time as the sprayed concrete (shotcrete) is applied. Further test panels shall be constructed and tested for each area of sprayed concrete of 500m², or part thereof.

The following further requirements shall be met:

a) Samples (Concrete Cores from Sprayed Concrete)

Three concrete cores shall be provided from each test panel. Cores shall not be taken within 125mm from the edges of the panel. Concrete cores shall be 100mm diameter and shall be taken to the full depth of the test panel.

b) Testing (Concrete Cores from Sprayed Concrete)

Each concrete core shall be tested to determine the compressive strength and density. Three concrete cores shall be tested at 28 days.

c) Compliance Criteria (Concrete Cores from Sprayed Concrete)

The results of tests for compressive strength of concrete cores shall be interpreted in accordance with SANS 50197. Adjustments to the measured strength, to take account of the age of the core when tested, shall not be permitted. The minimum compressive strength of concrete cores, converted to estimated in-situ cube strength, shall be greater than 20MPa at 28 days.

d) Non-compliance (Concrete Cores from Sprayed Concrete)

If the result of any test for compressive strength or density of concrete cores from sprayed concrete does not comply with the specified requirements, the *Contractor* shall submit proposals for any remedial *works* and changes to the materials, mix design, methods of production or methods of construction to the *Employer,* for his review and approval.

The cost of all such tests shall form part of the *Contractor's* normal process control and shall be deemed to be included in his tendered rates.

e) Checking of Applied Thickness

The *Contractor* shall check the thickness of applied shotcrete by means of randomly positioned probe holes. An acceptable procedure for these test probe holes shall include at least 10 test holes to be drilled for every 100m² of shotcreted area.

If the *Employer* considers that the number and/or positions of the test holes are not adequate, he may order the *Contractor* to drill additional holes entirely at the *Contractor*'s expense.

The basis for acceptance shall be that, in any area of $100m^2$, the arithmetic mean thickness of all the points checked shall be equal to or greater than the specified thickness. The thickness at any point shall also not be less than 80% of the specified thicknesses. Where the thickness is not acceptable, the *Employer* may order an additional layer of shotcrete to be applied and rechecked for thickness without additional payment, until the placed thickness is acceptable.

f) Strength Acceptance Criteria

The criteria for compliance with the strength requirements shall be the mean strength of three cores cut from a test panel, prepared and tested in accordance with SANS 5865.

The minimum strength requirements for shotcrete test samples shall be as follows:

- 28 day core compressive strength - 30MPa
- 3 day core compressive strength - 13MPa
- 1 day core compressive strength - 6MPa

All coring, preparation and testing shall be executed by an approved concrete testing laboratory.

The *Employer* shall assess the sprayed concrete quality based on the mean strength result compared to the specified 28-day compressive strength for each class of sprayed concrete.

Each test panel shall represent the section of work executed over the period agreed to by the *Contractor* and the *Employer* in advance. For the first 50m³ of shotcrete applied, test panels shall be prepared and tested for each 10m³ applied. The *Contractor* shall supply all panel moulds and core sampling equipment for sampling and testing shotcrete, which shall be held on Site for the full duration of these operations.

PST-6.5: FAILURE OF SHOTCRETE

Should test samples of shotcrete not achieve the specified minimum strength, the *Employer* may instruct the *Contractor* to carry out additional tests to determine new mix proportions, to avoid further failures. The *Contractor* may also elect to carry out core tests on applied shotcrete at his own cost.

If the *Employer* considers that the low strengths of the applied shotcrete may reduce the safety of the *works* and persons, or be detrimental to the effectiveness of the primary support, he may order that the following action be taken:

a) Remove the defective shotcrete in strips or panels in such a way that the safety of the *works* and persons is not endangered and replace with shotcrete that is acceptable, which may also require the replacement of the mesh, or
b) Apply additional layers of shotcrete not exceeding the thickness originally required.

In either case no payment will be made for the defective shotcrete already applied, nor for the *works* involved in removing it from the areas where it has been applied, nor for any mesh that must be replaced, including additional laps, nor for any costs involved in removing the resultant rubble from the excavation area and spoiling it in an approved spoil tip. Payment will only be made for placed and acceptable shotcrete.

5.24.7 PST-7: TOLERANCES

Tolerances (permissible deviations from design) for the lateral support walls shall be as follows:

a) Shotcrete

i.	Thickness	:	± 20mm
ii.	Planned position	:	± 50mm

b) Anchoring

i.	Anchor position	:	100mm

5.24.8 PST-8: SUPPORT MEASURE RECORDS

Records of the installation of all soil nails and rock bolts (if applicable) shall be kept by the *Contractor* on Site and a copy shall be submitted to the *Employer* within 7 days after each installation operation. The following records shall be provided, as appropriate:

a) Soil nail/rock bolt identification number or location

b) Drilling details, including:

- Date and time drilling started and finished.
- Machine and operator identification.
- Location, level, inclination, bearing, length and diameter of drill hole.
- Rate of penetration at 0.5 m intervals.

c) Water tightness of drill hole, including:

- Date and time water test started and finished.
- Details of any pre-grouting and redrilling.
- Length of test zone.
- Water pressure applied.
- Duration of test.
- Measured water absorption rate.

d) Details of steel soil nails and rock bolts, including:

- Type and diameter.
- Bond length.
- Overall length.
- Number and type of centralising spacers.
- Stressing record and lock-off load.

e) Details of grouting, including:

- Date and time grouting started and finished.
- Details of any packers used and length of grouted zones.
- Head maintained on grout during setting.

- Volume of grout accepted.

5.24.9 PST-9: SUPPORT MOVEMENT MONITORING

The *Contractor* shall provide method statements for measurement of movement monitoring to the *Employer* for approval prior to the commencement of the *works.* Records of the movement monitoring data shall be issued to the *Employer* within 24 hours of the measurements being taken.

The guidelines provided in the publication “Lateral Support in Surface Excavations” Code of Practice (1989) shall be implemented to monitor ground movements. The monitoring criteria shall typically comprise of the following actions:

- ALERT – top of excavation/wall moves 0.12%H : investigate why.
- ALARM – top of excavation/wall moves 0.30%H : concern, consider remedial measures.
- ACTION – top of excavation/wall moves 0.40%H : stop all work and apply remedial measures.

5.24.10 PST-10: SUPPORT MEASURE ELEMENTS

All support elements shall be carefully examined at the time of delivery. Any damaged elements shall be repaired or replaced, subject to approval by the *Employer*. Test records and material certificates for steel elements shall be submitted to the *Employer* prior to commencing the *works*.

The *Employer* shall be provided with unencumbered access to inspect all materials and equipment delivered to Site, including inspections at the premises of manufacturers and suppliers.

Only new materials shall be used for the support *works*.

5.24.11 PST-11: MEASUREMENT AND PAYMENT

Payment for items in this section shall include full compensation for all *works* associated with any additional temporary *works*, execution of the work and quality assurance procedures which are not separately covered by the measurement and payment items of the specifications. All costs associated with general access, work platforms and temporary *works* shall be included in the tendered rates.

The pay items as described below shall further include all costs (plant, equipment, material, labour, water, transport, testing, etc.) related to the successful completion of the various construction items as listed, as indicated on the drawings, or as instructed on Site by the *Employer*.

PST-11.1: SLURRY CUT-OFF WALL

PST-11.1.1: Establishment on Site for slurry wall construction, including the provision and removal of equipment for constructing the slurry wall ..... Unit: Sum

PST-11.1.2: Construction of 550mm thick (3.0MPa minimum strength) slurry cut-off wall by means of a Cutter-Soil-Mixer (CSM) or trench mixer ..... Unit: m²

PST-11.2: SHOTCRETE

PST-11.2.1: Establishment on Site for shotcreting, including the provision and removal of equipment for shotcreting..... Unit: Sum

PST-11.2.2: 25mm thick flash coat shotcrete (30MPa) strength applied as initial layer prior to placing mesh..... Unit: m²

PST-11.2.3: 175mm thick shotcrete (30MPa) strength with 2 x layers of galvanised ref. 395 mesh reinforcing ..... Unit: m²

PST-11.2.4: 200mm thick shotcrete (30MPa) strength with 2 x layers of galvanised ref. 617 mesh reinforcing ..... Unit: m²

PST-11.2.5: Place and maintain in position vertical geodrains (wickdrains) consisting of geofabric rapped in geonet, spaced centrally between soil nails and rock bolts for the full height of the excavation zone, including discharging the geodrains into 50mm Ø HDPE weephole pipes protruding through the toe of the wall..... Unit: m

PST-11.3: SOIL NAILS

PST-11.3.1: Establishment on Site for drilling, including the provision and removal of equipment for installing and testing soil nails ..... Unit: Sum

PST-11.3.2: Moving to and setting up the equipment at each position for drilling the holes ..... Unit: No.

PST-11.3.3: Drilling of holes, installation, grouting, fixing and tightening of 2 rows of self-drilling soil nails (R25N or equivalent approved) of length 6.0m, installed 10° to 15° to the horizontal into the soft excavation zone ..... Unit: No.

PST-11.3.4: Drilling of holes, installation, grouting, fixing and tightening of 4 rows of self-drilling soil nails (R32N or equivalent approved) of length 9.0m, installed 10° to 15° to the horizontal through the new 550mm thick slurry wall into the soft excavation zone ..... Unit: No.

PST-11.4: PROVISIONAL AMOUNTS

PST-11.4.1: 50 No. off 125mm Ø mini-piles of length 5.0m each, installed at 1.5m c/c, each pile reinforced with 4 x Y12 bars with R08 spirals at 1.0m c/c ..... Unit: Sum

6.0. CONTRACTOR DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

Technical Specification Tippler 3 Bulk Power Supply -

High and Medium Voltage Installations

Document Number 1924701-2-300-E-SP-0006

Document Details

Ref (SA)	1924701-2-300-E-SP-0006
Date	27 May 2016
Prepared by	Dirk Agenbag
Reviewed by	Brett Sansom, Colin Pym
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	13 April 2018	Issued for Construction	Colin Pym	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy.

The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

This specification covers the high and medium voltage equipment required as part of the *works,* including power transformers, medium and high voltage switchgear and medium voltage power cabling.

1.2 Purpose

The purpose of this specification is to set the minimum technical requirements for quality, workmanship, design (where required), fabrication, supply, installation, construction, testing and commissioning of the following but not limited to equipment/infrastructure:

- 132-66/11 kV power transformers.
- 132 kV and 66 kV outdoor circuit breakers.
- 132 kV isolators.
- 132 kV current transformers.
- 132 kV and 66 kV post insulators.
- 66 kV power voltage transformers (auxiliary supply to Eskom (Ystervark) section of New Main Intake Substation).
- 66 kV voltage transformers for protection purposes.
- 66 kV surge arresters.
- 11 kV dry type series reactors (if required).
- 11 kV NECRTs.
- 11 kV gas insulated switchgear (double busbar).
- 11 kV gas insulated switchgear (single busbar).
- 3.3 kV gas insulated switchgear.
- 11/3.3 kV dry-type transformers
- 11/0.4 kV dry type transformers
- 11 kV and 3.3 kV power cables and all associated accessories.
- HV & MV clamps and conductors.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site Information.
- Drawings.
- All other applicable contract documentation.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1: Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2: Abbreviations

Abbreviation	Meaning Given to the Abbreviation
AAC	All Aluminium Conductor
AC	Alternating Current
AF	Air Forced
AFLR	A - Authorised personnel only, F - Front, L - Lateral, R - Rear
Al	Aluminium
AMSL	Above Mean Sea Level
BIL	Basic Impulse Level
BoQ	Bill of Quantities
CT	Current Transformer
Cu	Copper
dB	Decibel
DB	Distribution Board
DBPC	Ditertiary Butyl Para-Cresol
DC	Direct Current
DGA	Dissolved Gas Analysis
DP	Degree of Polymerisation
DVD	Digital Video Disk
E/F	Earth Fault

Table 2: Abbreviations

Abbreviation	Meaning Given to the Abbreviation
ECSA	Engineering Council of South Africa
EMC	Electro-Magnetic Compatibility
ENC	Eskom National Contract
FAT	Factory Acceptance Test
GIS	Gas Insulated Switchgear
HSE	Health Safety and Environmental
HV	High Voltage
HVH	Heavy Very Heavy
Hz	Hertz
IAC	Internal Arc Classification
ID	Identification Document
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
ILAC	International Laboratory Accreditation Corporation
I/O	Input – Output
IP	Ingress Protection
IR	Infra-Red
ISO	International Organization for Standardization
kA	Kilo Ampere
KIPTS	Koeberg Insulator Pollution Test Station
kPa	Kilo Pascal
kV	Kilo Volt
LAP	List of Accepted Products
LCD	Liquid Crystal Display
LSC	Loss of Service Continuity
LV	Low Voltage
MCB	Miniature Circuit Breaker
MIB	Marshalling Interface Box
mm	Millimetre
ms	Milliseconds
MS	Microsoft
MV	Medium Voltage
MVA	Mega Volt Ampere
NC	Normally Closed
NEC	Neutral Electro-Magnetic Coupler
NECRT	Neutral electro-magnetic coupler (NEC) with neutral earthing resistor (NER) and auxiliary transformer.

Table 2: Abbreviations

Abbreviation	Meaning Given to the Abbreviation
NER	Neutral Earthing Resistor
Nm	Newton meter
NO	Normally Open
O&M	Operating and Maintenance
O/C	Over Current
^{o}C	Degree Celsius
OCTS	Off-Circuit Tap Switch
OEM	Original Equipment Manufacturer
OLTS	On Load Tap Switch
ONAF	Oil Natural Air Forced
OTI	Oil Temperature Indicator
PCB	Poly Chloride Biphenyls
PCD	Pitch Circle Diameter
PILC	Paper Insulated Lead Covered
PM	Partition Metallic
PTC	Positive Thermal Coefficient
PVC	Polyvinyl chloride
QA	Quality Assurance
r.m.s	Route Mean Square
RE/F	Restricted Earth Fault
RIO	Remote Input / Output Device
RIP	Resin Impregnated Paper
RIV	Radio Influence Voltage
RMU	Ring Main Unit
RTV	Room Temperature Vulcanization
s	Seconds
SABS	South African Bureau of Standards
SANS	South African National Standards
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition System
SF_6	Sulphur Hexafluoride
USCD	Unified Specific Creepage Distance
UV	Ultra-Violet
VA	Voltage-Ampere
VDS	Voltage Detection System
VLF	Very Low Frequency
VSD	Variable Speed Drive

Table 2: Abbreviations

Abbreviation	Meaning Given to the Abbreviation
VT	Voltage Transformer
W	Watt
WC	Water Content
WTI	Winding Temperature Indicator
XLPE	Cross-Linked Polyethylene
Z_nO	Zinc Oxide

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

For the Eskom portion of the *works*, only Eskom approved equipment, materials and the like shall be used. Reference shall be made to the latest LAP list available on Eskom's technical document website.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer*, such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The C*ontracto*r shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 *Employer's* Standards

The *Contractor* shall be responsible for compliance of all works with all the *Employer* standards and specifications, including, but not limited to, the following:

Table 3: *Employer's* Standards and Specifications

Standard	Description
EEM-Q-008	Corrosion Protection Specification
EEM-Q-012	General Electrical Equipment
EEM-Q-013	Commissioning and Handover
EEM-Q-017	Medium Voltage Switchgear and Control Gear for Substation
EEM-Q-018	Lighting on Equipment
EEM-Q-019	Cable Reel Systems
EEM-Q-020	Test on Electrical Equipment
EEM-Q-021	Electronic Equipment
EEM-Q-023	Medium Voltage Equipment for Port Equipment
SYS-P-0001	Business Codification
H500100-2-000-J-STD-0008	Instrumentation Identifications Standard
H500100-2-000-J-STD-0009	Tag Naming Standard

It is the responsibility of the *Contractor* to ensure that he obtains all of the *Employer's* standards (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the *works* by the *Contractor* to the standards.

3.4 South African and International Standards

The *Contractor* shall also ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include, but are not necessarily limited to, the following.

Table 4: South African Standards

Code	Standard Title
SANS 1019	Standard voltages, currents and insulation levels for electricity supply
SANS 1091	National colour standard
SANS 60076-1	Power transformers Part 1: General
SANS 60076-2	Power transformers Part 2: Temperature rise for liquid immersed Transformers
SANS 60076-3	Power transformers Part 3: Insulation levels, dielectric tests and

Table 4: South African Standards

Code	Standard Title
	external clearances in air
SANS 60076-4	Power transformers Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
SANS 60076-5	Power transformers Part 5: Ability to withstand short circuit
SANS 60076-6	Power transformers Part 6: Reactors
SANS 60076-7	Power transformers Part 7: Loading guide for oil-immersed power transformers
SANS 60076-8	Power transformers Part 8: Application guide
SANS 60076-10	Power transformers Part 10: Determination of sound levels
SANS 60076-11	Power transformers Part 11: Dry-type transformers
SANS 60076-12	Power transformers Part 12: Loading guide for dry-type power transformers
SANS 60076-21	Power transformers - Part 21: Standard requirements, terminology, and test code for step-voltage regulators
SANS 61869-1	Instrument transformers Part 1: General requirements
SANS 61869-2	Instrument transformers Part 2: Additional requirements for current transformers
SANS 60815-1	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 1: Definitions, information and general principles
SANS 60815-2	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 2: Ceramic and glass insulators for AC systems
SANS 60815-3	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions Part 3: Polymer insulators for AC. systems
SANS 10142-1	The wiring of premises Part 1: Low-voltage installations
SANS 10142-2	The wiring of premises Part 2: Medium-voltage installations above 1 kV AC not exceeding 22 kV AC and up to and including 3 000 kW installed capacity
SANS 1973-1	Low-voltage switchgear and controlgear ASSEMBLIES Part 1: Type-tested ASSEMBLIES with stated deviations and a rated short-circuit withstand strength above 10 kA
SANS 1973-3	Low-voltage switchgear and controlgear ASSEMBLIES Part 3: Safety of ASSEMBLIES with a rated prospective short-circuit current of up to and including 10 kA
SANS 60270	High-voltage test techniques - Partial discharge measurements
SANS 62271-1	High-voltage switchgear and controlgear Part 1: Common specifications
SANS 62271-100	High-voltage switchgear and controlgear Part 100: Alternating current circuit-breakers
SANS 62271-102	High-voltage switchgear and controlgear Part 102: Alternating current disconnectors and earthing switches
SANS 62271-103	High-voltage switchgear and controlgear Part 103: Switches for rated voltages above 1 kV up to and including 52 kV
SANS 62271-200	High-voltage switchgear and controlgear Part 200: AC metal enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
SANS 60044-1	Instrument transformers Part 1: Current transformers
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
SANS 780	Distribution transformers
SANS 60137	Insulated bushings for alternating voltages above 1 000 V

Table 4: South African Standards

Code	Standard Title
SANS 10198-1	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 1: Definitions and statutory requirements
SANS 10198-2	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 2: Selection of cable type and methods of installation
SANS 10198-3	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 3: Earthing systems - General provisions
SANS 10198-4	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 4: Current ratings
SANS 10198-5	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 5: Determination of thermal and electrical resistivity of soil
SANS 10198-6	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 6: Transportation and storage
SANS 10198-7	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 7: Safety precautions
SANS 10198-8	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 8: Cable laying and installation
SANS 10198-9	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 9: Jointing and termination of extruded solid dielectric-insulated cables up to 3,3 kV
SANS 10198-10	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 10: Jointing and termination of paper-insulated cables
SANS 10198-12	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 12: Installation of earthing system
SANS 10198-13	The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 13: Testing, commissioning and fault location
SANS 1339	Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV
SANS 60168	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1 000 V
NRS 029	Current transformers
NRS 030	Inductive voltage transformers
NRS 079	Mineral insulating oils (uninhibited) Part 1: Purchase, management, maintenance and testing

International standards shall include, but are not necessarily limited to, the following.

Table 5: International Standards

Code	Standard Title
IEC 60616	Terminal and tapping markings for power transformers
IEC 61869-1	Instrument transformers - Part 1: General requirements
IEC 60502-2	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) - Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
IEC 60071	Insulation co-ordination - Part 1: Definitions, principles and rules
IEC 60085	Electrical insulation - Thermal evaluation and designation
IEC 60156	Insulating liquids - Determination of the breakdown voltage at power frequency - Test method
IEC 60214	Tap-changers - Part 1: Performance requirements and test methods

Table 5: International Standards

Code	Standard Title
IEC61243-5	Live working - Voltage detectors - Part 5: Voltage detecting systems (VDS)
IEC 62217	Polymeric HV insulators for indoor and outdoor use - General definitions, test methods and acceptance criteria
IEC 60273	Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V
BS 1872	Specification for electroplated coatings of tin
ISO 12944-2	Corrosion Protection of Steel Structures
BS 3571	General recommendations for manual inert gas metal arc welding Part 1: MIG welding of aluminium and aluminium alloys
BS 4360	Specification for weldable structural steels
BS 5135	Arc welding of carbon and carbon manganese steels
DIN 2576	Flanges Slip-on type for Brazing or Welding; Nominal pressure 10 max
DIN 2631	Welding neck flanges; nominal pressure 6 (max)

3.5 Eskom Standards

Eskom standards shall include, but not be limited to, the following:

Table 6: Eskom Standards

Code	Standard Title
240-101940513	Substation Earth Electrode Resistance Measurement
240-53113923	Specification for Substation Clamps for Tube Aluminium Conductors
240-54615413	Standard For Commissioning Protection Assets
240-56030435	Outdoor Ceramic Station Post Insulators for Systems with Nominal Voltages up to 765 kV Specification
240-56063756	Outdoor Circuit Breakers for System with Nominal Voltages from 6.6kV up to and including 765 kV Standard
240-56063815	High Voltage Outdoor Disconnectors and Earthing Switches
240-75655504	Corrosion Protection Specification for New Indoor and Outdoor Distribution Equipment Manufactured from Steel
240-83534936	Tubular and Stranded Conductor Clamps Additional to the Existing Standards
240-87605434	Quality Checklist for Distribution Substation Primary Plant Prior to Handing Over for Commercial Operation
240-96393507	Soil Resistivity Testing for Substation Applications
240-62629353	Panel Labelling Standard
34-1245	Distribution Standard – Part 2: Earthing Section 3: Substation Earthing
34-1439	Standard for the Labelling of Substations and Networks
240-56062765	Inductive Voltage Transformers: Eskom Specific Requirements up to 132 kV in Accordance with NRS 030
34-1689	Current Transformers: Eskom Specific Requirements for Voltages up to 132 kV in Accordance With NRS 029

Table 6: Eskom Standards

Code	Standard Title
34-1985	Distribution Standard: Part 2 Earthing Section 1: MV and LV Distribution System Earthing
474-218	Specification for Substation Clamps for Stranded Aluminium Conductors
240-53113923	Specification for Substation Clamps for Tube Aluminium Conductors

It is the responsibility of the *Contractor* to ensure that he obtains all Eskom standards, specifications and associated requirements (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the *works* by the *Contractor* to the afore - and abovementioned.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 7: Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 SCOPE OF *WORKS*

5.1 *Works* Included

The *Contractor's* scope of *works* shall include, but not be limited to, the design, as applicable, supply, installation and commissioning of the electrical infrastructure/systems required for the bulk power project, including the following:

- All detailed designs, drawings and documentation as required in terms of this specification. The *Contractor* shall engage the services of approved specialist subcontractors and OEM's as necessary.
- All management, personnel, labour and other resources that are required to execute the *Contractor's* scope of *works*, in accordance with the requirements of this specification.
- Supply, installation and commissioning of all new electrical infrastructure as per the requirements of the bill of quantities, drawings, specifications and associated contract documentation including all packaging, delivery to Site, Site off-loading, Site storage and rigging.
- Co-ordination between services (mechanical, electrical and control).
- Quality management, as described in the Works Information and these specifications.
- Supply of installation and commissioning spares and operational spares, required for normal wear and tear during plant operation for the period of one year after commissioning, and special tools required for maintenance purposes, as described in Section 26.0.
- Operating and maintenance manuals, training and back-up support, as described under Section 27.0.
- Pre-commissioning and commissioning of electrical installations, including supporting documentation, as described under Sections 29.0.
- All as-constructed documentation, as described under Section 30.0.

The scope of electrical facilities forming part of the *works* includes, but is not limited to, the following:

- 132-66/11 kV 40 MVA power transformers.
- 132 kV circuit breakers.
- 132 kV current transformers.
- 132 kV motorised isolators.
- 132 kV non-motorised isolators.
- 132 kV post insulators.
- 66 kV voltage transformers.
- 66 kV power voltage transformers.
- 66 kV surge arresters.
- 66 kV post insulators.
- 66 kV circuit breakers.
- 11/3.3 kV 4.5 MVA dry-type transformer.
- 11/3.3 kV 3.5 MVA dry-type transformer.
- 11/0.4 kV 1 MVA dry-type transformers.
- 11/0.4 kV 3.15 MVA dry-type transformer.
- 11 kV 40 MVA series reactors (if required).
- 11 kV NECRT including 315 kVA auxiliary transformers.
- New Main Intake double busbar 11 kV switchboards and associated equipment.
- Substation M single busbar 11 kV switchboards and associated equipment.
- Substation M single busbar 3.3 kV switchboards and associated equipment.
- Substation N single busbar 11 kV switchboards and associated equipment.
- Substation N single busbar 3.3 kV switchboards and associated equipment.
- 11 kV power cables and all accessories within the substations and between the substations.
- All Associated cabling and wiring.
- Cleaning of existing Substation K 11 kV switchboard cable compartments and other sections as applicable by specialised subcontractor/OEM.
- All parts of the *works* to be owned and operated by Eskom, as described also in the Works Information and associated contract documentation, which shall also fully comply with their requirements.

The *Contractor* shall be responsible for reconfiguring the 11 kV electrical network as highlighted in the Works Information. The Main Intake Substation 11 kV switchgear will also feed the existing Substations A, H, J and K.

The systems shall be designed (where specified), installed and commissioned by the *Contractor* to provide a fully functional, operable and compliant system for the electrical network, in accordance with these specifications, Works Information, drawings, bill of quantities and all other related contract documentation.

It will be the responsibility of the *Contractor* to ensure that the specialist subcontractor/OEM fully co-operates, co-ordinates and furnishes all technical support and associated technical information to the *Employer* and Others as required, to ensure that the new infrastructure and systems are fully and correctly electrically and electronically integrated.

Should there be any discrepancies or misunderstandings regarding the *works* to be undertaken by the *Contractor*, the *Contractor* shall immediately notify the *Employer*.

5.2 *Works* Excluded

The following is excluded from the *works* and will be provided by Others:

- The busbar ducting from the 11/0.4 kV 3.15 MVA Tippler 3 Building Transformer to the Tippler 3 LV switchgear.
- Cables and terminations from the 3.3 kV switchgear at Substation M and N to the variable speed drives (VSDs).
- 3.3 kV VSDs.
- Training of personnel for the Eskom portion of the *works* is excluded from the scope.

5.3 Designs, Calculations and Drawings by the *Contractor*

5.3.1 General

All calculations, designs, drawings and reports to be produced by the *Contractor* shall be compiled and submitted in accordance with the procedures included in the Works Information as well as the further requirements as detailed below. All documents, for which prior approvals are required, shall be timeously submitted to the *Employer* for review and approval, prior to placement of orders, fabrication or manufacture.

The *Contractor* shall appoint specialist subcontractors and/or OEMs to undertake the designs, calculations and drawings as applicable and required, which shall be prepared and checked by suitably qualified and experienced professional engineers, registered with the Engineering Council of South Africa (ECSA) or an equivalent institution recognised by ECSA.

The specialist subcontractors and/or OEMs shall be appointed by the *Contractor,* subject to approval by the *Employer*. Designs, calculations and drawings shall not be prepared and checked by the same person and shall be reviewed by the *Employer* before the commencement of fabrication.

The *Employer* will provide the *Contractor* with the necessary formats for documents that are to be submitted for approval.

The *Employer* may, at his sole discretion, request additional design calculations, drawings and associated information, as deemed necessary for verification of the correctness and compliance of the designs. The cost of providing such additional information shall be deemed to be included in the tendered rates, i.e. further payments for such information will not be made.

5.3.2 Designs and Calculations by the *Contractor*

The *Contractor* shall submit all required calculations in a neat and legible manner. Where calculations are performed using specialised software programs, the *Contractor* shall also furnish copies of the final native software files, without any exclusions. The calculations shall be provided in a professional, neat format, to include, but not be limited to, the following, in the order as stated below:

- Summary of assumptions and conclusions.
- Table of contents.
- List of all associated drawings.

- List of compliancy standards.
- List of all text and references used.
- Nomenclature.
- Where applicable, calculations shall include, but not be limited to, the following areas:
  i. Interlocking philosophy/design document.
  ii. The switchgear OEM shall provide internal arc simulations for the New Main Intake Substation, Substation M and Substation N medium voltage switchgear rooms.
  iii. The dry-type transformer OEM shall provide arc simulations for Substation M, N and inside the Tippler 3 building transformer room, where all indoor transformers are located. Note: For Substations M and N, the OEM will also be required to obtain the 3.3kV VSD data from Others and include into the simulations.
  iv. Dynamic analysis and complete load flow studies, including fault level analysis.
  v. Derating of cables and sizing.
  vi. All protection settings.
  vii. Electrical equipment selection criteria.
  viii. A calculation, proving that the Buchholz relay will not operate under short time rated current conditions for 10s, shall be provided (for 11 kV NECRTs).

5.3.3 Drawings by the *Contractor*

All drawings shall be submitted in hard and soft copies. Soft copies shall be in 'rvt', 'dgn', 'dwg', 'dxf' and 'PDF' formats. Three hard copies are to be provided, which shall be fully signed off, unless specified otherwise.

The *Contractor* shall be solely responsible for the submission of any drawings that are to be provided by his appointed specialist subcontractors or OEM.

Typical drawings to be provided by the *Contractor* shall include, but will not be limited to:

- Equipment general arrangement and schematic drawings.
- General arrangement drawings.
- Single line diagrams.
- Switchgear schedules.
- Detailed panel layout drawings.
- Component layout drawings (LV compartment door and interior layout).
- Switchboard detailed design drawings.
- Interlocking system configuration diagram and logics.
- Transformer enclosure drawings.
- Nameplates details drawing.
- Wiring diagrams.

5.4 Safety

Reference is made to the environmental and safety requirements as detailed in the Works Information and the particular requirements as described below.

The *Contractor* shall take all necessary safety precautions to prevent static electricity discharge, sparking and any other unsafe condition, which could pose a safety risk to personnel, property and/or equipment.

All *works* shall be performed under strict lockout/disconnection conditions and a register shall be kept of all isolated circuits. The *Employer's* requirements shall also be incorporated in all safety procedures.

Provision shall be made for the following:

- The switching and lockout procedures shall form part of the *Contractor's* HSE documentation.
- Whenever a live circuit must be isolated, the *Employer* shall be notified.
- The *Employer* shall be present during the switch-off and will witness hand-over to the *Contractor*.
- The *Contractor* shall maintain a full key lockout system, with appropriate registers and signatures.
- No switching may be undertaken by the *Contractor*, unless specific approval has been provided by the *Employer*.

5.5 South African Electrical Compliance

Any equipment designed and fabricated/manufactured overseas shall comply fully with the relevant SANS/SABS and other associated statutory regulations and shall bear the associated SANS/SABS mark of approval where applicable. The *Employer* reserves the right to accept products that bear the mark of approval of other industry recognised and accepted standards, e.g. IEC, provided these are also recognised and approved by SABS/SANS.

5.6 *Employer* QA Representative

The *Contractor's* QA requirements shall be as set out in the accompanying Works Information.

The *Employer* may choose to appoint a QA/QC representative to monitor and report on some or all aspects of the production and fabrication processes. Full cooperation shall be extended to the appointed QA/QC representative. Associated costs for such services will be borne by the *Employer*.

5.7 *Contractor's* Subcontractor Declaration

Where *works* are to be performed by a subcontractor, the *Contractor* shall provide notices and obtain the *Employer's* approval prior to the appointment of the subcontractor. This shall include all subcontractors providing design, fabrication, assembly, installation and related services.

6.0 DESIGN CRITERIA

6.1 Electrical and Working Clearances

Electrical clearances provide a reliable air gap in order to withstand over-voltages. Generous clearances shall be provided to cater for the high variability of the withstand strength of the air gap, which is related to the air pressure, humidity and other factors.

Working clearances prescribe the distances that must be adhered to allow work to be carried out safely on isolated and earthed equipment whilst adjacent equipment is still live. Working clearance is derived from the “reach of a human being” and the applicable phase-to-earth electrical clearances.

The following minimum electrical and working clearances shall be adhered to (see Table 8 below), unless specified otherwise or required differently by statutory regulations, standards and the like. Note: Eskom requirements to be adhered to as well:

Table 8: Electrical and Working Clearances

System Nominal Voltage (kV)	System Highest Voltage (kV)	Minimum Electrical Clearance		Working Clearance	
		Phase to Earth (mm)	Phase to Phase (mm)	Vertical (m)	Horizontal (m)
3.3 kV	3.6 kV	80 mm	110 mm	2.5 m	1.2 m
11 kV	12 kV	200 mm	270 mm	2.7 m	1.3 m
66 kV	72 kV	770 mm	1050 mm	3.2 m	1.8 m
132 kV	145 kV	1200 mm	1650 mm	3.7 m	2.3 m

6.2 Insulation Coordination

The insulation of the HV and MV equipment shall generally be rated according to the parameters stated in Table 9 below, unless specified otherwise or required differently by statutory regulations, standards and the like. Note: Eskom requirements to be adhered to as well:

Table 9: Insulation Coordination

System Nominal Voltage (kV)	3.3 kV	11 kV	66 kV	132kV
System Nominal Voltage (kV)	3.3 kV	11 kV	66 kV	132 kV
System Highest Voltage (kV)	3.6 kV	12 kV	72.5 kV	145 kV
Lightning Impulse Withstand Voltage (kV)	40 kV	75 kV	325 kV	650 kV
Rated Short Duration Power-frequency withstand voltage (kV r.m.s.)	10 kV	28 kV	140 kV	275 kV

7.0 132-66/11 kV POWER TRANSFORMERS

7.1 General

The scope of the *works* consists of the design, manufacture, test, supply, delivery to Site for erection, erection, testing and commissioning of the transformers as described hereafter.

This specification covers the technical requirements for the design, manufacture, factory testing, installation and commissioning of three-phase, oil immersed, outdoor, 132-66/11 kV, 40 MVA ONAN/ONAF, YNd1 transformers with on-load tap changing equipment.

7.2 Technical Schedule

The 132-66/11 kV Power Transformers shall be in accordance with the requirements set forth in Table 10 below.

Table 10: Technical Schedule for 132-66/11 kV Power Transformers

Item	Description	Specified
1	**Nominal System Voltage**	
1.1	Rated Nominal Primary Dual Ratio Voltage 1	132 kV
1.2	Rated Nominal Primary Dual Ratio Voltage 2	66 kV
1.3	Rated Nominal Secondary Voltage	11 kV
2	**Continuous Rated Power for All Tapping's**	
2.1	ONAN Rated Apparent Power Output	28 MVA
2.2	ONAF Rated Apparent Power Output	40 MVA
3	**Overload Withstand Capability**	
3.1	Short-time overload withstand capability	To be provided by OEM
3.2	Long-time overload withstand capability	To be provided by OEM
4	**Minimum Insulation for windings**	
4.1	Primary Impulse withstand test voltage for line terminal	650 / 350 kV peak
4.2	Secondary Impulse withstand test voltage for line terminal	150 / 95 kV peak
4.3	60 second Primary Power Frequency Withstand Test, Separate Source	95 kV
4.4	60 second Secondary Power Frequency Withstand Test, Separate Source	50 / 28 kV
4.5	Primary-to-Earth 60 s, Induced-Overvoltage Withstand Test Voltages	230 / 140 kV
4.6	Secondary 60s, Induced-Overvoltage Withstand Test Voltages	44 / 22 kV
5	**Transformer Type**	
5.1	Vector Group	YNd1
5.2	Type of Transformer	Core
5.3	Number of Limbs	3
5.4	Winding Arrangement (Core/Secondary/Primary/Regulator)	Core/MV/HV/Reg
5.5	Type of Cooling	ONAN/F
6	**Core Design**	
6.1	Maximum Flux Density (at U_n)	< 1.72

Table 10: Technical Schedule for 132-66/11 kV Power Transformers

Item	Description	Specified
7	**Impedance at 75°at rated MVA on Principal Tapping**	16%
8	**Transformer Losses**	
8.1	Load-Loss	To be provided by OEM
8.2	No Load-Loss	To be provided by OEM
9	**Temperature rises at altitude of 1800m**	
9.1	Top oil	55°C
9.2	Windings (by resistance)	60°C
9.3	Hotspot of winding	< 73°C
9.4	Hotspot of metal parts in contact with oil	< 105°C
10	**Maximum acoustic noise ONAN/ONAF**	76 / 77 dB
11	**Voltage Tapping Range (% of the ratio on the principal tapping)**	
11.1	Tapping range (132/11 kV)	-7.5 % to +2.5 % with 0.625 % voltage per tap
11.2	Tapping range (66/11 kV)	-15 % to +5% with 1.25 % voltage per tap
11.3	Resulting no-load Voltage Appearing having MV constant	
11.3.1	On principal tapping	132 / 66 kV
11.3.2	On extreme plus tapping	135.3 / 69.3 kV
11.3.3	On extreme minus tapping	122.1 / 56.1 kV
12	**Main terminals and Bushings**	
12.1	Type	Outdoor
12.2	Details of Primary bushing / terminal	RIP
12.2.1	Stem size (diameter x length)	26 x 125 mm
12.2.2	Current Rating (including 30% overcurrent)	> 314.92 A
12.2.3	Impulse withstand voltage at sea level	650 kV peak
12.2.4	Power frequency withstand voltage	275 kV r.m.s.
12.2.5	Creepage	> 4500 mm (31 mm/kV)
12.3	Details of Secondary bushing / terminal	RIP
12.3.1	Stem size (diameter x length)	38 x 125 mm
12.3.2	Current Rating (including 30% overcurrent)	> 2729 A
12.3.3	Impulse withstand voltage at sea level	75 kV peak
12.3.4	Power frequency withstand voltage	28 kV r.m.s
12.3.5	Creepage	> 740 mm (31 mm/kV)
12.4	Details of Neutral bushing / terminal	RIP
12.4.1	Stem size (diameter x length)	26 x 125 mm
12.4.2	Current Rating (including 30% overcurrent)	> 314.92 A
12.4.3	Impulse withstand voltage at sea level	650 kV peak

Table 10: Technical Schedule for 132-66/11 kV Power Transformers

Item	Description	Specified
12.4.4	Power frequency withstand voltage	275 kV r.m.s
12.4.5	Creepage	> 1500 mm (31 mm/kV)
13	**Base Plate Thickness**	25 mm
14	**Safe Withstand Vacuum at Sea Level**	1.5 kPA
15	**Tap Changers**	
15.1	Type	Vacuum OLTS
15.2	Number of maintenance free operations	300 000
15.3	Nominal 50 Hz Ratings of Tap-Changer	
15.3.1	Voltage	> 44 kV
15.3.2	Current (vacuum type)	To be provided by OEM
15.4	Insulation levels of tap-changer	650 kV peak
15.5	Tap-changer 50 Hz withstand	275 kV r.m.s
16	**Indicating and Protective Devices**	
16.1	Pressure relief device	Yes
16.2	Oil- and gas-actuated relay	Yes
16.3	Conservator bag required	Yes
16.4	Dehydrating breathers	Yes
16.5	Oil level indicators	Yes
16.6	Oil temperature thermometer	Yes
16.7	Winding temperature thermometer	Yes

7.3 Standards and Specifications

The transformers shall be designed, manufactured and tested in accordance with SANS 60076 (all applicable parts) and other standardized specifications as applicable.

All materials and equipment as supplied and installed shall be new and of a quality compliant with the relevant specification(s). The *Contractor* shall ensure compliance with these specifications and shall, if so instructed by the *Employer*, provide proof of such compliance, all at his own cost.

7.4 Service Conditions

Winding temperature rises and top oil temperature rises shall not exceed 55ºC/50ºC respectively. The above temperature limits differ from those specified in SANS 60076-7 and other applicable standardized specifications.

7.5 Loadings and Ratings

The transformers shall be designed and constructed for loading in accordance with the latest parts and revisions of SANS 60076 (Large Power Transformer category) and shall have full rating capability for step-down operation. The current carrying capability of the transformer under all loading conditions shall be limited only by the capacity of the core and coils, not by the capacity of other components and accessories.

The transformer shall be capable of withstanding, without damage, the thermal and dynamic stresses caused by short circuit as specified in SANS 60076-5 and other standardized specifications, as applicable.

The short circuit current shall be limited only by the impedance of the transformer (the upstream MVA source of the transformer is to be regarded as infinite).

Short-circuit withstand capability shall be based on a 2 second fault clearance time. Conformance to these short-circuit requirements shall be demonstrated by furnishing certified test data on a tested transformer with core and coil of similar design and construction, as well as the design calculations.

The transformer shall be suitable for voltage stresses associated with load rejection as detailed in SANS 60076-1.

The neutral connection shall be dimensioned for the appropriate earth fault current with the neutral directly connected to earth. The transformer is not intended to connect significant load between phase and neutral.

7.5.1 Maximum Temporary Over-Voltage

Under switching conditions, the power frequency line voltage may exceed the maximum system voltage (U_m). The transformers shall be designed to withstand the following over voltages without damage.

- U_m for continuous.
- 1.05 U_m for 5 min.
- 1.25 U_m for 5 s.
- 1.5 U_m for 1 s.
- 1.7 U_m for 0.25 s.

7.6 Design and Construction

The complete power transformer installation shall be designed for a minimum service lifespan of 40 years.

All tanks, bases, radiators, covers, junction boxes and any other attached compartments shall be fabricated from steel of sufficient strength to withstand normal transportation, installation, and service stresses without distortion or damage to any part.

Welding shall comply with the latest national, and where applicable international, welding standards. Site installation shall not require further welding.

All accessories and connections shall be vandal-proof and designed to minimise vibrations in service.

7.6.1 Main Tank and Accessories

The tank shall be designed and braced to withstand application of full vacuum as well as all forces during transport and during operational service, including the most severe fault conditions. Impact or shock recorders shall be used during transportation of the transformer, to verify that during transport and at delivery on-Site that no damage to the units has occurred as a result of the transportation process.

The tank design and construction shall minimise the possibility of water or air ingress. All joints shall be bolted and shall be provided with gaskets and flanges suitable for the design pressures. The construction shall be such that pockets of air are not formed inside the tank during construction or operation of the equipment. The tank cover shall be bolted using stainless steel bolts and shall be designed to effectively shed water.

The base shall be suitable for skidding or moving on rollers in any direction, as well as lifting into position by crane. Each transformer shall be provided with pulling eyes and jacking pads suitable for jacking the complete transformer filled with oil. Dimensions of the jacking pads shall be shown on the transformer outline drawing.

Transformer outline drawings shall show the centre of gravity for transportation and installation of the transformer. Anti-vibration mountings shall be provided for all transformers.

Earthing terminals shall be provided close to each corner of the tank for connection to the external earthing systems. All metal parts of the transformer shall be bonded to the main tank by suitably dimensioned and rated earthing straps.

Temporary, removable fall arrest handrails, toeboards and associated brackets shall be provided for installation around the periphery of the top of the transformer tank, providing safe access during the

installation and assembly of the transformer, and for future maintenance access. The transformer tank shall be delivered with the handrail and toeboard installed wherever possible.

7.6.2 Core

Cores shall be constructed of the highest quality, non-aging, cold-rolled, grain-orientated, high permeability silicon steel, particularly suited for the intended application. The steel shall comprise of thin laminations, properly annealed after cutting to suitable sizes and rolled to ensure smooth surfaces at the edges. Each sheet shall have an insulating surface treatment or coating, providing the required inter-lamination resistance in such a way that it will not deteriorate as a result of pressure and the action of hot oil.

The cores shall be carefully assembled and rigidly clamped to ensure adequate mechanical strength to support the windings and to prevent shifting of lamination during shipment, and also to reduce vibration to a minimum under operating conditions.

The core shall be designed to minimise no-load losses and shall be constructed from iron and silicon alloy with enhanced grain orientation. Design and construction of the core shall minimise eddy currents.

The design shall ensure reliable operation with no significant loosening or vibration of core components over the design lifetime of the transformer. The complete core and winding assembly shall be removable from the tank for repairs. Lifting eyes or lugs shall be provided for handling the core assembly when it is 'untanked'.

Each core shall be securely earthed to the tank. Core earth connections shall be detachable and shall be made in an externally located terminal box with a suitable test bushing, accessible without making entry into the main tank.

7.6.3 Windings

The windings shall be made of electrolytic copper of high conductivity. Insulation material of high quality (Class A, IEC) shall be utilized. The windings shall be assembled in a manner that is best suited for the particular application. Proper consideration shall be given to all factors and conditions during service, such as high dielectric and mechanical strength of insulation, coil characteristics and minimum restrictions to free circulation of oil.

Coils shall be made up, shaped and braced to provide for expansion and contraction resulting from temperature changes in order to avoid abrasion of insulation and to provide rigidity to resist movement and distortion caused by abnormal operating conditions. Adequate barriers shall be provided between the windings and the core and between high and low voltage windings.

End coils shall have additional protection against abnormal line disturbances. The entire design, construction and treatment of the windings and their assembly on the core shall embody state of the art improvements, conforming to the latest best practices.

The windings shall be designed to minimise load losses. Provision shall be made for the earthing of the neutral or star windings. The neutral insulation shall be designed and constructed such that the transformer can be operated un-earthed (i.e. fully insulated). Graded insulation to the neutral connection is not acceptable.

7.6.4 Minimum Insulation Requirements

The transformer shall be designed to meet the following minimum insulation levels for normal operation:

Table 11: 132-66/11 kV Power Transformer Minimum Insulation, Fault and Creepage Requirements

Description		Requirement
System highest voltage U_m (kV_{rms})		145 kV
System nominal voltage U_n (kV_{rms})		132 kV
System fault withstand level (kA)		40 kA
Lightning impulse voltage withstand level at sea level (BIL) (kV peak)	Line Terminal	650 kV
	Neutral Terminal	275 kV

Table 11: 132-66/11 kV Power Transformer Minimum Insulation, Fault and Creepage Requirements

Description			Requirement
Power frequency withstand voltage level at sea level (60s 50Hz)		Separate source	95 kV
		Induced	230 kV
Bushings	Line	BIL (kV Peak)	650 kV
		60 s 50 Hz (kV_{rms})	275 kV
	Neutral	BIL (kV Peak)	650 kV
		60 s 50 Hz (kV_{rms})	275 kV
	Creepage (@31 mm/kV)		4500 mm
OLTS	System nominal voltage (Un) (kV_{rms})		132 - 66 kV
	BIL (kV peak)		650 kV
	60 s 50 Hz (kV_{rms})		275 kV

7.6.5 Internal Current Transformers

The transformers shall be equipped with internal current transformers on both the primary and secondary side. All internal current transformer designs shall comply with SANS 60044, SANS 61869 and other applicable standards.

Current transformers shall be of the low-reactance type on all ratios and shall preferably be of the bushing type.

All current transformers shall be capable of mechanically and thermally withstanding the same overcurrents and overloads, for the same periods, as the associated windings of the transformer.

The following information relating to protective current transformers shall be submitted for approval:

- Magnetisation curve.
- Secondary winding resistance.
- Secondary winding leakage reactance.
- Any other information as required by the *Employer*.

Where more than one protective current transformer is provided in any one phase, the current transformer designated ‘main protective current transformer’ shall be located furthest from the transformer windings.

Internal current transformer requirements are provided in Table 12 below.

Table 12: Transformer Internal Current Transformers

Position	Function	Class	Ratio	Turns Ratio	Im (mA) (Max)	Vk (V) (Min)	Rs (Ω) (Max)
HV Phases	HV RE/F	TPS	400/1	1/400	150	400	1.6
HV Phases	Metering	0.2S	400/1	1/400			
HV Neutral	HV RE/F	TPS	400/1	1/400	150	400	1.6
HV Neutral	HV E/F	TPS	400/1	1/400	150	400	1.6
MV Phases	MV O/C	TPS	2400/1	1/2400	42	750	9.6

7.6.6 Acoustic Levels

The transformer, tap changing equipment and supplementary cooling equipment acoustic levels shall be verified in accordance with SANS 60076-10.

The transformer shall be designed to limit the audible sound level to 75 dBA.

7.6.7 Tap Changers

7.6.7.1 General

Each transformer shall be provided with equipment for tap changing to enable variation of the effective transformation ratio whilst the transformers are on-load, without producing phase displacement.

The tap changer shall incorporate an electrical driver tap changing mechanism and shall be of the high speed resistor transition type, in compliance with the requirements of IEC 60214, IEC 60512 and other applicable standardized specifications.

7.6.7.2 On-Load Tap Switch (OLTS) Equipment

On-load load tap switch (OLTS) equipment shall be provided in the high voltage winding. On-load tap-changing equipment shall:

- Comply with IEC 60214 and other standardized specifications, as applicable.
- Be designed to be maintenance free for 300 000 operations.

The equipment's arcing/diverter contacts shall be housed in a separate compartment mounted on the tank and designed to prevent any interchange of oil between the compartment and the tank.

The OLTS shall be designed to provide at least 300 000 operations at full load current at the maximum nameplate rating before contact replacement is necessary. Mechanical tap position indication and tap change counter shall be provided as part of the OLTS assembly. The *Contractor*/OEM shall provide a life curve for the contacts with a recommended contact inspection schedule (maintenance schedule) for the tap changer with his offer.

The OLTS shall include motor operation and manual operation facilities. Facilities for local and remote motor operation (complete with selector switch) shall be provided.

7.6.7.3 Tapping Range

The range of regulation shall be +5 % -15 % of 1.25 % per tap for the 66/11 kV voltage ratio and +2.5 % -7.5% of 0.625% per tap for the 132/11 kV ratio.

7.6.7.4 Motor Operation

The OLTS shall be driven by a motor-operated mechanism, incorporating the ability to temporarily stop the tap changing operation under any fault detection by the overcurrent blocking relay.

The motor drive control shall be such that, on initiation of a tap change operation by means of a control switch or push-button, the tap changer shall complete its movement from one service position to an adjacent one, irrespective of whether or not the control switch or push-button has been operated continuously during the running time of the motor drive. Another operation shall only be possible when the control switch or push-button has been released and the control system is again in the rest position.

Limit switches shall be provided to prevent over-running of the tap change mechanism. These shall be directly connected in the motor circuit. In addition, mechanical end stops shall be fitted to prevent over running of the mechanism under any conditions.

A safety device shall be incorporated in the drive between the motor and the tap change mechanism to prevent damage to the mechanism in the event of incorrect operation of the limit switches for any reason.

The motor shall be operated with AC auxiliary supply of 400 V, 3-phase LV. A main incoming MCB shall be provided at the OLTS mechanism box.

7.6.7.5 Manual Operation

The handle or crank for manual operation shall be at a convenient level above ground and shall be interlocked with the motor supply, so that the motor cannot be energised when the handle is being operated. A safety mechanism shall be provided which shall interrupt the electrical supply to the drive motor when the local manual mechanical operating device is engaged.

7.6.7.6 OLTS Mechanism Box

Equipment for the automatic and manual control of the OLTS equipment shall be furnished in a weatherproof (IP65), pad-lockable OLTS mechanism box, mounted under or adjacent to the OLTS compartment in a suitable location, to allow access and operation from ground level. The voltage regulating relay shall be installed in a remote control panel. All other equipment required for manual and automatic OLTS operation shall be provided in the OLTS mechanism box. The mechanism box shall be fitted to the transformer with anti-vibration mountings. The mechanism box or cabinet shall be at a convenient level, arranged for ease of inspection and shall be equipped with the following, as a minimum:

- A hinged and removable door suitable for locking with a padlock.
- Electrical protection of motor and control circuits.
- A single-phase LV anti-condensation space heater, which shall be controlled by means of a humidistat, with an adjustable operating range and a cut-out thermostat with an adjustable operating range, to prevent overheating.
- A fixed internal lamp controlled by a door switch.
- 10 % spare terminals.
- A drawing, on robust material to the *Employer's* approval, indicating the connections within the box which shall be fixed to the inside of the door.
- Full mechanical protection to IP2X of any shafts or moving parts outside the mechanism.

7.6.7.7 Remote Tap Position Indication

A remote tap position indicator shall be provided on the remote control panel. Provision shall be made for remote indication of the tap position at a remote terminal unit for the SCADA system. Separate transducers shall be provided in the OLTS drive mechanism box for the two remote tap position indicators. The signal range shall be programmable in the mA range and shall be agreed with the *Employer*.

7.6.8 Cooling Equipment and Controls

7.6.8.1 General

Each transformer shall be furnished with integral-mounted, removable equipment to provide the required cooling capacity to maintain the specified transformer rating. The radiators shall be detachable to allow replacement or repair in the event of a leak. An isolating valve shall be provided such that the radiator can be safely isolated and removed without de-energising the transformer. Blanking plates shall be provided with the delivery to facilitate this arrangement.

The cooling of the transformers shall be Oil Natural Air Natural/Oil Natural Air Forced (ONAN/ONAF). The naturally-cooled rating (ONAN) of each of the main windings shall be at least 0.70 p.u. of the rated power of these windings.

The *Contractor* shall deliver the transformer complete, with required accessories, auxiliary controls and filled with oil. If the transformers cannot be transported with oil due to weight limitations etc., the *Contractor* shall notify the *Employer*, and furnish for approval by the *Employer* the OEM's recommendations for transporting the oil separately and filling the transformers on-Site.

Radiators shall be hot dip galvanised to SANS ISO 1461. The radiators shall be shall be detachable for maintenance and transport purposes. Shut-off valves shall be provided on the tank such that individual cooling units may be removed without draining oil from the main tank. These valves shall clearly indicate the open and closed positions. Air-bleed and oil drain valves shall be provided on each radiator. All oil valves shall be made of brass.

The completed cooling system (including fans and associated fan control box for ONAF rated transformers) shall be completely assembled on the transformer in the factory and match-marked before transportation to ensure proper fit in the field. The system shall be designed and located to not cover or block any manhole, handhold or oil sampling valve.

7.6.8.2 ONAF Specific Cooling Requirements

ONAF cooling equipment (fans) shall be mounted using anti-vibration mountings and shall be IP2X rating with guards placed over fan blades to provide personnel protection. Fans shall be hot dip galvanised to SANS ISO 1461 to prevent corrosion. There shall be separate MCBs for each bank of alarms.

Automatic and manual control of fans shall be provided. Manual control switches shall be provided in the control cabinet to allow testing and maintenance of the cooling fans and pumps. Controls shall provide for changes to the sequence of cooler groups.

Cooling fans shall be located a minimum height of 600 mm above the base of the transformer.

7.6.9 Insulating Oil

A sufficient quantity of new insulating oil for complete filling to the recommended level shall be furnished with each transformer. The oil shall comply with the requirements of NRS 079 and shall not contain polychlorinated biphenyls (“PCBs”) and shall be inhibited with DBPC (2-6 ditertiary butyl para-cresols). The transformer main nameplate shall state that the oil is inhibited and does not contain PCBs.

The insulating oil shall meet all the requirements as defined by IEC 60296 and other applicable standards.

7.6.9.1 Type and Quality

Only new naphthenic-based oils, which must be certified as such prior to filling, shall be used.

The oil shall be as specified NRS 079, without any additive. The colour coding of the drums containing the oil shall comply with the requirements of NRS 079 and other applicable standardized specifications.

Under no circumstances shall poor quality oil be filled into the transformer and only thereafter be brought up to specification by circulation within the transformer.

7.6.9.2 Dielectric Strength

The power frequency dielectric breakdown strength of the oil in any part of the transformer and on-load tap switch shall meet the transformer manufacturer’s requirement, but shall in no case be less than 70 kV/2.5 mm for virgin oil prior to filling nor less than 60 kV/2.5 mm at time of take-over.

Dielectric strength shall be determined in accordance with the method prescribed in IEC 60156 and other standardized specifications as applicable.

7.6.9.3 Moisture Content

The moisture content of the oil before filling the transformer and on-load tap switch shall not exceed 10 parts per million (ppm).

At time of take-over, the moisture content of the insulating oil shall not exceed 20 ppm in the main tank and the on-load tap switch compartment. If this is not achieved, drying/filtering of oil shall be undertaken.

The *Contractor* shall demonstrate that the moisture content in the paper insulation body of the transformer is less than 1%. The test to verify the moisture content shall be in accordance with an internationally accepted standard method for determining the moisture in paper. The test certificates proving the requirements of the moisture contents shall be provided upon delivery of the units and prior to energising of the units.

7.6.9.4 Degree of Polymerisation

After dry out, the *Contractor*/OEM shall provide the Degree of Polymerisation (DP) value of the paper. Minimum value is 950 DP. The paper used shall be thermally upgraded paper.

7.6.9.5 Oil Sampling and Testing

One sample is required in each of the following cases:

- During testing in the factory: a particle test shall be performed before and after each filling of the transformer for factory testing. The particle count in oil shall be less than 1000/10 ml for particles less than 2 µm.
- At time of take over: all units delivered to Site without oil, at least 7 days after in-situ oil processing has been completed, to test for dielectric strength, dissolved gas analysis (DGA), and acidity (A), but with the main emphasis on water content. Samples taken sooner will not necessarily reflect the correct water content (WC).
- 2 days after energizing, to test for DS, WC, and DGA (*Contractor's* responsibility).
- After the 1st, 3rd and 6th month from date of energizing for DS, WC and DGA (*Contractor's* responsibility).
- On-load tap switch diverter switches: A sample, to test for WC and DS only, shall be taken before commissioning and thereafter annually. This sample shall be taken from the tap switch diverter conservator or diverter drain valve.

7.6.9.6 Oil-filling/impregnation Under Vacuum

When a transformer is designed to be oil-filled under vacuum, an instruction to this effect shall feature prominently on the rating-and-diagram plate or on a separate plate mounted adjacent to it.

All transformers installed in vacuum-proof tanks shall be oil impregnated and filled under vacuum.

Oil impregnation or drying under vacuum shall be done with the transformer and oil at a temperature of at least 60 ºC.

7.6.9.7 Poly Chloride Biphenyls (PCB) content

All oils used in the transformer and its accessories shall be free of PCBs (zero ppm). A formal test certificate to this effect shall be included in the transformer manual.

7.6.9.8 Contact with bare copper

Bare copper in contact with transformer oil shall be minimized by using appropriate paper covering or painting.

7.6.10 Oil Preservation System

The oil preservation system shall be conservator type with breather. Valves shall be provided at the lowest point of any oil-filled chamber. A valve shall be provided for draining the main tank.

7.6.10.1 Conservator Tank

The conservator tank shall be in two separate sections, one serving the main tank and the other serving the tap switch diverter switch compartment. The capacities shall be sufficient to accommodate the change in oil volume over the range of specified ambient temperatures.

Each section shall have an oil level gauge, located so that it can easily be read by a person standing at ground level. Oil level indicators of the glass tube type shall not be used. Inspection windows shall have fixed metal grills to protect the glass against malicious damage, e.g. on tap changers, Buchholz and gas pressure relays.

Each section of the conservator shall be fitted with a float switch with low oil level signal contact. Each section shall include a sump to hold any solid deposits. A valve shall be provided for draining the conservator sump.

A removable cover shall be provided on each conservator section to allow inspection and cleaning of the interior.

A fixed pipe shall be brought to ground level and terminated with a valve to enable topping up in the event of oil loss, without the need to switch the transformer out of service.

Conservator mounting brackets shall be suitably designed to withstand any applied forces resulting from transportation of the transformer unit with the conservator tank mounted and filled with transformer oil to the required operating level.

7.6.10.2 Breathers

Each section of the conservator shall be fitted with an approved oil sealed silica gel breather. The breathers shall be located so that maintenance can be carried out at ground level. No valve shall be fitted between a breather and its associated section of the conservator.

7.6.10.3 Oil Filtration

The transformer tank and the OLTS compartment shall be designed and equipped for vacuum filling and oil treatment on Site and shall be fitted with outlets and gate valves for the simultaneous connection of an oil filter, an oil heater and a vacuum control switch tank.

Care shall be taken when positioning the filter points to ensure a good flow of all the oil through the filter plant, e.g. in the case of the main tank, one point shall be located high on the tank at one end and the other low down on the tank at the diagonally opposite end. The connection for the vacuum control switch shall be such as to facilitate efficient drawing of a vacuum, e.g. to the highest point of the conservator, and the valve/flange shall be located for easy access from the ground.

The arrangement of the oil filtration connections and the interface details shall be submitted to the *Employer* for review.

7.6.10.4 Vacuum Withstand

The main tank, conservator, tap change diverter compartment, radiators and cable boxes shall all be capable of withstanding as close to full vacuum as is achievable, e.g. down to 10 Pa.

An interconnecting pipe, with a valve (normally closed), shall connect the main tank and the tap switch diverter compartment, to allow equalisation of pressure during evacuation (in which case the valve will be open). The valve shall be located so that it is accessible from ground level.

7.6.10.5 Oil Sampling Devices

Oil sampling valves shall be fitted to the top and bottom of the transformer tank and to the OLTS tank compartment, and shall be fitted with removable threaded bosses.

Sampling points shall be accessible to a person standing at ground level.

All specialised tools and equipment required for drawing oil samples shall be provided with the transformer and stored in the O&M workshop.

7.6.10.6 Oil Valves

All oil valves shall be provided with means of securing them in the open and closed positions with a padlock. They shall clearly indicate whether they are in their open or closed positions and shall be fitted with appropriate blanking plates.

All oil valves shall be made of brass.

The oil circuit diagram shall be shown on the weights and capacities plate on the main tank.

As far as practicable, oil valves and associated equipment shall be constructed and/or shielded so as to minimise the risk of unauthorised interference and vandalism and shall be fitted with a lockable hasp.

7.6.10.7 Oil Piping

Non-metallic pipes for oil are not acceptable. A valve shall be provided at the lowest point of each main oil pipe.

7.6.11 Terminals and Bushings

7.6.11.1 External Bushings

All bushings suitable for overhead connection shall be porcelain air-insulated type.

Creepage distance to earth shall be a minimum of 4500 mm, based on a minimum unified specific creepage distance (USCD) of 31 mm/kV in accordance with SANS 60815.

Terminal markings shall be clearly and prominently shown on the cover plate and on the side of the walls of the main tank below each bushing location. Painted markings are not acceptable. Identification of terminals shall be in accordance with IEC 60616.

7.6.11.2 Terminals

Position of open terminals:

- The high-voltage bushings shall be approximately parallel to the major axis of the transformer.
- The low-voltage bushings shall be approximately parallel to the major axis of the transformer, and symmetrical with the high voltage bushings.

All terminal groups shall be arranged so that, when viewed in the direction of power flow, the neutral terminal shall be on the left, followed by the line terminals in alphabetical order.

The power shall always be assumed to flow from the winding with the highest voltage rating towards all other windings.

Unless otherwise specified, air-side bushing terminals shall be solid copper or copper alloy cylinders of the diameter and length specified in Table 13. They shall be electro-tinned in accordance with BS 1872, Classification Cu/z/Sn/10/b without subsequent heat treatment or machine cleaning being necessary.

Table 13: Dimensions of Open Air Terminals

Bushing Type	Diameter (mm)	Length (mm)
Primary	26 mm	125 mm
Primary Neutral	26 mm	125 mm
Secondary	38 mm	125 mm
NOTE – Neutral terminals shall be fitted with terminal connectors and bolted clamping plates, all tinned or plated, and suitable for connecting two undrilled 50 mm x 3 mm flat copper bars.		

7.6.12 Surge Arresters

For external bushings, mounting brackets shall be supplied and fitted to support surge arresters.

The arresters shall be metal oxide, station type with a silicon outer housing. The arresters shall be mounted on a dedicated mounting bracket adjacent to the associated bushing.

Each arrester shall be connected to the earth bus with a suitably sized stranded copper conductor. The conductor shall be neatly dressed, without sharp bends, and attached using bolted connectors that will allow replacement of the conductor if necessary.

7.6.13 Surge Arrester Brackets

The arrangement for surge arrester brackets shall be in accordance with the dimensions as indicated in Figure 1.

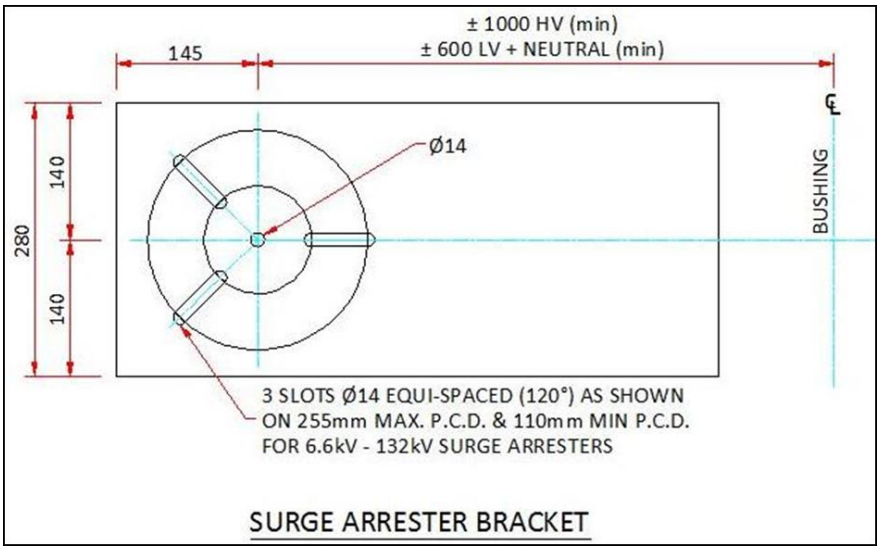
7.6.14 Internal Current Transformers

Current transformers (CTs) shall be of the bushing type and dimensioned according to the rated current of the relevant transformer winding. The thermal rating factor (ECR) shall not be less than 2.0.

CT secondaries shall be wired to a central control cabinet. Facilities for shorting the CT secondaries as well as formation of the CT star-point and earthing of same shall be provided.

The CTs shall be mounted in turrets above the tank cover. Draining of oil or removal of bushings shall not be required in order to inspect, maintain or replace the CTs.

Figure 1: Surge Arrester Bracket Mounting



7.6.15 Data for Rating and Diagram Plates

Where current transformers are built into the transformer, the combined rating and diagram plate shall provide full details of the location of each current transformer, its polarity, secondary terminal markings and also all the information required by SANS 61869 and other standardized specifications as applicable, with the provision that no information is to be duplicated.

The following symbols may be used on rating and diagram plates:

- IL = Secondary insulation level (DC 3 kV).
- Hz = Rated frequency.
- I_{th} = Rated short-time current and rated time kA-s.
- R_s = Secondary winding resistance at 75 ºC.
- N = Turns ratio.
- V_k = Kneepoint voltage.
- I_m = Magnetizing current.
- I_p = Primary current.
- I_s = Secondary current.
- VA = Output in (VA).

7.6.16 Terminal Markings

The system of markings used to identify the terminals for current transformers supplied with power transformers, shall indicate:

- The polarity of the primary and the secondary terminals, or, where no primary terminals exist as such, the orientation of the current transformer.
- The current transformer designation.
- The connection in which it appears (e.g. a phase or neutral connection).
- The sequence relative to other current transformers appearing in the same connection.

The current transformer winding (primary and/or secondary) and its polarity shall be denoted by the letter P and/or S and the numerals 1 and 2 as specified in SANS 61869.

The convention to be used shall always place P1 (and/or S1) nearer the external terminal of the transformer and P2 (and/or S2) nearer the winding.

The winding alpha-numerics and the polarity alpha-numerics shall be prefixed by letters denoting the phase or neutral connection in which the current transformers appear and these alpha-numerics shall be prefixed by numerals giving the sequence of the current transformers relative to other current transformers in the particular phase or neutral connection.

These numbers shall be counted in the case of star-connected windings, from the power transformer external terminal towards the neutral point connection, and, in the case of delta-connected windings, in a direction from the external terminal through the particular phase winding towards the junction with another phase.

7.6.17 Control Cabinet

One main control cabinet or marshalling kiosk shall be furnished and installed on each transformer. The marshalling kiosk shall be of enclosure class IP 65 (dust and rain tight), and sleet resistant. All transformer devices shall be wired to the control cabinet.

The cabinet and all devices shall be easily accessible from ground level. The dimensions and location of the marshalling kiosk shall be agreed with the *Employer*.

All external circuits and cables from devices on the transformer shall enter the cabinet from the bottom. The cabinet shall be provided with gasketed, removable blank aluminium bottom plate(s).

Control cabinet doors shall have a three-point cabinet type latch with a single handle and shall include provisions for padlocking. The doors shall be able to be securely latched open to at least 120 degrees from the closed position.

A copper earthing bar for earthing of devices and incoming control and power cabling shall be provided in the control cabinet. All devices (except for the earthing bar) shall be mounted no closer than 100 mm from the bottom and the front of the cabinet. No devices shall be mounted to the bottom.

Indicators and control devices mounted in the control cabinet shall have device nameplates made of engraved, laminated black plastic with white letters.

The control cabinet shall be provided with at least one space heater to prevent condensation of moisture within the cabinet. Space heater capacity shall be as required to maintain the cabinet internal temperature above the dew point. Heaters shall be remote - and thermally insulated from any devices or painted surfaces.

The control cabinet shall be equipped with at least two internal LED luminaires, controlled by the door switch/switches. The cabinet shall have a secondary switch to turn the lights off when the door is shut.

A socket outlet to supply portable test equipment shall be mounted inside the control cabinet.

7.6.18 Control and Auxiliary Power

All DC control devices shall be designed for continuous operation on an unearthed station battery. Electrical devices served from this supply shall not impose any earth connections on the battery.

DC control power and 3-phase AC Auxiliary power shall be bulk supplied from an external source to the control cabinet. Main terminals shall be provided for terminating the auxiliary power circuit(s).

7.6.19 Wiring

General wiring installation shall be in accordance with SANS 10142, SANS 1973-3 and other standardized specifications as applicable.

Cabling, auxiliary control and wiring shall have a dielectric withstand test voltage of 2 kV AC (1 minute). CT wiring shall be minimum 6 mm², stranded copper. All other wiring shall be minimum 2.5 mm² copper. Control cabling shall have a minimum Voltage rating of 600/1000 V and the cable shall be armoured. All wires shall be identified at each end with legible permanent labels, as per the applicable specifications. No adhesive markers or labels shall be used. Spade-type or hook-type terminals are not acceptable.

All terminal blocks other than CT terminals shall be screw type (Phoenix UK6N or equivalent approved) and shall be minimum IP2X rated. CT terminals shall be arranged such that the disconnect link cannot be accessed unless the CT secondary has been shorted. Terminal blocks for external circuits shall be grouped in the control cabinet for easy accessibility, unrestricted by interference from structural members and instruments. Sufficient space shall be provided on each side of each terminal block to allow an orderly arrangement of all leads to be terminated on the block. No more than two wires shall be permitted per terminal.

All cables between the transformer devices and accessories and the control cabinet shall be suitably mechanically protected. Exposed cables will not be accepted. Where utilised, conduit and accessories shall be corrosion resistant. Grommets shall be installed in all openings in metal barriers. All wiring to devices shall be completed in the factory prior to delivery.

All equipment boundary/interface terminals and the equipment wires connected to those terminals shall have a unique wire/terminal number in accordance with the *Contractor's* drawings and approved by the *Employer.*

7.6.20 Paint and Corrosion Protection

All metallic surfaces subject to corrosion shall be shot blasted, cleaned and painted with the OEM's premium standard cleaning and paint system. The first protective paint coat shall be applied on the same day without any outdoor exposure. A minimum of 2 coats of weather and oil-resistant paint shall be used. These shall be contrasting colours so that full coverage can be easily established. Minimum final paint thickness shall be 0.15 mm and shall be suitable for at least 10 years' service without requiring significant treatment or maintenance. Further details of the OEM's proposed cleaning and paint system shall be submitted with the tender.

The internal surfaces of tanks, core frames and any vessels or chambers which are to contain oil should be sealed by means of oil-resistant paint or varnish (as appropriate), the main objective of this being to prevent the catalytic action of the steel on the oil.

The exterior colour of the main tank shall be light grey (SANS 1091 'G29'). The *Contractor* may submit an alternative grey colour for consideration by the *Employer*. The *Contractor* shall submit a sample painted surface to the *Employer* for final approval. The inside of the tank and the control cabinet shall be white. Surfaces inaccessible after assembly shall be protected for the life of the equipment. Surfaces not painted shall be protected by appropriate masking during the cleaning and painting of adjacent surfaces.

The exterior finish colour of the conservator tank shall be RAL1013 (Oyster White).

The OEM's paint system shall be selected according to the climatic conditions stated in this specification. Corrosion of all parts shall be minimised or eliminated for the life of the equipment.

The overall paint system shall meet the requirements of Paint System S7.04 of ISO 12944-2 (Corrosion Protection of Steel Structures) and shall provide high durability coating with category C5-M corrosion protection, suited to environments with high condensation, pollution and salinity.

All radiators, fans, clips and any exposed metalwork shall be powder coated. The coating system shall be suitable for harsh corrosive coastal environments.

Cable management systems shall be in accordance with Specification No 1924701-2-300-E-SP-0008: Low Voltage Installations and other applicable contract documentation.

Mechanism boxes and/or control cabinets shall be manufactured from Grade 316L stainless steel and shall be powder coated (colour: light grey to SANS 1091: 'G29'). The *Contractor* may submit an alternative grey colour for consideration by the *Employer*.

All nuts, bolts and washers shall be 316L stainless steel. Any dissimilar metals shall be separated by non-conductive spacers.

The roof of the tank and all other areas where an operator may require access to for maintenance purposes shall be painted with high quality non-slip paint.

7.6.21 Protection Devices

Alarm indication contacts shall be potential free and electrically separate. All alarm and spare contacts and indication leads shall be wired to terminal blocks in the control cabinet. All contacts shall be indicated in the de-activated state.

An adequate number of removable covers shall be provided to access the protection devices and to allow their inspection, maintenance and replacement. Valves shall be provided on the conservator side of any gas-activated or oil-activated relay.

7.6.21.1 Buchholz Relay

Each power transformer shall be equipped with Buchholz relay provided with contacts for alarm and tripping. The relay shall be responsive to gas accumulation in the relay float chamber and to oil flow between power transformer and conservator tank caused by transformer fault.

A double float and vane anti-seismic Buchholz relay shall be provided in the pipe connection from the main tank to the oil conservator tank as well as in the pipe from the tap switch compartment to the tap switch conservator tank. These relays shall be such that a slow release of gas closes an alarm circuit while a sudden pressure rise results in the operation of an alarm and trip circuit. They shall each be fitted with a minimum of two trip and one alarm contact.

The gas release connection from the Buchholz relays shall be brought down (through copper tubing) to gas sampling devices, which shall be accessible to a person standing at ground level. The relay must be accessible when the power transformer is in operation. Two shut-off valves, manually controlled, shall be installed between the conservator and the main tank to enable dismantling and testing of the Buchholz relay. The test connection from the Buchholz relays shall also be terminated beside the Buchholz gas sampling devices. Isolating valves, accessible from ground level, shall be provided in both of these connections. All test and sampling points shall be clearly marked and identified.

7.6.21.2 Oil Temperature Indication (OTI)

A dial type liquid temperature indicator shall be furnished to indicate top oil temperature. In addition to providing visible indication, it shall be equipped with a separate alarm contact and two trip contacts. The indicator shall be mounted at eye level and equipped with a maximum temperature indicating hand and manual reset.

Location and mounting arrangement shall be such that the sensing element can be removed without loss of oil and will not interfere with tanking and untanking the transformer core and coils, and such that the thermostat can be removed from the transformer pocket without disconnecting the protected wiring. Two spare transformer pockets shall be provided on the transformer.

The OEM shall recommend the temperature at which the alarm and tripping contacts should close, to afford proper overload protection of the power transformers.

7.6.21.3 Winding Temperature Indication (WTI)

A dial type hot spot winding temperature indicator shall be furnished and mounted at eye level. In addition to providing visible indication of the temperature of the winding, each indicator shall be equipped with a separate alarm contact and separate contacts to control the cooling equipment. Each winding temperature indicator-relay shall incorporate a current transformer, responsive to its associated phase winding current, calibrating resistor, temperature detector element and heater, all mounted and connected to simulate the hot-spot temperature of the winding.

7.6.21.4 Oil Level Indicator

Separate oil level indicators shall be provided for the main tank and OLTS tank. High and Low level alarms shall be provided.

7.6.21.5 Online Gas Monitoring Device

Provision for connection of an online fault gas monitoring system shall be provided. The monitor shall be a GE hydrant type or approved equivalent. The system shall be installed near the bottom radiator connection, where there is good oil flow.

7.6.21.6 Pressure Relief Device

Each power transformer shall be fitted with a pressure release device. The pressure release device shall be a diaphragm or valve of adequate size to protect the tank, as well as the tap changer compartment, against an internal over-pressure and/or explosion. It shall preferably be of a type suitable for repeated operation that requires practically no maintenance. It shall be designed to minimize the discharge of oil and to exclude air and water after operation.

A pressure relief device with trip and signal contacts, which is set to open on excess pressure and to reseal automatically, shall be fitted to the main tank and to the tap-change diverter switch oil compartment.

Any blow-out of oil shall be directed safely away from the transformer. Where a testing facility is included in the pressure relief device, access to the testing device shall be possible without dismantling surrounding equipment.

The diverter switch compartment shall be provided with a means of relieving excess pressure without damaging the transformer or endangering personnel.

7.7 Tests

Testing shall be in accordance with SANS 60076. The FAT and SAT tests shall include, but not be limited to, the tests described in this section.

7.7.1 Factory Acceptance Tests

Each transformer shall be completely assembled at the factory, utilising materials and equipment that will be a part of the final assembled unit, and shall be subjected to all routine tests specified in SANS 60076 and additional tests as specified herein. All tests shall be performed at the expense of the *Contractor*/OEM.

7.7.1.1 Routine Tests

7.7.1.1.1 Routine Tests

- Pressure test on the main tank.
- Visual inspection of tank welding.
- Dye-penetration test of load bearing members to detect weld defects.
- Leakage test on gaskets and bolted covers.
- Tests to prove tank vacuum capability.
- Check of galvanising thickness.
- Check of paint thickness.
- Check of all bushings.
- Routine tests on tap changer.
- Ratio test.
- Impedance test.

7.7.1.1.2 Tests on Completion

- Measurement of the winding resistance for all windings and on all taps.
- Voltage-ratio measurement and check of vector group.
- Applied overvoltage test.
- Induced overvoltage test.
- Measurement of impedance voltages.
- Impulse Test (3 x full wave and chopped wave).
- Measurement of No-load losses.
- Measurement of load losses (including calculation to adjust for 75°C).
- Measurement of harmonics.
- Sound level measurements.
- Partial discharge test with limits as shown in Table 14, where U_r is the rated voltage.

Table 14: Partial Discharge Test Limits

Voltage Level	Duration (s)	Max partial discharge level (pC)
1.0 * U_r	0 s	---
1.2 * U_r	0 s	---
1.4 * U_r	0 s	---
1.8 * U_r	30 s	---
1.4 * U_r	300 s	100 pC
1.2 * U_r	30 s	50 pC
1.0 * U_r	30 s	30 pC

Partial discharge measurements shall be taken as per SANS 60270 and other applicable standardized specifications for the durations as specified in Table 14 above.

7.7.1.2 Ancillary Equipment

Type and routine tests documentation shall be provided for all ancillary equipment, such as bushings, relays, level switches, temperature indicators / alarms, and cooling motors.

7.7.1.3 Type Tests

The proposed design shall be type tested and the relevant type test certificates listed below shall be provided.

- Temperature rise test.
- Noise level test.
- Impulse test (full wave and chopped wave).
- Short-circuit test.
- On-load tap changer test.
- Bushing tests.
- Current transformer tests.
- Gas and oil-actuated relay tests.
- Digital thermometer tests.
- Swept frequency response analysis.

7.7.1.4 Oil Tests During Factory Tests

The oil in the transformer shall be sampled and tested before and after transformer testing. A dissolved gas analysis shall be performed for each sample. A copy of the oil test report shall be included with the certified transformer test report.

7.7.2 Site Acceptance Testing

The results of all the Site tests done during commissioning shall be documented and a copy of the results included in the transformer manual. These tests shall include the verification of:

- Voltage ratios on all three phases for each tap position.
- The vector group.
- Measure insulation, HV to tank MV to tank HV to MV (5 kV).
- A functional test for all alarm and trip contacts.
- CT insulation, HV to tank at 5 kV, secondary to tank at 1 kV, maximum magnetising curve for the cores to be used, ratio tests for all taps and polarity.
- The control/power cabling insulation (min 1 kV).
- The correct operation and indication of tap-changers and timing checks.
- The correct position of all valves in the oil circuits.
- Nameplate impedance to be verified.
- Wiring to the marshalling interface box terminals and to the tap change mechanism box terminals.
- Verify winding and oil thermometer accuracies.
- Tan delta tests to be done on all bushings with test taps.
- Disconnect the transformer core earth and megger to tank to ensure that the core is not bonded to the tank, 1 kV max. Ensure reconnecting of the core earth on completion of testing.
- Main tank and tap change oil levels to be checked.
- Check to see if the main tank to conservator valve is open.
- Frequency response analysis.
- Check silica gel.

8.0 DRY TYPE TRANSFORMERS

The *works* for the dry type transformers as described in this specification shall make provision for the performance, design, manufacturing, factory testing, delivery, off-loading, installation, testing and commissioning for dry type transformers and their auxiliaries. This specification shall be read in conjunction with SANS 60076-11 and other standardized specifications as applicable.

8.1 Technical Schedule

Table 15: Technical Schedule for 11/3.3 kV 3.5 MVA and 4.5 MVA Transformers

Item	Description	Specified
1	**Continuous rated power for all tappings (AN rating)**	3.5 MVA and 4.5 MVA
2	**Rated voltage op principal tapping**	
2.1	Primary voltage on principal tapping	11 kV
2.2	Secondary voltage on principal tapping	3.3 kV
3	**Short-time withstand capability**	As per SANS/IEC standards
4	**Voltage tapping range of primary/secondary ratio (OCTS range)**	
4.1	Max	+5 %
4.2	Min	-5%
4.3	Size of steps	2.5 %
4.4	Number of positions	5
5	**Minimum insulation for windings**	
5.1	Rated power frequency withstand voltage	
5.1.1	Primary side	28 kV
5.1.2	Secondary side	10 kV
5.2	Rated lightning impulse withstand voltage	
5.2.1	Primary side	75 kV
5.2.2	Secondary side	40 kV
6	**Transformer type**	
6.1	Vector group	Dyn11
6.2	Transformer type	Indoor, dry-type
6.3	Type of cooling	Air - Natural Air-forced (AF) (additional)
7	**Impedance at 75° at rated MVA on principal tapping**	7% for 3.5 MVA 7% for 4.5 MVA
8	**Transformer losses**	
8.1	No load losses	< 8 kW
8.2	Load losses	< 30 kW

Table 15: Technical Schedule for 11/3.3 kV 3.5 MVA and 4.5 MVA Transformers

Item	Description	Specified
9	**Climatic, environmental and fire classes**	
9.1	Environmental class	E2
9.2	Climatic class	C2
9.3	Fire barrier class	F1
10	**Cable connections**	
10.1	11 kV terminals (3.5 MVA transformer)	Top entry plug-in type
10.2	11 kV terminals (4.5 MVA transformer)	Top entry plug-in type
10.3	3.3 kV terminals (3.5 MVA transformer)	Top entry plug-in type
10.4	3.3 kV terminals (4.5 MVA transformer)	Top entry plug-in type
11	**Indicating and protective devices**	
11.1	Temperature sensor (part of required temperature and fan controllers)	PT 100 sensor per phase
12	**Accessories**	
12.1	Vibration pads	Yes
12.2	Bi-directional wheels	Yes
12.3	Cable boxes	If required
12.4	Enclosure	Yes : 3CR12 stainless steel
12.5	Enclosure IP rating	IP 54
12.6	Lifting lugs and pulling eyes	Yes
12.7	Space heaters	Yes
12.8	Cooling fans	Yes
12.9	Any others as specified	

Table 16: Technical Schedule for 11/0.4 kV 1 MVA and 3.15 MVA Transformers

Item	Description	Preferred/Specified
1	**Continuous rated power for all tappings (AN rating)**	1 MVA and 3.15 MVA
2	**Rated voltage on principal tapping**	
2.1	Primary voltage on principal tapping	11 kV
2.2	Secondary voltage on principal tapping	0.4 kV
3	**Short-time withstand capability**	As per SANS/IEC standards
4	**Voltage tapping range of primary/secondary ratio (OCTS range)**	
4.1	Max	+5 %
4.2	Min	-5%
4.3	Size of steps	2.5 %
4.4	Number of positions	5
5	**Minimum insulation for windings**	

Table 16: Technical Schedule for 11/0.4 kV 1 MVA and 3.15 MVA Transformers

Item	Description	Preferred/Specified
5.1	Rated power frequency withstand voltage	
5.1.1	Primary side	28 kV
5.1.2	Secondary side	3 kV
5.2	Rated lightning impulse withstand voltage	
5.2.1	Primary side	75 kV
6	**Transformer type**	
6.1	Vector group	Dyn11
6.2	Transformer type	Indoor, Dry-type
6.3	Type of cooling	Air – Natural Air Forced (AF) (additional)
7	**Impedance at 75°at rated MVA on principal tapping**	5% for 1 MVA 7% for 3.15 MVA
8	**Transformer losses**	
8.1	No load losses	≤ 6 kW for 3.15 MVA ≤ 1 kW for 1 MVA
8.2	Load losses	≤ 22.5 kW for 3.15MVA ≤ 9 kW for 1 MVA
9	**Climatic, environmental and fire classes**	
9.1	Environmental class	E2
9.2	Climatic class	C2
9.3	Fire barrier class	F1
10	**Cable connections**	
10.1	11 kV terminals (1 MVA transformer)	Top entry plug-in type
10.2	11 kV terminals (3.15 MVA transformer)	Top entry plug-in type
10.3	400 V terminals (1 MVA transformer)	Cable box, air insulated type
10.4	400 V terminals (3.15 MVA transformer)	Busbar connection to LV switchboard via cable box, air insulated type
11	**Indicating and protective devices**	
11.1	Temperature sensor (part of required temperature and fan controllers)	PT 100 sensor per phase
11.2	Transformer Unit Protection: For 3.15 MVA 11/0.4 kV Tippler 3 building transformer	ABB RET615 or equal approved installed in separate enclosure mounted on the main enclosure. All supplies, terminals, wirings, and any other additional equipment required to be installed in this enclosure to provide fully functional, operable and compliant transformer unit protection.

Table 16: Technical Schedule for 11/0.4 kV 1 MVA and 3.15 MVA Transformers

Item	Description	Preferred/Specified
12	**Accessories**	
12.1	Vibration pads	Yes
12.2	Bi-directional wheels	Yes
12.3	Cable boxes	One side
12.4	Enclosure	Yes with cable boxes, 3CR12 stainless steel
12.5	Enclosure IP rating	IP 54
12.6	Lifting lugs and pulling eyes	Yes
12.7	Space heaters	Yes
12.8	Cooling fans	Yes
12.9	Any others as specified	

8.2 Design and Construction

8.2.1 Core

The transformer core shall consist of thin, individually insulated sheets of high permeability, grain-oriented, non-aging silicone steel. The core shall be constructed to minimise losses and sound levels. The designed flux density shall be kept well below saturation, at a value no higher than 1.5 Tesla.

The assembled core shall be braced with heavy (minimum 6 mm) structural angle or channel steel to apply uniform clamping forces across the entire width, top and bottom. The core shall be protected from corrosion with a 185 °C or higher rated rust-resistant coating.

8.2.2 Transformer Active Part

Windings shall be properly sized, insulated and supported for the line and load currents and voltages that will be encountered during the transformer's service life. The active part shall also be properly supported and sized to provide for the short circuits as per the technical schedule.

The dry-type transformers shall be self-protected transformers, i.e. the transformer shall be designed such that it provides for short circuits where the short circuit current is only limited by the transformer's own impedance, with the transformer connected to an infinite bus at system Voltage (U_n).

The encapsulation process shall be such as to ensure solid void free castings. The curing process shall be microprocessor controlled and monitored to ensure proper curing. The epoxy used shall be self-extinguishing.

8.2.3 Mechanical Construction

The core and frame shall be of adequate strength to withstand, without damage, the stresses that may be imposed during handling, transportation, installation and service. All nuts shall be effectively locked by means of locking plates, standard machined lock nuts or other approved means. Pinning of bolt-ends and/or threads alone or the use of tempered pressed steel nuts shall not be acceptable.

8.2.4 Lifting Facilities

Lifting lugs or other means shall be provided for the convenient lifting of the transformer, without imposing undue stress on the transformer assembly.

8.2.5 Earthing

Provision shall be made for earthing the transformer in the form of earthing pads. The contact surfaces of the pads shall be protected from corrosion by means of heavy duty 316L stainless steel, unless otherwise specified or instructed by the *Employer.*

8.2.6 Cable Boxes

Dry-type transformers shall be equipped with cable boxes where required and shall be supplied complete with all the fittings necessary for attaching and connecting the cables.

8.2.7 Enclosures

The dry-type transformers shall be installed in an enclosure with a minimum ingress protection rating of IP54. Enclosures shall be made of 3CR12 stainless steel. An additional box, with a glass panel for viewing, shall be provided on the main enclosure to house the temperature and fan monitoring/control equipment. The box shall be lockable with a padlock. This shall be on the side of the main enclosure.

Further to the above, for the 3.15 MVA 11/0.4 kV Tippler 3 building transformer an additional pad lockable box shall be provided next to the box housing the temperature and fan monitoring/control equipment on the main enclosure, where all the required transformer unit protection equipment i.e. IED, RIO, wiring, terminals, mounting strips etc. are to be located. This box shall also have an incorporated glass panel for viewing the IED HMI and associated equipment.

All of the abovementioned additional boxes required on the main enclosures respectively shall be sized accordingly for all of the equipment they are to house. The IP rating of the additional boxes shall be the same as for the main enclosure ie. IP54. The enclosures, and associated additional boxes shall be designed and build by the OEM only.

The design of the entire enclosures shall take into account the abovementioned boxes, LV cable boxes, cooling fans, where required incorporated internal/external current transformers, connections of MV and LV cables/busbars and the like. Furthermore the final design and dimensions of the enclosures shall also ensure that they can be installed in their respective allocated rooms whilst still providing sufficient clearances for the units to allow for the following, but not limited to:

- Operational or maintenance personnel can undertake safely, and without compromising the complete transformer unit, under power ‘Live’ or ‘Dead’ conditions the activities as per the OEM’s and where applicable the *Employer’s* operational and maintenance specified procedures in conjunction with statutory regulations, standards and the like. If required, suitable interlocks and associated equipment shall be provided.
- Under no circumstances may inadvertent contact to any ‘Live’ equipment be possible. This shall include internally and externally of the enclosure.

Cooling of the transformer shall be such as to maximise the heat transfer from the transformer section to the exterior of the enclosure.

The *Contractor* shall optimise the cooling design in the most cost effective way and shall demonstrate how he derived at the proposed design.

Allowance for full redundancy shall be made for the cooling fans. It is preferred that the design of the enclosures and associated equipment allows safe access to the cooling fans for removal whilst the transformer is still in service.

The final designs, shop drawings and the like of the enclosures shall be provided to the *Employer* for review and approval.

The transformers shall be provided with bi-directional wheels, which shall allow insertion and removal of the transformer from its operating position.

8.2.8 Transformer Unit Protection Requirements for the 3.15 MVA 11/0.4 kV Tippler 3 Building Transformer

The transformer unit protection required shall form part of the detailed design, supply, installation and commissioning requirements of the *Contractor*. Reference shall be made to specification 1924701-2-300-E-SP-0009 for further detailed requirements.

8.2.9 Cooling

8.2.9.1 Cooling classes

The dry-type transformer shall be AN/AF (ventilated forced air cooled, as additional).

8.2.9.2 Temperature and Cooling Fan Monitoring

Provision shall be made to monitor the fans for forced air cooling. A fan failure alarm shall be given when power to the fan is interrupted or if the fan speed drops below or speeds up beyond the prescribed threshold values.

The transformer core and windings shall be protected by fuse-integrated Positive Thermal Coefficient (PTC) temperature probes. At least two probes shall be provided, with one used for alarming and the other to trip the transformer. The recommended alarm and trip threshold values shall be provided by the *Contractor*/OEM.

The probes shall be incorporated in the LV winding on the transformer centre core limb.

The transformer shall be equipped with a local display unit, displaying the transformer temperature. An additional 4-20 mA temperature signal shall be provided for remote monitoring purposes.

8.2.9.3 Cooling Fan Control Equipment

An isolating switch, rated to carry and break full-load current for each cooling fan shall be provided. These switches shall be lockable by padlock in the “OFF” position for maintenance purposes.

In the case of an ANAF specified transformer, a “manual”/”auto” cooling fan control change-over switch shall be provided. When switched to manual, the cooling fans shall be energised and when switched to auto the fans shall require a specific loading on the transformer to energise the fans.

Motor starters used for the fans shall be of the AC 3-phase type 2 co-ordination.

A separate LV power supply shall be provided for the purpose of monitoring and control of the temperature and cooling fan equipment, unless otherwise specified or shown on the drawings.

8.2.10 Additional LV Supply System for Tippler 3 Building Transformer

For the 3.15 MVA 11/0.4 kV Tippler 3 building transformer, an additional main LV (400/230 Vac) power supply shall be made available to supply power to the relevant transformer on-board equipment ie. cooling fans and the like.

The abovementioned shall be in the form of a wall mounted DB board located inside the Tippler 3 building transformer room, fed via cabling from the transformer secondary side busbars, and compartmentalised to house all required switchgear etc. The DB shall also house any additional power supplies ie. 24 V, 110 V etc. as required for the temperature and fan monitoring/control equipment, transformer unit protection equipment and the like. Should a UPS and battery back-up be required (in particular for the transformer unit protection equipment if applicable), the aforementioned shall also be provided and be of such a design that it shall be housed inside the DB board.

The DB, cabling, cable management systems, UPS and batteries (if applicable) etc. shall also comply with the relevant requirements as set out in document 1924701-2-300-E-SP-0008 and associated other contract documentation and/or drawings. The final location of the DB, routing of the cabling and cable management systems shall be determined on-Site in conjunction with the *Employer*. The entire LV supply system shall be designed by the OEM and shall be deemed to form part of the transformer system. The *Contractor* shall include the abovementioned in his pricing for the transformer.

The final design, including all calculations and the like shall be submitted to the *Employer* for review and approval.

8.2.11 Corrosion Protection and Colour

The corrosion protection shall be in accordance with SANS 121 and other applicable standards. The exterior finish colour of the dry-type transformer shall be light grey (SANS 1091 ‘G29’).

8.2.12 Wiring

General wiring installation shall be in accordance with SANS 10142, SANS 1973-3 and other standardized specifications as applicable.

Cabling and auxiliary control and auxiliary wiring shall have dielectric withstand test voltage of 2 kV AC (1 minute). CT wiring shall be minimum 6 mm², stranded copper. All other wiring shall be minimum 2.5 mm², copper. Control cabling shall have a minimum voltage rating 600/1000 V and the cable shall be unarmoured, unless otherwise specified or instructed by the *Employer*. All wires shall be identified at each end with legible permanent slip-on sleeve type labels. No adhesive markers or labels shall be used. Spade-type or hook-type terminals are not acceptable.

All terminal blocks other than CT terminals shall be screw type (Phoenix UK6N or equivalent) and shall be minimum IP2X rated. CT terminals shall be arranged such that the disconnect link cannot be accessed unless the CT secondary has been shorted. Terminal blocks for external circuits shall be grouped in the control cabinet for easy accessibility, unrestricted by interference from structural members and instruments. Sufficient space shall be provided on each side of each terminal block to allow an orderly arrangement of all leads to be terminated on the block. No more than two wires shall be permitted per terminal.

All cables between the transformer devices and accessories and the control cabinet shall be suitably mechanically protected. Exposed cables are not acceptable. Where utilised, conduit and accessories shall be corrosion resistant. Grommets shall be installed in all openings in metal barriers. All wiring to devices shall be completed in the factory prior to delivery.

All equipment boundary/interface terminals and the equipment wires connected to those terminals shall have a unique wire/terminal number in accordance with the *Contractor's/*OEM's drawings and approved by the *Employer.*

8.2.13 Climatic, Environmental and Fire Classes

The dry-type transformers shall have the following fire, environmental and climatic classes in accordance with SANS 60076-11: Clause 13.1:

- Environmental Class E2: In order to be able to withstand condensation or pollution or combination of both.
- Climatic Class C2: The transformer is suitable for operation, transport and storage at ambient temperatures down to -25 °C.
- Fire Class F1: Transformer subjected to fire hazard. Restricted flammability is required. The emission of toxic substances and opaque smokes shall be minimised.

8.2.14 Harmonics

The dry-type transformers maybe subjected to excessive harmonics due to the dynamic loads which they will supply respectively. The *Contractor* shall ensure that the dry-type transformers can withstand the harmonics generated from these loads.

The *Contractor* shall also engage with the *Employer* to obtain the specific information, in particular from the loads as supplied and installed by Others, to verify the capability of the units to withstand the generated harmonics. The *Contractor* is advised to give special attention to motor loads and their starting/stopping methods.

8.3 Tests

The testing shall be in accordance with SANS 60076. The FAT and SAT tests shall include, but not be limited to, the tests highlighted within this section.

8.3.1 Factory Acceptance Tests

Each transformer shall be completely assembled at the factory, utilising materials and equipment that will be a part of the final assembled unit, and shall be subjected to all routine tests specified in SANS 60076 and additional tests as specified herein. All tests shall be performed at the expense of the *Contractor.*

The following minimum tests shall be performed:

- Transformer ratio verification.
- Transformer vector group verification.
- Insulation resistance test between LV and HV windings and windings to earth or tan-delta (loss angle) measurement.
- Impedance measurement: The impedance of every transformer shall be measured on the principal tapping position and on the two extreme tapping positions in accordance with the requirements of SANS 60076-1.
- Load-loss measurements: The load losses on every transformer shall be measured on the principal tapping position and corrected to the reference temperature specified in SANS 60076-11.
- No-load loss and current measurements: The no-load losses and the no-load current of every transformer shall be measured as specified in SANS 60076-11.
- The temperature rise test shall be carried out in accordance with SANS 60076-11.
- Power–frequency voltage withstand test: Both a separate-source AC withstand voltage test and an induced AC withstand voltage test shall be performed in accordance with SANS 60076-11 Clauses 19 and 20 respectively.
- Partial discharge test: A partial discharge test shall be done on all dry-type transformers. The test shall be done in accordance with SANS 60076-11.
- Lightning impulse withstand voltage test.

The *Employer* regards the heat run test as a quality test and not a type or special test as per SANS/IEC 60076-11. Thus, where more than one transformer or consecutive transformers are ordered of the same design, a heat run test shall be done on all ordered transformers.

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the indoor dry-type transformers offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered dry type transformers before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add further inspection hold and/or witness points. The *Contractor* shall make due allowances for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection(s). The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer’s premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT) or from this inspection.

8.3.2 Site Acceptance Tests

The results of Site tests done during commissioning shall be documented and a copy of the results included in the transformer manual. These tests shall include the verification of:

- Voltage ratios on all three phases for each tap position.
- The vector group.
- Measure insulation.
- A functional test for all alarm and trip contacts.
- CT insulation.
- The control/power cabling insulation (min 1 kV).
- The correct operation and indication of tap-changers.
- Nameplate impedance to be verified.
- Verify winding thermometer accuracies.

9.0 INDOOR MEDIUM VOLTAGE SWITCHGEAR

The medium voltage switchgear consists of 11 kV and 3.3 kV switchboards. The medium voltage switchgear shall be in accordance with SANS/IEC 62271 and other standardized specifications and regulatory standards, as applicable.

9.1 General

The 11 kV switchboards shall consist of the number of cubicles as shown on the drawings and associated contract documentation. The switchboards shall have the following but not limited to features:

- SANS classification IAC, AFLR.
- Single busbar system with fixed vacuum circuit breakers for Substation M and Substation N.
- Double busbar system with fixed vacuum circuit breakers for the New Main Intake Substation.
- The 11 kV and 3.3 kV switchboards shall be from the same OEM.

Drawings for each switchboard to be submitted by the *Contractor* for review and approval by the *Employer* prior to commencement of manufacture shall include, but is not limited to the following.

- General arrangement drawings for each switchboard.
- Switchgear schedule for each board with reference to component schedule.
- Schematic diagrams for each circuit, which shall include all the wire numbers, termination numbers, termination strip numbers, fuse sizes and spare contacts.
- Component schedule for each circuit on the switchboard.

The OEM responsible for the switchboards shall provide certificates, issued by a reputable and recognized laboratory, to demonstrate that the design, construction, ratings and testing procedures for the complete switchboards, as well as all equipment and components installed inside it, are in strict compliance with the latest revision of the applicable IEC standards.

The OEM shall provide conclusive evidence that he possesses extensive experience in the field of MV switchgear and has already supplied equipment of the same type and make, which is in current operation.

9.2 Design Criteria

9.2.1 Rated Normal Currents

The rated normal currents of components shall be as stated in the technical data and shall be valid for a maximum temperature of 40 °C.

9.2.2 Temperature Limits and Environment

For switchboards and equipment located indoors, in unpolluted and non-corrosive atmosphere, the ratings shall be guaranteed under the following ambient conditions:

Environmental conditions:

• Maximum temperature	40 °C
• Maximum 24 h average temperature	35 °C
• Minimum (correspondents to “minus 5 °C indoor class”)	-5 °C
• Maximum relative humidity for one month	90 %
• Maximum relative humidity for 24 hours	95 %

The switchboards shall be suitable for installation and service up to an elevation of 1000 m above sea level. For higher altitudes the switchgear shall be de-rated to the applicable altitude, in accordance with IEC 60071-1.

9.2.3 Internal Arc Fault Test

The 11 kV and 3.3 kV gas insulated switchboards shall be Internal Arc Classified (IAC) AFLR (fault level same as specified rated short time withstand current – see Table 17) for 1 second in accordance with SANS 62271-200.

The type test certificates and type test reports shall be submitted to the *Employer* at tender stage. This is a critical requirement for the MV Switchgear. Type test reports shall not be older than 7 years.

9.3 Technical Schedule

The 11 kV and 3.3 kV switchboards shall comply with the requirements as listed in the table and further specification below. All the MV switchgear offered shall be rated for 12 kV and operated at 11 kV and 3.3 kV. The technical schedule for the MV Switchgear is shown in Table 17 below.

Further reference shall be made to the drawings, bills of quantities and other applicable contract documentation.

Table 17: Technical Schedule for Indoor Medium Voltage Switchgear

Item	Description	Specified
1	**Ratings**	
1.1	Rated voltage (U_r)	12 kV
1.2	Number of phases	3
1.3	Rated short-duration power-frequency withstand voltage (U_d)	28 kV
1.4	Rated peak lightning impulse withstand voltage (U_p)	75 kV
1.5	Rated frequency (f_r)	50 Hz
1.6	Rated normal current (I_r) - busbar	2500 A (Main Intake Sub) 1250 A (11 kV Sub M and Sub N) 1250 A (3.3 kV Sub M and Sub N)
1.7	Rated short-time withstand current (I_k)	40 kA (Main Intake Sub and Sub N) 31.5 kA (11 kV Sub M) 25 kA (3.3 kV Sub M and Sub N)
1.8	Rated peak withstand current (I_p and I_{pe})	100 kA (Main Intake Sub and Sub N) 80 kA (11 kV Sub M) 63 kA (3.3 kV Sub M and Sub N)
1.9	Rated duration of short circuit (t_k) – main circuit and earthing switch	3 s
1.10	Rated duration of short circuit (t_{ke}) - earthing circuit	3 s
1.11	Rated DC supply voltage of closing and opening devices and of auxiliary and control circuits (U_a)	110 Vdc
1.12	Rated short-circuit breaking current (I_{SC}) of circuit-breaker	40 kA (Main Intake Sub and Sub N) 31.5 kA (11 kV Sub M) 25 kA (3.3 kV Sub M and Sub N)
2	**Circuit Breaker**	
2.1	Vacuum circuit breaker type	VD4
2.2	Number of mechanical operations	M2 (10 000)

Table 17: Technical Schedule for Indoor Medium Voltage Switchgear

Item	Description	Specified
2.3	Electrical endurance	E2
2.4	Nominal system voltage (U_n)	11 kV and 3.3 kV
2.5	Maximum system voltage (U_m)	12 kV
2.6	Power frequency withstand voltage (U_d)	28 kV
2.7	Lightning impulse withstand voltage (U_p)	75 kV
2.8	Power frequency	50 Hz
2.9	Rated normal current (I_r) – incomers	2500 A (11 kV Main Intake Sub) 1250 A (11 kV Sub M and Sub N) 1250 A (3.3 kV Sub M and Sub N)
2.10	Rated normal current (I_r) - feeders	2000 A (11 kV Main Intake Sub) 630 A (11 kV Sub M and Sub N) 630 A (3.3 kV Sub M and Sub N)
2.11	Rated normal current (I_r) – bus section breakers	2500 A (11 kV Main Intake Sub) 1250 A (11 kV Sub M and Sub N) 1250 A (3.3 kV Sub M and Sub N)
2.12	Rated short-circuit breaking current (I_{sc})	40 kA (Main Intake Sub and Sub N) 31.5 kA (11 kV Sub M) 25 kA (3.3 kV Sub M and Sub N)
2.13	Rated short-circuit making current (I_{ma})	100 kA (Main Intake Sub and Sub N) 80 kA (11 kV Sub M) 63 kA (3.3 kV Sub M and Sub N)
2.14	Rated short time withstand current I_k (3 seconds)	40 kA (Main Intake Sub and Sub N) 31.5 kA (11 kV Sub M) 25 kA (3.3 kV Sub M and Sub N)
2.15	Rated duration of short-circuit	3 s
2.16	Rated peak withstand current (I_p)	100 kA (Main Intake Sub and Sub N) 80 kA (11 kV Sub M) 63 kA (3.3 kV Sub M and Sub N)
2.17	Operating sequence	O - 0.3s – CO – 3 min – CO
2.18	Rated opening time (t_3)	≤ 45 ms
2.19	Rated breaking time (t_b)	≤ 60 ms
2.20	Rated auxiliary supply	110 Vdc
3	**Three-position disconnector**	
3.1	Rated voltage	12 kV
3.2	Power frequency withstand voltage (U_d)	28 kV
3.3	Lightning impulse withstand voltage (U_p)	75 kV
3.4	Rated normal current (I_r) - incomers	2500 A (11 kV Main Intake Sub) 1250 A (11 kV Sub M and Sub N) 1250 A (3.3 kV Sub M and Sub N)
3.5	Rated normal current (I_r) - feeders	2000 A (11 kV Main Intake Sub) 630 A (11 kV Sub M and Sub N)

Table 17: Technical Schedule for Indoor Medium Voltage Switchgear

Item	Description	Specified
		630 A (3.3 kV Sub M and Sub N)
3.6	Rated normal current (I_r) – bus sections and risers	2500 A (Main Intake Sub) 1250 A (11 kV Sub M and Sub N) 1250 A (3.3 kV Sub M and Sub N)
3.7	Rated short-circuit withstand current (I_{sc})	40 kA (Main Intake Sub and Sub N) 31.5 kA (11 kV Sub M) 25 kA (3.3 kV Sub M and Sub N)
3.8	Rated peak withstand current (I_p)	100 kA (Main Intake Sub and Sub N) 80 kA (11 kV Sub M) 63 kA (3.3 kV Sub M and Sub N)
3.9	Rated duration of short-circuit (t_k)	3 s
3.10	Rated auxiliary supply	110 Vdc
3.11	Motorised operation	Yes
3.12	Number of mechanical operations	M1
4	**Service continuity of the switchgear**	
4.1	Loss of service continuity category	LSC2B
5	**Partition class**	PM
6	**Internal arc classification**	
6.1	Internal arc classification	AFLR
6.2	Classification test current value	40 kA (Main Intake Sub and Sub N) 31.5 kA (11 kV Sub M) 25 kA (3.3 kV Sub M and Sub N)
6.3	Classification test current duration	1 s
6.4	Pressure relief direction	Upwards
6.5	Ducting required for venting outside switchroom (yes/no)	Yes
7	**Switchboard design and construction**	
7.1	Technology type	GIS (SF_6)
7.2	Busbar system	Double for New Main Intake Single for Sub M and Sub N
7.3	Circuit breaker assembly	Fixed
7.4	Busbar VT assembly	Fixed
8	**Ingress protection**	
8.1	Ingress protection – MV compartment	IP 65
8.2	Ingress protection – LV compartment	IP 4X
8.3	Cable compartment	IP 4X
9	**Protection**	
9.1	Incomer circuits	See protection specification
9.2	Transformer feeder circuits	See protection specification

Table 17: Technical Schedule for Indoor Medium Voltage Switchgear

Item	Description	Specified
9.3	Cable feeder circuits	See protection specification
9.4	Bus section circuit	See protection specification
9.5	Cable live indicators	Yes
10	**Current transformers**	
10.1	IDMT O/C & E/F	
10.1.1	Ratio	Circuit Dependent
10.1.2	Accuracy class	PX
10.1.3	Kneepoint voltage (V_k)	To be provided by OEM
10.1.4	Excitation current (I_m)	To be provided by OEM
10.1.5	CT secondary winding resistance (R_s)	To be provided by OEM
10.2	Cable differential	
10.2.1	Ratio	Circuit Dependent
10.2.2	Accuracy class	PX
10.2.3	Kneepoint voltage (V_k)	To be provided by OEM
10.2.4	Excitation current (I_m)	To be provided by OEM
10.2.5	CT secondary winding resistance (R_s)	To be provided by OEM
10.3	Metering	
10.3.1	Ratio	Circuit Dependent
10.3.2	Accuracy class	0.2S
11	**Voltage transformers**	
11.1	Core 1 (Protection)	
11.1.1	Ratio	11 000/√3 / 110/√3 3 300/√3 / 110/√3
11.1.2	Accuracy class	3P
11.1.3	Burden	10 VA
11.2	Core 2 (metering)	
11.2.1	Ratio	11 000/√3 / 110/√3 3 300/√3 / 110/√3
11.2.2	Accuracy class	0.5
11.2.3	Burden	10 VA
11.3	Core 3 (stabilising winding)	
11.3.1	Ratio	11 000/√3 / 110/3 3 300/√3 / 110/√3
11.3.2	Accuracy class	3P
11.3.3	Burden	15 VA
12	**Panel finish and coating**	
12.1	Corrosion protection	Yes

Table 17: Technical Schedule for Indoor Medium Voltage Switchgear

Item	Description	Specified
12.2	Colour of 11 kV panels	RAL 7035 (Light Grey - tbc)
12.3	Colour of 3.3 kV panels	RAL 5003 (Sapphire Blue - tbc)
13	**Cable connections (standard allowance on each board)**	
13.1	As per single line diagrams	
14	**Name plates**	
14.1	Switchgear panel (SANS 62271-200)	Yes
14.2	Circuit-breaker (SANS 62271-100) - where applicable	Yes
14.3	CT (SANS 60044-1) - where applicable	Yes
14.4	VT (SANS 60044-2) - where applicable	Yes
14.5	Duplicate nameplates provided in LV compartment for circuit-breaker, CTs, VT, CPT - where applicable	Yes
15	**Accessories**	
15.1	Access ladders	2 per substation
15.2	Number of toolboxes for operating	2 per substation
15.3	Number of toolboxes for maintenance	2 per substation
15.4	Operating and maintenance DVD	Yes
15.5	Test plugs	Yes
15.6	Extended operating leads	Yes

9.4 Design and Construction

9.4.1 General

The switchboards shall comprise of indoor, gas-insulated, metal-enclosed systems. For Substations M and N, single busbar systems shall be provided. The New Main Intake Substation's medium voltage switchgear shall be of the double busbar type. The switchboards shall be suitable for local and remote control. The switchboards shall normally be operated remotely.

The switchboard shall be designed in accordance with the relevant IEC specifications to ensure:

- Loss of service continuity type: LSC2B.
- Partitioning class: type PM.
- Mounting of all voltage transformers within the arc proof enclosure.
- Easy installation and reduced construction costs.
- Arrangement for future extensions on both sides of the switchboard.
- Internal arc shall be vented out of the switchgear rooms.

Each switchboard shall be equipped with a base frame for ease of installation. The switchboards shall be installed with a minimum clearance of 1.5 m away from the substation walls on the sides and the back of the panels. The minimum space required in front of the panels is 3 m, unless specified or instructed otherwise.

If applicable, the switchboards shall also be supplied with riser panels/bases for accommodation of the type of cable, CT's and the like.

9.4.2 Cubicle Design and Compartments

The enclosure and internal partitioning of the cubicles shall be of high quality aluminium-zinc coated steel sheets or stainless steel, with a minimum thickness of 2.5 mm. The front shall be closed off by pressure resistant doors, which shall open to an angle of not less than 150°.

Every cubicle of the switchboards shall be divided in separate compartments for power components as follows:

- Bus-bar compartment.
- Power cable and cable instrument transformer (CT/VT) compartment.
- Circuit breaker compartment.
- Busbar voltage transformer compartment.
- Low voltage compartment.

All compartments shall be segregated by metal partitions.

Correct performance and operation shall be ensured by the provision of proper interlocks with mechanical position indicators, to facilitate the correct and safe operation of the switchgear.

Where openings in the outer enclosure are required for the purpose of ventilation (for high current ratings), the following provisions shall apply:

- Degree of protection shall be IP65 for the MV compartment and IP44 for the LV compartment.
- Venting designs shall prevent any explosive gasses from being emitted into the operational area.

The cubicle mechanism shall be equipped with a mimic diagram to clearly show the status of the switching devices in all possible positions.

9.4.3 Main Busbar Compartment

This compartment, located within the switchgear enclosure, shall contain the bus-bar system. The busbar system shall be connected to the circuit breaker insulating contacts by means of branches.

The busbars shall be contained in a sealed busbar compartment and insulated with sulphur hexafluoride (SF_6) gas. The compartment shall be gassed and sealed at the place of manufacture and shipped to Site in the fully gassed state.

The busbar compartment and associated sealing shall be designed to be maintenance free for the full design lifetime.

9.4.4 Power Cable Compartment

The power cable compartment shall be accessible from the front of the switchboard. The cable compartment shall comprise of, but not be limited to, the following:

- The switchgear that will be operated at 11 kV shall make use of inner cone cable connection systems, based on the specific switchgear required at each location.
- The switchgear that will be operated at 3.3 kV shall make use of outer cone cable connection systems.
- A disconnect switch, capable of operation from the front of the panel and providing clear indication of operational position.
- A fault make cable earth switch with operation from the front of the cubicle.
- An integral interlocking device between fixed vacuum circuit breaker and the three position switch.
- Current transformers or current and/or voltage instrument transformers.
- All MV power cables shall enter the MV Switchgear from the bottom.
- Cable compartments shall be sized not only for the cables that must be connected to the switchgear as per the drawings and bills of quantities, but must also provide for one additional cable per phase for each size of cable as specified.

9.4.5 Circuit Breaker Compartment

This compartment shall be designed to accommodate the fixed circuit breaker and all accessories required for its operation, with the compartment door closed.

The following components shall be mounted in this compartment:

- The primary connections, namely the bushings containing the power connections to the circuit breaker compartment, the bus-bar and cable compartments.
- The three-position switch disconnector.
- Connection for the circuit breaker control wiring.

The position of the circuit breaker and three-position switch disconnector shall be visible from the front of the switchboard panel.

9.4.6 Low Voltage Compartment

The low voltage compartment shall be encased to be separate from the high voltage compartments. The low voltage compartment shall be closed with a door and shall be positioned above the circuit breaker compartment. Sufficient space shall be available for all the required secondary equipment, such as:

- Connection terminals and wiring (in proper wiring ducts or trunking).
- Interconnections between cubicles for connection of auxiliary cables.
- Auxiliary equipment (fuses, low voltage MCBs, the measuring instruments, protection relays, control and signalling devices, etc.).
- Low voltage cables shall be kept separate from medium voltage cables at all times. Provision shall be made for separate cable entry points.

LV cables shall enter the MV Switchgear from the top of the LV compartment.

9.4.7 Installation Facility

The panels shall be delivered to Site as factory-assembled and tested units.

A base frame shall be used on the floor, installed by the switchgear manufacturer, or his approved subcontractor, for a faster and easier alignment.

After the cubicles (or cubicle assemblies) have been positioned side by side in a single row and bolted together and the power and control cables are connected, the system must be ready for operation.

9.4.8 Doors and External Covers Coating

The doors and the external cover plates shall be painted. The finishing coat for the switchboards shall be the following, unless otherwise specified or instructed by the *Employer*:

- 11 kV switchboards – (Light Grey - tbc).
- 3.3 kV switchboards – (Sapphire Blue - tbc).

9.4.9 Degree of Protection

The protection degrees in compliance with IEC 60529 standards shall be the following:

- IP65 for the MV housing.
- IP44 for the LV compartment.

9.4.10 Switching Devices

9.4.10.1 Circuit Breakers

The switchboards shall be equipped with fixed vacuum circuit breakers that comply with SANS 62271-100.

The circuit breakers shall be for triple pole operation and shall have primary contacts that operate within a vacuum. The stationary mounted circuit breakers shall be fully type-tested. Copies of test certificates, as

evidence of successful completion of type tests, shall be submitted with the switchgear acceptance certification.

The circuit breakers shall be designed for electrical spring charging, but shall also make allowance for manual charging of the spring.

All circuit breakers shall be routine tested in accordance with SANS 62271-100. The circuit breakers shall be equipped as follows:

- With stored energy spring mechanism for motor charging and emergency manual operation, or by means of a magnetic actuated mechanism.
- With mechanical push buttons for closing and opening.
- With mechanical indicators for switch position and mechanism position.
- With mechanical counter.
- With shunt release OFF.
- With shunt release ON.
- With auxiliary signalling contacts.

The circuit breakers shall be suitable for the following switching duty, in accordance with the latest IEC 62271-100 standard.

- For mechanical endurance, class M2.
- For electrical endurance, class E2.
- Capacitor switching class C2.

9.4.10.2 Three-Position Switch

The three-position switches shall have the same ratings as the circuit breakers. The mechanical endurance of the three-position switches shall be M1 (2000 operations).

The three position switches shall have the following positions:

- Open position.
- Closed position.
- Ready-to-Earth position.

The three-position switches shall be motorised to allow remote control, with allowances also made for local, manual operation from the front of the switchgear panels.

9.4.10.3 Earthing Switches

Each feeder or incomer circuit shall be equipped with a cable earth switch to earth the power cables. The earth switch shall form part of the three-position switch. The three-position switches shall be in the “ready-to-earth’’ position before the circuit breaker can be closed to earth the cable.

The earth switches shall comply with SANS 62271-102, and have a class of E2. The devices shall have a fault make capacity that can withstand the switchboard short circuit current rating.

The earth switch opening and/or closing operations shall make provision for locks with independent padlocks.

9.4.11 Interlocking

In order to ensure proper operation and to prevent malfunctions that could jeopardise the safety of personnel and place the installation at risk, a series of interlocks shall be provided to protect the operators and the switchgear.

Mechanical and electrical interlocking between the operation of the circuit breakers and the three-position switch mechanisms shall be ensured.

The *Contractor* shall be responsible for a comprehensive interlocking design of the 11 kV and 3.3 kV switchboards. The *Contractor* shall submit his interlocking philosophy/design document to the *Employer* for review and acceptance.

9.4.11.1 Bay Interlocking

Bay interlocking refers to the interlocking that happens within a single switchboard panel. This refers to the mechanical and/or electrical interlock that is integral to the switchboard panel. The circuit breaker needs to be in the open position for the operator to be able to operate the three-position switch.

9.4.11.2 Bay-to-Bay Interlocking

Bay-to-bay interlocking refers to the interlocking that happens within a switchboard and includes the following minimum features:

- The switchboard needs to be isolated from all sources of supply in order to earth the main busbar via the circuit breaker and the three-position switches in the bus section and riser panels. This requires that all incomer circuit breakers are in the open position and the incomer three-position switches are in the open position.

- The bus section and incomer circuit breakers can therefore not be closed if the busbar earth switch is applied.

9.4.11.3 Board-to-Board Interlocking

The board-to-board interlocking systems shall include the following minimum features:

- Interlocking between two switchboards with a bus section and riser in-between. This interlocking will be of the three out of four interlocking principal. This means that only three out of the four three position switches may be closed at any moment in time. These three position switches refer to the bus section, riser and two incomers.

- Interlocking between an MV switchboard (11 kV) and another MV switchboard (3.3 kV). The interlock needs to be provided to ensure that the board to board feeder circuit breaker is not closed when the cable earth switch is applied on the other board's incomer circuit.

9.4.12 Signal Lamps

Indication lights shall be required to indicate whether the circuit breaker is in the open of closed position and whether the circuit is earthed.

Signal lamps are of the multi-LED bayonet coupling type and easily replaceable from the front of the panel, without the use of tools. The signal lamp lenses shall be coloured as follows:

- Circuit-breaker closed: Red.
- Circuit-breaker open: Green.
- Circuit earthed: Yellow.

9.4.13 Accessories

9.4.13.1 Labelling

Abbreviations to descriptions on the labels are generally not acceptable. Where abbreviations are unavoidable, due to the limited number of characters that can be engraved/etched on labels, the abbreviations shall be submitted to the *Employer* for approval.

9.4.13.2 Operating and Maintenance Tools

The *Contractor* shall provide all special maintenance tools and equipment for the switchgear. The *Contractor* shall provide an operating and maintenance tool set for each switchboard.

The *Contractor shall* also provide housing for these tool sets and appropriate mountings within the housing against the substation walls.

9.4.13.3 Extended Operating Leads

All circuit breakers in the switchboard shall be switchable via extendable operating leads (also referred to as remote type pendant switches).

The *Contractor* shall provide suitable extended operating leads with every substation. The lead shall be of such a length that the operator can stand on the outside of the MV Switchgear room to operate the relevant circuit breaker.

9.4.13.4 Test Plugs

The *Contractor* shall provide a voltage and current test plugs for testing of cables, insulation testing of the panels and testing of the protection systems by primary current injection.

9.4.13.5 Cable Live Voltage Detection System

Each incoming and feeder cubicle shall be fitted with a cable live voltage detection system. The system shall detect the voltage on the power cables connected to the cubicle and indicate the presence of voltage via LCD display.

The cable live indicating system shall be in accordance with IEC 61243-5 for voltage detection systems (VDS). The VDS system shall preferably be fitted on the low voltage compartment door.

It shall be possible to connect phase balance or phase comparators to the VDS system.

9.5 Arc Explosion Ducting

Pressure relief via pressure relief ducts and absorbers into the substation room are strictly prohibited. The *Contactor* shall make allowances for all pressure relief ducts and associated equipment in order to be ducted to the outside of the MV switchgear rooms respectively. For Substations M and N the ducting will exit the building, whereby suitable upwards and angled bend pieces shall be provided in order for the pressure to be released on-top of the buildings' roofs respectively, unless specified otherwise or instructed differently by the *Employer*. For the Main Intake Substation, the ducting shall be taken to -, and terminated at the dedicated plenum rooms.

At the end of the ducting externally, it shall be provided with suitable cover(s) to prevent the ingress of dust, rain, any other contaminants, animals and the like. The design of the cover(s) shall be such that when an arc occurs and vented via the ducting, the cover(s) shall open to release the pressure without negatively affecting the venting process and jeopardising the IAC of the switchgear. Furthermore, internally the ducting shall be slightly angled downwards from the switchgear to the walls, to aid in the prevention of water reaching the switchgear in the event of the cover(s) failing to prevent the ingress of water.

The switchgear shall be so designed and manufactured to prevent the occurrence of an internal arc. The switchboard design shall also make allowances for maximum personnel safety, even in case of an internal arc.

In addition to the above, the *Contractor* shall also ensure compliance of the pressure relieve ducting to the following:

- Arc explosion ducting shall be fitted across the entire length of the switchboards.
- The explosion ducting shall be designed, supplied and installed by the switchboard manufacturer or an approved supplier and installer recommended by the switchboard OEM.
- The ducting shall match the switchboard with respect to the colour finish of the panels, unless specified or instructed otherwise.
- The integrity of the panel may in no way be jeopardised by the installation of an inferior system supplied and/or installed by a non-approved ducting supplier.

9.6 Testing

MV Switchgear shall be tested in accordance with SANS 62271. The FAT and SAT tests shall include, but not be limited to, the tests described in this section.

9.6.1 Type Tests

The metal enclosed switchgear shall be type tested at a recognised and certified test laboratory. The *Contractor* shall provide the relevant certificates and test reports to prove compliance with SANS 62271. The tests include, but are not limited to, the following:

- Internal arc type test.
- Making and breaking capacity tests.

- Short time current test.
- Temperature rise test.
- Impulse voltage and power frequency voltage test.
- Mechanical endurance type test.

The *Contractor* shall provide MV Switchgear that is identical to the type of switchgear tested. If any functional component of the MV Switchgear differs from the one described in the type test certificates/ reports, the components will be subject to retesting before approval by the *Employer*. The conditions under which the type tests are performed, i.e. panel configuration, number of tests to be done and the like, shall be agreed between the test authority, *Employer* and *Contractor.*

Manufacturing of the first switchboard shall not commence without the prior approval of the type testing by the *Employer*.

9.6.2 Routine Tests

Routine tests shall be carried out on the new switchgear in accordance with the requirements provided in SANS 62271-100 and shall include, but not be limited to, the following:

- Wiring and function tests.
- Equipment verification tests.
- Low voltage circuit insulation test.
- High voltage power frequency test.
- Partial discharge tests.
- Circuit breaker operation timing tests.

9.6.3 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the indoor medium voltage switchgear, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered indoor medium voltage switchgear before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add the necessary inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer’s premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

9.6.4 Site Acceptance Testing

Commissioning checks and a test programme, as determined by the manufacturer, shall be carried out in accordance with SANS 62271. This shall include checks after installation, circuit-breaker mechanical tests and measurements, checks of certain specific circuit breaker operations and electrical tests and measurements.

Tests shall include, but are not limited to, the following:

- 80% power-frequency voltage tests of the main circuits in accordance with SANS 62271-200 7.105.
- Tightness tests for vacuum switchgear in accordance with SANS 62271-200 7.105 (dielectric test across the open contacts at a voltage stated by the manufacturer).
- Verification of remote control operation using the hand-held remote control unit for circuit-breaker.
- Testing of all interlocking.

Mechanical tests and measurements on the circuit-breakers may include, but are not limited to, the following:

- Verification of the rated operating sequence.
- Measurement of time quantities.

Checks of certain specific operations for the circuit-breakers may include, but are not limited to, the following:

- Simulation of fault-making operation and check of anti-pumping device.
- Behaviour of the circuit-breaker on a closing command while an opening command is already present.
- Application of an opening command on both releases simultaneously.

Electrical tests shall include, but are not limited to, the following:

- Measurement of resistance of the main circuits of the assembly in accordance with SANS 62271-200.
- Dielectric tests on auxiliary and control circuits in accordance with SANS 62271-200.

For each measurement of the operating time, a recording shall be made of each individual operating coil current, namely Close, Trip I and Trip II. The resolution of the function times shall be clearly indicated in the test reports.

For measurement of the steady-state contact resistance of the main circuit, a DC current of at least 50 A shall be used. The results shall be given in μΩ and the resolution shall be at least 1 μΩ.

Reasons for differences between the results of the tests made on Site and the results of the tests as they were carried out at the OEM's premises shall be clearly stated and corrections shall be made.

The results of pre-commissioning tests after installation on Site shall be documented, signed off and a copy of the results included with the switchgear documentation for hand-over as part of the quality process. All tests shall be witnessed by the *Employer.*

10.0 132 kV AND 66 kV OUTDOOR CIRCUIT BREAKERS

10.1 General

Circuit breakers shall be of a proven design with type tests conducted in accordance with SANS 62271-100. Detailed type test reports shall be certified by an approved laboratory, affiliated to a reputable international organization, verifying compliance and the successful completion of such tests.

Circuit breakers shall operate on the principal of self-generating gas pressure within the interrupter for arc extinction, e.g. puffer type.

10.2 Technical Schedule

The 66 kV and 132 kV circuit-breakers shall be in accordance with the technical schedules shown in Tables 18 and 19 below.

Table 18: Technical Schedule for 66 kV Outdoor Circuit Breakers

Item	Description	Specified
1	**Normal Service Conditions**	
1.1	Operation	3 pole
1.2	Installation	Outdoor
1.3	Altitude	≤ 1 800 amsl
1.4	Maximum ambient temperature	45 °C
1.5	Minimum ambient temperature	-10 °C
1.6	Relative humidity	100 %
1.7	Degree of protection	IP44
1.8	Pollution level	Severe (31 mm/kV specific creepage)
1.9	Rated nominal system voltage	66 kV
1.10	Rated maximum system voltage	72.5 kV
1.11	Rated system frequency	50 Hz
2	**Rated Insulation Levels**	
2.1	Rated power frequency withstand voltage (1 min)	
2.1.1	common value	140 kV
2.1.2	across the isolating distance	160 kV
2.1.3	across open CB	160 kV
2.2	Rated lightning impulse withstand voltage (1s)	
2.2.1	common value	325 kV
2.2.2	across the isolating distance	375 kV
2.2.3	across open CB	375 kV
3	**Composite and/or RIP Bushings**	
3.1	Rated voltage	72.5 kV
3.2	Rated Current	3150 A
3.3	Rated power frequency withstand voltage	140 kV

Table 18: Technical Schedule for 66 kV Outdoor Circuit Breakers

Item	Description	Specified
3.4	Rated lightning impulse withstand voltage	375 kV
3.5	Partial discharge level, ≤ 5 pC	≤ 92 kV
3.6	Creepage distance	≥ 31 mm/kV
4	**Current Ratings**	
4.1	Rated continuous current	2500 A
4.2	Rated short-time withstand current	25 kA
4.3	Rated short circuit duration	3 s
4.4	Rated peak withstand current	62.5 kA
4.5	Temperature rise of active parts at rated continuous current	≤ 65 °C
4.6	Temperature rise of terminals at rated continuous current	≤ 50 °C
4.7	Temperature rise of enclosure at rated continuous current	≤ 15 °C
5	**SF_6 Gas System**	
5.1	Annual SF6 leakage	< 1 % per year
6	**Circuit Breaker Mechanism**	
6.1	Type	SF_6 Auto-puffer
6.2	Operating mechanism	Spring type, three-pole
6.3	Circuit-breaker mechanical endurance class	Class M2
6.4	Maximum number of mechanical operation for drive mechanism	10 000
6.5	Rated operating sequence according to IEC	O - 0.3 s - CO -1 min – CO
6.6	Stored switching sequence	O – CO
6.7	Classification of circuit-breaker according to its restrike performance (line- and cable charging breaking current)	Class C2
6.8	Maximum number of operations at rated current	5000
6.9	Short circuit breaking current	25 kA
6.10	First reference voltage	To be provided by OEM
6.11	Point of time t1	104 µs
6.12	Peak value	To be provided by OEM
6.13	Point of time t2 and t3	312 µs
6.14	Starting point td	2 µs
6.15	Rate of rise	2 µs
6.16	Characteristic For Short Line Fault	
6.16.1	Short line fault current	To be provided by OEM
6.16.2	Wave impedance	To be provided by OEM
6.16.3	Peak value	To be provided by OEM

Table 18: Technical Schedule for 66 kV Outdoor Circuit Breakers

Item	Description	Specified
6.16.4	Rated peak factor	1.6
6.16.5	Time delay tdL	< 0.1 µs
6.16.6	Time tL to peak uL	3.08 µs
6.16.7	Rate of rise of transient recovery voltage	7.84 kV/µs
6.16.8	Opening time	23 ± 4 ms
6.16.9	Arcing time	11.5 – 21.5 ms
6.16.10	Break time	< 50 ms
6.16.11	Closing time	30 ± 5
6.16.12	Contact speed:	To be provided by OEM
6.16.12.1	Opening	4.6 ± 0.5
6.16.12.2	Closing	4.6 ± 0.5
6.17	**Circuit-breaker operating mechanism enclosure requirements**	
6.17.1	Operating mechanisms, local control facilities and all parts requiring lubrication protected by weatherproof enclosures	Yes
6.17.2	Degree of protection for enclosures containing exposed bearings, auxiliary switches, motors and other electrical devices	IP 55
6.17.3	Degree of protection for all open areas in the circuit-breaker common base frame as well as externally mounted indicating devices (where applicable)	IP 2X
6.17.4	Degree of protection for all other enclosures	IP 54
6.17.5	Operating mechanism enclosure, handles and fixings material	316L stainless steel/ Painted aluminium
6.17.6	Maximum height to top of mechanism allows servicing from ground (*Un* ≤ 132 kV)	2000 mm
6.17.7	Front access door secured with a heavy-duty locking mechanism	Yes
6.17.8	Padlocking facility shackle diameter	6 mm
6.17.9	Front access door equipped with travel stop	Yes
6.17.10	Rigid, corrosion resistant documentation pocket provided on inside of front access door, securely attached no protrusion through door	Yes
6.17.11	Enclosure colour	Light grey (‘G29’)
6.18	**Auxiliaries**	
6.18.1	Rated voltage	110 Vdc
6.18.2	Rated current	5 Adc
6.18.3	Operating Coils	
6.18.3.1	Rated voltage	110 Vdc
6.18.3.2	Rated power	200 W

Table 18: Technical Schedule for 66 kV Outdoor Circuit Breakers

Item	Description	Specified
6.18.3.3	Operating current	2 Adc
6.18.4	Circuit-breaker Motor	
6.18.4.1	Rated voltage	110 Vdc
6.18.4.2	Rated power	900 W
6.18.4.3	Operating current	13 Adc
6.18.4.4	Starting current	20 Adc
6.18.4.5	Auxiliary contacts	5 NO + 5 NC

Table 19: Technical Schedule for 132 kV Outdoor Circuit Breakers

Item	Description	Specified
1	**Normal Service Conditions**	
1.1	Operation	3 pole
1.2	Installation	Outdoor
1.3	Altitude	≤ 1 800 amsl
1.4	Maximum ambient temperature	45 °C
1.5	Minimum ambient temperature	-10 °C
1.6	Relative humidity	100 %
1.7	Degree of protection	IP44
1.8	Pollution level	Severe (31 mm/kV specific creepage)
1.9	Rated nominal system voltage	132 kV
1.10	Rated maximum system voltage	145 kV
1.11	Rated system frequency	50 Hz
2	**Rated Insulation Levels**	
2.1	Rated power frequency withstand voltage (1 min)	
2.1.1	common value	275 kV
2.1.2	across the isolating distance	315 kV
2.1.3	across open CB	315 kV
2.2	Rated lightning impulse withstand voltage (1s)	
2.2.1	common value	650 kV
2.2.2	across the isolating distance	750 kV
2.2.3	across open CB	750 kV
3	**Composite and/or RIP Bushings**	
3.1	Rated voltage	145 kV
3.2	Rated Current	3150 A
3.3	Rated power frequency withstand voltage	275 kV

Table 19: Technical Schedule for 132 kV Outdoor Circuit Breakers

Item	Description	Specified
3.4	Rated lightning impulse withstand voltage	650 kV
3.5	Partial discharge level, ≤ 5 pC	92 kV
3.6	Creepage distance	≥ 31 mm/kV
4	**Current Ratings**	
4.1	Rated continuous current	3150 A
4.2	Rated short-time withstand current	40 kA
4.3	Rated short circuit duration	3 s
4.4	Rated peak withstand current	104 kA
4.5	Temperature rise of active parts at rated continuous current	≤ 65 °C
4.6	Temperature rise of terminals at rated continuous current	≤ 50 °C
4.7	Temperature rise of enclosure at rated continuous current	≤ 15 °C
5	**SF_6 Gas System**	
5.1	Annual SF6 leakage	< 1 % per year
6	**Circuit Breaker Mechanism**	
6.1	Type	SF_6 Auto-puffer
6.2	Operating mechanism	Spring type, three-pole
6.3	Circuit-breaker mechanical endurance class	Class M2
6.4	Maximum number of mechanical operation for drive mechanism	10 000
6.5	Rated operating sequence according to IEC	O - 0.3 s - CO -1 min – CO
6.6	Stored switching sequence	O – CO
6.7	Classification of circuit-breaker according to its restrike performance (line- and cable charging breaking current)	Class C2
6.8	Maximum number of operations at rated current	5000
6.9	Short circuit breaking current	40 kA
6.10	First reference voltage	208 kV
6.11	Point of time t1	104 µs
6.12	Peak value	291 kV
6.13	Point of time t2 and t3	312 µs
6.14	Starting point td	2 µs
6.15	Rate of rise	2 µs
6.16	Characteristic For Short Line Fault	
6.16.1	Short line fault current	36 kA
6.16.2	Wave impedance	450 Ω
6.16.3	Peak value	194 kV

Table 19: Technical Schedule for 132 kV Outdoor Circuit Breakers

Item	Description	Specified
6.16.4	Rated peak factor	1.6
6.16.5	Time delay tdL	<0.1 µs
6.16.6	Time tL to peak uL	3.08 µs
6.16.7	Rate of rise of transient recovery voltage	7.84 kV/µs
6.16.8	Opening time	23 ± 4 ms
6.16.9	Arcing time	11.5 – 21.5 ms
6.16.10	Break time	<50 ms
6.16.11	Closing time	30 ± 5
6.16.12	Contact speed:	To be provided by OEM
6.16.12.1	Opening	4.6 ± 0.5
6.16.12.2	Closing	4.6 ± 0.5
6.17	**Circuit-breaker operating mechanism enclosure requirements**	
6.17.1	Operating mechanisms, local control facilities and all parts requiring lubrication protected by weatherproof enclosures	Yes
6.17.2	Degree of protection for enclosures containing exposed bearings, auxiliary switches, motors and other electrical devices	IP 55
6.17.3	Degree of protection for all open areas in the circuit-breaker common base frame as well as externally mounted indicating devices (where applicable)	IP 2X
6.17.4	Degree of protection for all other enclosures	IP 54
6.17.5	Operating mechanism enclosure, handles and fixings material	316L stainless steel/ Painted aluminium
6.17.6	Maximum height to top of mechanism allows servicing from ground (*Un* ≤ 132kV)	2000 mm
6.17.7	Front access door secured with a heavy-duty locking mechanism	Yes
6.17.8	Padlocking facility shackle diameter	6 mm
6.17.9	Front access door equipped with travel stop	Yes
6.17.10	Rigid, corrosion resistant documentation pocket provided on inside of front access door, securely attached no protrusion through door	Yes
6.17.11	Enclosure colour	Light grey (‘G29’)
6.18	**Auxiliaries**	
6.18.1	Rated voltage	110 Vdc
6.18.2	Rated current	5 Adc
6.18.3	Operating Coils	
6.18.3.1	Rated voltage	110 Vdc
6.18.3.2	Rated power	200 W

Table 19: Technical Schedule for 132 kV Outdoor Circuit Breakers

Item	Description	Specified
6.18.3.3	Operating current	2 Adc
6.18.4	Circuit-breaker Motor	
6.18.4.1	Rated voltage	110 Vdc
6.18.4.2	Rated power	900 W
6.18.4.3	Operating current	13 Adc
6.18.4.4	Starting current	20 Adc
6.18.4.5	Auxiliary contacts	5 NO + 5 NC

10.3 Design and Construction

The circuit breaker design and construction shall comply with the requirements of SANS 62271-100. The circuit breakers are required to perform as follows:

- The circuit breaker shall provide for three-pole operation.
- The circuit breaker shall be fully pre-fabricated.
- The unit shall undergo complete routine factory pre-testing, to comprehensively test the electrical and mechanical functionality.
- The circuit breaker shall be transportable without dismantling any major parts of the unit, to prevent the necessity for any HV testing on Site.
- The circuit breakers shall be fully transportable inside purpose made ISO containers or wooden crates, for transportation on a standard trailer on normal road surfaces.
- Once installed, repetition of the electric tests on the circuit-breaker will not be required, apart from commissioning tests and tests of the wire connections between circuit-breakers, centipede overhead conductors and other components, such as voltage transformer, power transformer and the like.
- The circuit breaker shall be designed to minimize the scope of civil *works* for the foundations. The unit shall be designed to fit on a single, purpose-designed concrete platform, unless otherwise specified or required by the OEM.
- The circuit breaker shall be designed to minimize erection time.
- Replacement of one phase of the circuit breaker shall be possible with a minimum down time of the substation, provided that a spare pole is readily available.
- The circuit-breakers shall be equipped with a minimum number of flanges and an optimized number of gas segregations, in order to prevent and reduce the risk of gas leakages during the lifespan of the circuit-breakers. Circuit breakers with a double O-ring fitted on all the flanges will be preferred.

A lock-out and tripping feature shall be incorporated, to prevent operation of the circuit breaker whenever the gas pressure falls below a level at which the circuit breaker would be incapable of performing in accordance with its rated duty. Gas monitors shall be temperature compensated.

An alarm feature shall also be incorporated, to indicate falling gas pressures prior to lockout of the circuit breaker. The rate of gas leakage per annum shall be guaranteed and shall not be greater than 1% for any compartment. The system of gas monitoring shall be temperature compensated and shall be subject to approval by the *Employer*.

The 132 kV circuit breakers installed at the New Main Intake Substation will require an additional trip coil.

10.4 Tests

10.4.1 Type Tests

The circuit breakers shall be subject to type tests at the manufacturer's factory as per clause 6 of SANS 62271-100. A detailed test report, certifying compliance of such tests, shall be provided. The following mandatory type test shall be performed before shipment:

- Dielectric tests.
- RIV tests.
- Measurement of the resistance of main circuit.
- Temperature rise test.
- Short-time current tests, line charging current breaking tests.
- Tightness test.
- EMC test.
- Mechanical tests.
- Short circuit making and breaking tests.
- Capacitive current switching.
- Critical current tests.
- Out-of-phase switching tests.
- Small inductive current breaking tests.

10.4.2 Routine Tests

Individual circuit breakers shall be subjected to the following routine tests, as per Clause 7 of SANS 62271-100:

- Power frequency dry tests on the main circuits.
- Dielectric test on control and auxiliary circuits.
- Measurements of the ohmic resistance of main circuits.
- Tightness test.
- Design and visual check.
- Mechanical operating test.
- Test on components.
- Test of painted and galvanised surfaces.

The type tests shall be made on one circuit breaker to be supplied before beginning of routine tests. The *Employer* may waive the type test certificates if tests performed on identical circuit breakers are available and acceptable to the *Employer*.

10.4.3 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the 132 kV and 66 kV circuit breakers offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered 132 kV and 66 kV circuit breakers before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add further inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer’s premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

10.4.4 Site Acceptance Tests

Commissioning checks and a test programme (as determined by the manufacturer) shall be carried out in accordance with SANS 62271 for all circuit breakers. The test programme shall be incorporated into the circuit breaker inspection and test plan. This shall include checks after installation, mechanical tests and measurements, checks of certain specific operations and electrical tests and measurements.

Electrical tests shall include, but are not limited to, the following:

- Measurement of the steady-state contact resistance of the main circuit.
- Measurement of the dynamic contact resistance of the main circuit.

The measurement of the time quantities shall be done at nominal and minimum coil control voltages.

For each measurement of the operating time, a recording shall be made of each individual operating coil current - namely Close, Trip I and Trip II. The resolution of the function times shall be clearly indicated in the test reports.

During the measurement of the re-charging time of the closing spring, the peak motor current in the spring charging process shall be measured as well as the continuous motor current. Measurements shall be made both at the nominal and minimum control voltage.

The results of pre-commissioning tests after installation on Site shall be documented, signed off and a copy of the results included with the switchgear documentation for hand-over as part of the quality process. All tests shall be witnessed by the *Employer.*

11.0 132 kV OUTDOOR CURRENT TRANSFORMERS

The CTs shall comply with the requirements of IEC 61869, IEC 60044 and any other associated standards. Insulators fitted to the CTs shall comply with SANS 60815 for application in polluted conditions.

The main and back-up IEDs shall provide protective functions based on values measured from analogue current signals supplied from cores dedicated to protection functions.

Where a dedicated measurement transducer is connected, this shall use a separate current transformer circuit, designed to provide the analogue current signal at the prescribed accuracy and burden.

The neutral of each CT circuit shall be earthed at one place only, i.e. on the incoming neutral terminal inside the protection panel. A sliding link terminal shall be provided on the earth connection for isolation proposes in order to facilitate insulation resistance testing.

All CTs shall be connected to the respective circuits through 4-way PK2 test blocks that ensures short circuiting of the CT incoming terminals circuit upon withdrawal of the test block cover.

132 kV CTs shall be installed on the HV side of the transformer. These CTs shall have a continuous current rating of 2500 A and shall be equipped with six secondary cores, which provide for 2 x protection, 2 x buszone and 2 x metering cores. The protection and metering cores shall make provision for multiple tapping positions.

11.1 Technical Schedule

The 132 kV CT shall be in accordance with the Technical Schedule shown in the table below.

Table 20: Technical Schedule for 132 kV Outdoor Current Transformers

Item	Description	Specified
1	**Service Conditions**	
1.1	Altitude	1800
1.2	Climate conditions	Coastal & Inland
1.3	Ambient Temperature	-10 ºC to +45 ºC
1.4	Level of pollution that equipment will be subjected to	High
1.5	Lightning area	Yes
2	**General requirements**	
2.1	Nominal system voltage (Un)	132 kV
2.2	Maximum system voltage (line-to-line) (Um)	145 kV
2.3	Number of phases	1
2.4	Nominal continuous primary current	2500 A
2.5	Nominal short time current (Thermal)	40 kA
2.6	Nominal short time current (Dynamic)	64 kA
2.7	Time for which thermal applies	3 s
2.8	Power frequency short-duration withstand voltage	275 kV
2.9	Lightning impulse withstand voltage	650 kV
3	**Details of CT Cores**	
3.1	Number of cores	6
3.2	Number of Metering cores	2

Table 20: Technical Schedule for 132 kV Outdoor Current Transformers

Item	Description	Specified
3.3	Number of Protection cores	2
3.4	Number of Buszone cores	2
4	**Metering Cores**	
4.1	Position of Cores	Cores 5 & 6
4.2	Nominal ratio	1/2400 MR
4.3	Rated burden	See Table 23
4.4	Accuracy class	See Table 23
5	**Protection Cores**	
5.1	Position of Cores	Cores 1 & 4
5.2	Nominal turns ratio	1/2400T MR
5.3	Continuous current rating	
5.4	Primary	2500
5.5	Secondary	1
5.6	Accuracy class	TPS
5.7	Rated knee-point voltage Vk	See Table 21
5.8	Magnetising current	See Table 21
5.9	Maximum total secondary winding resistance Ri	See Table 21
6	**Buszone Cores**	
6.1	Position of Cores	Cores 2 & 3
6.2	Nominal turns ratio	1/1600T MR
6.3	Accuracy class	TPS
6.4	Rated knee-point voltage Vk	See Table 22
6.5	Magnetising current	See Table 22
6.6	Maximum total secondary winding resistance Ri	See Table 22
7	**Primary Terminal**	
7.1	Type	Stem
7.2	Orientation	Horizontal
7.3	Size	38 mm

11.2 Protection Cores

The protection cores are designated as cores 1 and 4 of the secondary core configuration. Details of the required ratio tappings and associated information shall be as indicated in Table 21below.

Table 21: 132 kV CT – Protection Cores 1 and 4 Arrangement

Tapping	Ratio	Class	Vknee (min)	Imag (max)	Rct (Ω) @ 75°C
S2 – S3	1/200T	TPS	200 V	300 mA	0,8
S1 – S2	1/400T	TPS	400 V	150 mA	1,6
S1 – S3	1/600T	TPS	600 V	100 mA	2,4
S4 – S5	1/800T	TPS	800 V	75 mA	3,2
S3 – S4	1/1000T	TPS	1000 V	60 mA	4,0
S2 – S4	1/1200T	TPS	1200 V	50 mA	4,8
S1 – S4	1/1600T	TPS	1600 V	38 mA	6,4
S3 – S5	1/1800T	TPS	1800 V	33 mA	7,2
S2 – S5	1/2000T	TPS	2000 V	30 mA	8,0
S1 – S5	1/2400T	TPS	2400 V	25 mA	9,6

11.3 Buszone Cores

CTs shall be provided with two buszone cores. These cores shall provide multiple tappings with turn ratios of 1/1000, 1/1200 and 1/1600. Details of the required ratios and associated requirements are provided in Table 22 below.

Table 22: 132 kV CT – Buszone Cores 2 and 3 Arrangement

Tapping	Ratio	Class	Vknee (min)	Imag (max)	Rct (Ω) @ 75°C
S1 – S2	1/1000T	TPS	550 V	50 mA	2
S1 – S3	1/1200T	TPS	660 V	42 mA	2,4
S1 – S4	1/1600T	TPS	880 V	31 mA	3.2

11.4 Measurement Cores

Metering cores shall provide for multi-ratio tappings from 400/1 to 2400/1. Further details are indicated in Table 23 below:

Table 23: 132 kV CT – Measurement Cores 5 and 6 Arrangement

Tapping	Ratio	Class	VA
S2 – S3	200/1	0.2	2.5VA
S1 – S2	400/1	0,2	5VA
S1 – S3	600/1	0.2	10 VA
S4 – S5	800/1	0,2	10VA
S3 – S4	1000/1	0.2	10 VA

Table 23: 132 kV CT – Measurement Cores 5 and 6 Arrangement

Tapping	Ratio	Class	VA
S2 – S4	1200/1	0,2	10VA
S1 – S4	1600/1	0,2	10VA
S3 – S5	1800/1	0.2	10 VA
S2 – S5	2000/1	0,2	10VA
S1 – S5	2400/1	0,2	10VA

11.5 Tests

The 132 kV current transformer tests shall be carried out in accordance with SANS 60044-1 and SANS 61869.

11.5.1 Type Tests

The *Contractor*/OEM shall provide evidence, prior to manufacturing, that the following type tests have been successfully performed on equipment that is identical to the proposed equipment to be incorporated in the *works*:

- Short-time current tests.
- Temperature rise test.
- Lightning Impulse test.
- High-voltage power frequency wet withstand test.
- Determination of errors (10%, 100% and 120%).

11.5.2 Routine Tests

The following routine tests shall be carried out in accordance with SANS 60044-1, Section 6, Sub clause 6.1 and 6.2:

- Verification of terminal marking.
- Power-frequency dry withstand test on primary winding.
- Partial discharge measurement.
- Power-frequency dry withstand test on secondary winding(s).
- Power-frequency withstand tests, between sections.
- Over-voltage, inter-turn withstand test.
- Determination of accuracy class (errors, and phase displacement/composite error).
- Sealing test (visual test only).

The *Employer* may waive the type test if the certificates of type tests performed on identical current transformers are available and acceptable to the *Employer*.

11.5.3 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the outdoor current transformers offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered current transformers before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add further inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advance notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer's premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

12.0 132 kV AND 66 kV OUTDOOR POST INSULATORS

12.1 General

The New Main Intake Substation shall be equipped with 132 kV and 66 kV post insulators in the HV Yard. The Ystervark Substation shall be equipped with 132 kV post insulators. The 11 kV outdoor yard insulators at the New Main Intake Substation shall be 66 kV post insulators in order to ensure sufficient working clearances.

12.2 Technical Schedule

The 132 kV post insulators shall be in accordance with the Technical Schedule shown in Table 24 below.

Table 24: Technical Schedule for 132 kV Outdoor Post Insulators

Item	Description	Specified
1	**General**	
1.1	"IEC 60273" Classification	C4-550
1.2	Specific creepage distance	31 mm/kV
2	**Insulator details**	
2.1	Insulator type	Solid core
2.2	Insulator material	Porcelain
2.3	Colour of glaze	Dark Brown
3	**Electrical Insulation Characteristics**	
3.1	Rated lightning impulse withstand voltage (peak)	550 kV
3.2	Rated short time power freq. withstand voltage, wet	230 kV r.m.s
4	**Dimensional characteristics**	
4.1	Creepage factor (l/S)	4 (31 mm/kV)
4.2	Shed profile: Plain or Alternating	Alternating
4.3	Minimum shed spacing to projection (s/p) ratio	0.65
4.4	Minimum distance between sheds of the same diameter	30 mm
4.5	Maximum creepage distance vs. clearance	5
4.6	Insulator height (across mounting flanges)	1220 ± 1 mm
4.7	Maximum nominal diameter of insulating part	300 mm
5	**Mechanical Properties**	
5.1	Bending (cantilever) failing load	$\geq$ 4 kN
5.2	Torsion failing load	$\geq$ 3000 Nm
6	**Fixing Arrangements**	
6.1	Top fitting pitch circle diameter	127 mm
6.2	Top fitting - number of holes	4
6.3	Top fitting - diameter of holes	M16
6.4	Bottom fitting pitch circle diameter	127 mm
6.5	Bottom fitting - number of holes	4

Table 24: Technical Schedule for 132 kV Outdoor Post Insulators

Item	Description	Specified
6.6	Bottom fitting - diameter of holes	M16
6.7	Flange material	Cast iron
6.8	Metal finish - minimum hot dip galvanizing thickness	100 µm
6.9	Mounting bolt: Type	Grade 8.8
6.10	Confirmation of the integrity of the supplied fastening arrangement	Yes

The 66 kV post insulators shall be in accordance with the Technical Schedule shown in Table 25 below.

Table 25: Technical Schedule for 66 kV Post Insulators

Item	Description	Specified
1	**General**	
1.1	"IEC 60273" Classification	C4-325
1.2	Specific creepage distance	31 mm/kV
2	**Insulator details**	
2.1	Insulator type	Solid core
2.2	Insulator material	Porcelain
2.3	Colour of glaze	Dark Brown
3	**Electrical Insulation Characteristics**	
3.1	Rated lightning impulse withstand voltage (peak)	350 kV
3.2	Rated short time power freq. withstand voltage, wet	140 kV r.m.s
4	**Dimensional characteristics**	
4.1	Creepage factor (I/S)	4 (31 mm/kV)
4.2	Shed profile: Plain or Alternating	Alternating
4.3	Minimum shed spacing to projection (s/p) ratio	0.65
4.4	Minimum distance between sheds of the same diameter	25 mm
4.5	Maximum creepage distance vs. clearance	5
4.6	Insulator height (across mounting flanges)	770 ± 1 mm
4.7	Maximum nominal diameter of insulating part	225 mm
5	**Mechanical Properties**	
5.1	Bending (cantilever) failing load	4 kN
5.2	Torsion failing load	≥ 2000 Nm
6	**Fixing Arrangements**	
6.1	Top fitting pitch circle diameter	127 mm
6.2	Top fitting - number of holes	4
6.3	Top fitting - diameter of holes	M16
6.4	Bottom fitting pitch circle diameter	127 mm
6.5	Bottom fitting - number of holes	4

Table 25: Technical Schedule for 66 kV Post Insulators

Item	Description	Specified
6.6	Bottom fitting - diameter of holes	M16
6.7	Flange material	Cast iron
6.8	Metal finish - minimum hot dip galvanizing thickness	100 µm
6.9	Mounting bolt: Type	Grade 8.8
6.10	Confirmation of the integrity of the supplied fastening arrangement	Yes

12.3 Insulator Type and Material

Post insulators and post insulator units shall be of the cylindrical, solid-core type with cemented external metal fittings. The insulating material shall be of glazed porcelain. The glaze shall be dark brown in colour, unless otherwise approved. Alternative materials may be offered, but shall be subject to the *Employer*'s approval.

The ceramic body shall be sound, thoroughly vitrified and free of defects and blemishes that could adversely affect the performance or durability of the post insulator. The insulators shall be capable of withstanding seismic events of up to 0,3g. The exposed parts of the ceramic body shall be smoothly glazed and free of surface defects, inclusions and the like, which could detrimentally affect the performance of the post insulator.

12.4 Electrical Insulation Withstand Level

The rated insulation withstand levels for lightning and switching impulse, as well as short-time power frequency withstand, shall be in accordance with the standard values indicated in SANS 60273.

12.5 Mechanical Characteristics

12.5.1 Cantilever Strength

Post insulators shall be standardised according to mechanical strength classes, based on the values of the specified minimum cantilever failing load in the bending test, in accordance with the classification indicated in SANS 60273.

12.5.2 Torsional Strength

Torsional failing loads are critical to the application in disconnector switches. The minimum values shall be as indicated in SANS 600273.

12.6 Fixing Arrangements

The end fittings shall comply with the dimensional characteristics stated in SANS 60273. The end fittings shall be manufactured from cast iron. The mechanical strength of the end fittings shall be demonstrated by appropriate mechanical tests. Portland and alumina cements are preferred for metal end fitting attachment. The use of sulphur cement is not acceptable.

12.7 Metal Finish

All ferrous fittings shall be hot dip galvanised in accordance with SANS 121 to a minimum coating thickness of 100 µm. Threaded holes shall be suitable for standard metric sized bolts, after the galvanising process. The thread of tapped holes shall not be re-tapped after galvanising.

12.8 Tests

12.8.1 Type Tests

Post insulators shall be subject to the following standard type tests for outdoor applications, as specified in SANS 60168:

- Verification of dimensions.
- Dry lightning impulse withstand voltage test.
- Wet switching impulse withstand voltage test.
- Wet power-frequency withstand voltage test.
- Mechanical failing load test carried out in bending.

12.8.2 Special Tests according to IEC

- Radio interference test (see IEC 60437). For ceramic post insulators, the RIV test shall be performed as if in service, with the relevant fittings installed for applications at nominal system voltages of 132 kV and above. The test shall be compensated for relative air density consistent with an altitude of 1800 m above sea level. The limit for RIV shall be 65 dB at 0.5 MHz under dry conditions at the service altitude of 1800 m. Details of tests undertaken and the test setup used shall be supplied with the tender submission and will be evaluated by Eskom for conformity to field service conditions. If required, additional tests may be stipulated, at the cost of the *Contractor*/OEM, to better represent field service conditions.

- Artificial pollution test (see IEC 60507). Details of artificial pollution tests, conducted in accordance with IEC 60507, and the pollution levels as evaluated must be supplied with the tender submission. The tests will be evaluated for its acceptability in relation to the creepage levels offered and their intended application in the different pollution environments.

12.8.3 Routine Tests

Routine tests shall be performed in accordance with SANS 60168 on all post insulators units prior to despatch from the OEM's premises.

Test certificates, including the results of routine production tests, shall be retained by the *Contractor*/OEM and shall be available for the *Employer's* inspection. The following tests are to be carried out on all insulator units:

- Visual examination.
- Mechanical test (50% of the specified mechanical failing load, applied in four mutually perpendicular directions, each for a minimum time of 3 s).

12.8.4 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the outdoor post insulators offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered post insulators before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add the necessary inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer's premises to Site. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

13.0 66 kV OUTDOOR VOLTAGE TRANSFORMERS

VTs shall comply with the requirements of NRS 030 and the requirements as set out in this specification. VTs shall comply with the environmental operating conditions set out in NRS 030.

The design provides for two (2) sets of VT's at the 66 kV busbars. The 66kV VT's will be utilised for tariff metering and unit protection at Ystervark Substation. A dedicated three-phase protection VT circuit shall be supplied from the Eskom busbar protection VT(s), transformer unit protection, as detailed on the protection drawings.

The VT supplies for the protection and measurements circuits shall be taken into a junction box mounted in a suitable position on the medium lattice structure.

The *Contractor* shall include all costs associated with the installation of the transformers pertaining to delivery and off-loading and shall make provision for all cranes and/or rigging equipment as may be necessary for installation of the VT onto the lattice structure.

13.1 Technical Schedule

The 66 kV outdoor voltage transformers shall be in accordance with the Technical Schedule shown in Table 26 below.

Table 26: Technical Schedule for 66 kV Outdoor Voltage Transformers

Item	Description	Specified
1	**Service Conditions**	
1.1	Altitude	1 800 m
1.2	Climate conditions	Coastal
1.3	Ambient Temperature	-10 °C to 45 °C
1.4	Level of pollution that equipment will be subjected to	High
1.5	Lightning area	Yes
2	**General requirements**	
2.1	Nominal system voltage (Un)	66 kV
2.2	Maximum system voltage (line-to-line) (Um)	72.5 kV
2.3	Frequency	50 Hz
2.4	Number of single phase Voltage Transformers per set	3
2.5	Rated Burden per Phase	100 / 50 VA
2.6	Accuracy Class	3P / 0.2
2.7	Primary Voltage	66 / √3
2.8	Secondary Voltage	110 / √3
2.9	Power frequency short-duration withstand voltage	140
2.10	Lightning impulse withstand voltage	350
2.11	Power Winding required	No
3	**Creepage distance**	
3.1	Minimum creepage distance for other than medium pollution (IEC 60815)	31 mm/kV
4	**Secondary Protection**	

Table 26: Technical Schedule for 66 kV Outdoor Voltage Transformers

Item	Description	Specified
4.1	Method	Fuses
4.2	Current rating of fuses	32 A
4.3	Maximum permissible duration of secondary short circuit current	1
5	**Primary Terminal**	
5.1	Type	Stem
5.2	Orientation	Vertical
5.3	Size	26 mm

Table 27 below depicts the detailed requirements pertaining to the 66 kV Power Voltage Transformers for installation under this project.

Table 27: Technical Schedule for 66 kV Outdoor Power Voltage Transformers

Item	Description	Specified
1	**Service Conditions**	
1.1	Altitude	1800 m
1.2	Climate conditions	Coastal
1.3	Ambient Temperature	-10 °C to 45 °C
1.4	Level of pollution that equipment will be subjected to	Heavy
1.5	Lightning area	Yes
2	**General requirements**	
2.1	Nominal system voltage (Un)	66 kV
2.2	Maximum system voltage (line-to-line) (Um)	72.5 kV
2.3	Frequency	50 Hz
2.4	Number of single phase Voltage Transformers per set	3
2.5	Rated Burden per Phase	2500 VA
2.6	Voltage Factor	2.1
2.7	Primary Voltage	66 / √3
2.8	Secondary Voltage	110 / √3
2.9	Power frequency short-duration withstand voltage	140
2.10	Lightning impulse withstand voltage	350
2.11	Power Winding required	Yes
3	**Creepage distance**	
3.1	Minimum creepage distance for other than medium pollution (IEC 60815)	31 mm/kV
4	**Secondary Protection**	
4.1	Method	Fuses
4.2	Current rating of fuses	32 A

Item	Description	Specified
4.3	Maximum permissible duration of secondary short circuit current	1
5	**Primary Terminal**	
5.1	Type	Stem
5.2	Orientation	Vertical
5.3	Size	26 mm

13.2 Tests

Tests shall be carried out in accordance with SANS 60044-5.

13.2.1 Routine Tests

The following routine tests shall be carried out at the OEM's premises:

- Polarity and verification of terminal markings.
- Power frequency dry withstand test on primary windings.
- Partial discharge measurement.
- Power frequency test between sections and on secondary windings.
- Test for accuracy.
- Over-voltage inter-turn withstand test.
- Sealing test.

13.2.2 Type Tests

Certificates for the following type tests, conducted in accordance with SANS 60044-5, shall be submitted:

- Temperature rise test.
- Short circuit withstand capability test.
- Lightning Impulse test on primary windings.
- Wet test and determination of errors.

13.2.3 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the outdoor voltage transformers offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered voltage transformers before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer's premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

14.0 132 kV OUTDOOR ISOLATORS

14.1 General

This specification covers the technical requirements for high-voltage outdoor disconnectors and earth switches, including the design, manufacture, testing, supply, delivery, erection and maintenance training for the outdoor type disconnectors, earth switches and associated equipment as specified herein.

14.2 Technical Schedule

The 132 kV outdoor isolators shall be in accordance with the Technical Schedule shown in Table 28 below.

Table 28: Technical Schedule for 132 kV Outdoor Isolators

Item	Description	Specified
1	**System Conditions**	
1.1	System voltage	132 kV
1.2	Number of phases	3
1.3	Nominal system frequency	50 Hz
1.4	System earthing	Effectively earthed
1.5	Rated supply voltage of auxiliary and control circuits	110 Vdc
1.6	Expected life	40 years
2	**Disconnector ratings (SANS 62271-102)**	
2.1	Rated voltage (Ur)	145 kV
2.2	Rated normal current (Ir)	2500 A
2.3	Rated short-time withstand current (Ik)	40 kA
2.4	Short-time withstand current duration (tk)	3 s
2.5	Rated peak withstand current (Ip)	100 kA
2.6	Rated short-duration power frequency withstand voltage	275 kV
2.7	Rated lightning impulse withstand voltage	$\geq$ 550 kV
2.8	Mechanical endurance class	M2
2.9	Rated value of bus transfer current for DS	1600 / 300 A or 80 % of rated current
2.10	Across the isolating distance (LIWL)	630 kV
3	**Detail and type of disconnector**	
3.1	Type of disconnector required	Centre Rotate Double Break (CRDB)
4	**Mounting of disconnector**	
4.1	Mounting height (lowest part of insulation above ground level)	2500 mm
4.2	Electrical clearances - Between live portions at system voltage and earth	≥ 3700 mm
5	**Type of operation mechanism**	
5.1	Disconnector	Either motor or hand operated type
6	**Operating movement**	

Table 28: Technical Schedule for 132 kV Outdoor Isolators

Item	Description	Specified
6.1	Disconnector	Vertical
7	**Motor driven mechanism - voltage**	110 Vdc
8	**Main Terminals**	
8.1	Type	Pad
8.2	Material	Aluminium
8.3	Orientation: vertical or horizontal	Horizontal
9	**Insulation and Clearances**	
9.1	Insulator type designation	C6-550
9.2	Cantilever strength class	6 kN
9.3	Creepage distance	31 mm/kV
9.4	Insulator material	Porcelain
10	**Insulator Test Voltage**	
10.1	Lightning impulse withstand voltage (1,2/50 µs) referred to sea level - To earth and between phases in the open position	550 kV
10.2	Power frequency withstand voltage (60 second) referred to sea level - To earth and between phases in the open position	275 kV
11	**Insulator Dimensions**	
11.1	Top flange PCD with 4 x 14mm (Plain) holes	127 mm
11.2	Bottom flange PCD with 8 X 14mm (Plain) holes	127 mm
12	**Auxiliary Switches**	
12.1	Number of Poles	16 Pole
12.1.1	Type F	1
12.1.2	Type M	5
12.1.3	Type G	8
12.1.4	Type N	2
12.1.5	Type GS	2 (if required)
13	**Ratings for auxiliary switches**	
13.1	Breaking capacity (110 V ≤ Ua ≤ 250 V)	440 W
13.2	Class type	1
13.3	Breaking current for 110 V DC	2 A
13.4	Continuous current	10 A
13.5	Short-time current for 30 second	100 A
14	**Miscellaneous**	
14.1	Protection of housing, mechanism enclosures and nameplates	
14.1.1	IP rating	IP55
14.1.2	Material type	316 stainless steel

Table 28: Technical Schedule for 132 kV Outdoor Isolators

Item	Description	Specified
14.1.3	Nameplates and their fixings shall be weather and corrosion proof	Yes
14.1.4	Nameplate material	aluminium or stainless steel
14.2	Cubicle heating and ventilation	
14.2.1	Electrical heating - Supply voltage, 50 Hz	110 V
14.3	Secondary terminals, gland plate and cable connections	
14.3.1	Terminal type	Spring loaded

14.3 Ratings

Double side-break, centre rotate disconnectors shall be used, which shall be rated at 2500 A continuous current and short-time current of 40 kA, unless otherwise specified.

Insulation shall be for severe pollution conditions with insulators designed for creepage at 31 mm/kV.

When current switching duty is foreseen (i.e. for current values higher than 50 mA the equipment shall be rated for busbar transfer and induced current switching, whichever is applicable, according to the requirements of SANS 62271-102.

14.4 Operating Conditions and Environment

All equipment shall be designed to operate under the conditions as specified below:

- Ambient temperatures ranging from -10 ºC to +45 ºC. Allowance shall be made for sudden and drastic temperature changes that may be encountered, with resulting condensation of water vapour within the housings, mechanism boxes and hollow components.
- Solar radiation intensity up to a level of 1100 W/m², with significant ultra-violet (UV) radiation intensity.
- Derating effects due to lower air density in terms of dielectric withstand, Radio Influence Voltage (RIV) behaviour and continuous current handling capability up to an altitude of 1 800 m above sea level.
- Airborne pollution in the form of dust, smoke, corrosive gases and saline content, due to the location within areas of industrial activity, close proximity to the sea and the like.
- Mechanical forces due to wind and overhead conductor loadings up to a maximum continuous value of 1500 N in any direction, imposed on the main terminals.
- Seismic activity is not a normal requirement. Account shall however be taken of continuous activities, such as vibrations generated at substation conductors, power transformers and shunt reactors.

14.5 Safety

The design and installation of the equipment shall make adequate allowances for the safety of the operating personnel. The electrical working clearance from ground to parts at system voltage, as required in terms of the Occupational Health and Safety Act No. 85 of 1993, shall be fully complied with. Working clearance is defined as the distance from the closest live part at service voltage to ground level.

The electrical working clearance applicable to the 132 kV disconnectors is 3700 mm.

Moving parts shall be suitably positioned and/or screened and shall present no hazard to personnel or adjacent equipment. There shall be no electrical shock hazards for operating personnel.

14.6 Resistance to Corrosion

The design and installation of all equipment shall take full account of the corrosive conditions to which it will be exposed. Particular note shall be taken of the risks attached to dissimilar metals when in contact with each other.

All structural steelwork and associated fasteners, including washers, shall be hot-dipped galvanised in accordance with SANS 121 (ISO 1461) or of stainless steel grade 316.

Wherever stainless steel bolts or screws are used, the threads shall be coated with a suitable anti-seize compound or long-life grease during the assembly process.

14.7 Operation

Allowances shall be made for operating forces on mechanical facilities, in accordance with SANS 62271-102

The *Contractor* shall state the nominal forces (with permissible tolerances) required for operating the equipment. These forces shall not increase in service beyond the stated maximum tolerance. These values shall be verified and recorded as part of the pre-commissioning tests.

14.8 Radio Influence Voltage (RIV)

The equipment shall have been type tested for acceptable RIV behaviour in accordance with Clause 6.3 of SANS 62271-102.

14.9 Design

The disconnector to be supplied and installed shall be of the double side-break, centre rotate type.

The disconnector shall be manually operated with a single operating device per unit.

14.9.1 Adjustment Facilities and Stability of Settings

At points where stable and fine adjustments are necessary for correct functional behaviour, this must be achievable in a step-less manner. Typical examples are right/left handed threaded components, slotted flanges and/or levers, or other methods which enable this functionality.

The use of round section U-bolt clamps, or similar methods for making fine adjustments, will not meet this “step-less” requirement and are thus unacceptable.

Adjustment facilities shall be fixed by an approved method, such as locknuts, which do not require drilling and pinning.

Adjustment facilities and their fixings shall be designed for the application life of the equipment.

14.9.2 Ice-Breaking Capability

Notwithstanding the fact that the operating environment is not conducive to severe icing conditions, mechanical strength reserves and safety factors of the equipment shall be satisfactorily demonstrated by having successfully passed an ice-breaking test in accordance with SANS 62271-102.

14.9.3 Switching of Induced Currents

When induced current switching is required, this will be as per the requirements of Annex C of SANS 62271-102.

14.9.4 Operating Mechanisms

14.9.4.1 Manual Operation

Manually operated mechanisms shall be evaluated and approved by the *Employer* on the basis of their proven reliability within the industry, including supporting samples, drawings and descriptive literature. The following design features are deemed acceptable:

- A robust steel handle of not less than 40 mm or greater than 55 mm outside diameter.
- The operation of swing type handles takes place preferably in the horizontal plane.
- The operation of crank type handles takes place preferably in a vertical plane.
- The height for the operating handle is between 1000 mm and 1200 mm above ground level.
- The length of a swing type handle is between 750 mm and 1200 mm.
- The output shaft is galvanically connected to the substation earth mat via the support structure, by means of a multi-stranded insulated flexible copper conductor with a cross-sectional area of at least 65 mm^2.
- Adequate physical clearance is provided to prevent injury to operating personnel.
- Padlocking facilities are provided in both the “open” and “closed” positions.
- Padlocking facilities are suitable for use with the *Employer’s* padlock with 8 mm shank.
- There are no nesting places for insects, such as wasps or bees. Accumulation of water and/or debris will not occur and the equipment complies with IEC 60529: Classification IP55.
- The open and closed positions are positively identified at the mechanism with “ON” and “OFF” labels respectively.
- The direction in which to achieve open and close is clearly indicated.
- There is a door stop provided on all hinged doors.

14.9.5 Enclosures

14.9.5.1 General Design

Enclosures shall be designed to facilitate internal access and to prevent unauthorised access to controls in the case of motor operating mechanisms.

Upper surfaces of enclosures shall be shaped or sloped to prevent accumulation of water.

The design of the enclosure shall be such that access to the control circuitry can be obtained when the operating handles is either locked in the open/closed position.

14.9.5.2 Degrees of Protection

All enclosures shall comply with IEC 60529: Classification IP55.

14.9.5.3 Sealing

Where components require sealing off from the elements, the effectiveness of such sealing shall be maintained for the normal service life of the equipment. This includes prevention of moisture accumulation inside sealed-off areas. This applies to the mechanism enclosures as well as enclosed type current transfer contacts, output shafts, bearing housings and control cubicles.

The method of sealing of doors and other items, such as output shafts, shall be subject to approval by the *Employer*. The following design features are deemed acceptable:

- No seals are exposed directly to the elements.
- Seals on doors and removable panels are of extruded EPDM rubber or heavy duty foamed polyurethane.
- Natural rubber or felt seals are not acceptable.

14.9.5.4 Control Cables and Gland Plates

Control cables terminated inside enclosures shall enter at the bottom of the enclosure.

Cables shall be of the covered steel wire armoured multiple core type, fitted with armour grip type glands, unless specified otherwise or allowed for differently in the BoQ or drawings.

Gland plates shall be removable, undrilled and made of brass or corrosion resistant aluminium alloy. Steel gland plates are not acceptable.

A dimension of the gland plate shall be:

- Minimum available area of the gland plate shall be at least 75 mm x 75 mm.
- Minimum thickness at least 2 mm (for brass) or 4 mm (for aluminium).

14.9.5.5 Secondary Terminals

Auxiliary switches, internal wiring and other equipment requiring connection to external apparatus shall be wired to terminal strips in the circuit breaker mechanism box. Each terminal strip shall be provided with not less than 6 spare terminals. The arrangement of the terminal strips (vertical orientation) in the equipment shall facilitate the entry of the incoming control cables in the bottom entry configuration.

The terminal blocks shall be of the screw clamp, spring loaded insertion type. The terminal width of 10mm is preferred. Terminal widths less than 8 mm will not be accepted. The terminal blocks shall be capable of accepting back-to-back insulated hook blade lugs without damaging or deforming the lug.

All electrical circuits for external connection shall be terminated at a secondary terminal strip. The secondary terminal strips shall be arranged vertically or horizontally within the enclosure.

For horizontally arranged secondary terminals, the lowest part of the terminal strip shall be at least 150 mm above the gland plate. For vertically arranged secondary terminals this value may be less than 150 mm above the gland plate, provided sufficient clearance to the sides of the enclosure is provided for arranging and terminating the incoming cable cores.

The secondary terminals shall be of the DIN rail-mounted spring-loaded type. An approved type of terminal shall be supplied.

At least 4 x spare terminals shall be provided.

14.9.5.6 Secondary Wiring

All wiring shall be carried out in multi-stranded copper conductor having a minimum equivalent area of 1.5 mm² and insulated to withstand a routine test voltage of 2 kV for 60 s, unless otherwise specified, or so instructed by the *Employe*r or otherwise required by the OEM.

Each individual wire must be terminated with lugs suitable for the secondary terminal block or component terminal used. Bare wire ends are not acceptable.

Wiring shall be clearly identified by an approved means, such as ferruling at both ends or laser etching of the insulation. Thermal impression of the insulation or adhesive labels as a means of wiring identification is not acceptable.

Wiring to components mounted on swing frames shall be arranged to twist at and along the hinge point. All workmanship with regards to the above shall be subject to the *Employer's* approval in writing before first delivery.

14.9.5.7 Control Elements

All control elements such as contactors, thermal overload relays, push buttons and limit switches shall be regular items available from standard product lines and readily interchangeable with an equivalent item from alternative suppliers. All items shall be in accordance with the relevant SANS and/or IEC standards.

Mounting of control elements on access doors is not acceptable.

All control elements must be labelled with their locations inside the drive. The location of the label shall be on the backing plate where the relays are fixed, in order to retain the labelling should the relay be changed during its life time.

14.9.5.8 Auxiliary Switches

Auxiliary switches shall be of an approved type.

Auxiliary switches shall be driven positively and the linkage system employed shall ensure correct action throughout the operation.

The number and type of auxiliary contacts required for each mechanism shall be specified.
Auxiliary switch contacts shall be galvanically independent.

All spare auxiliary switch contacts shall be wired to the secondary terminal strip. Auxiliary switch contacts shall be protected against ingress of dust particles (degree of protection IP55).

Auxiliary switches shall faithfully reproduce the main contact position and achieve the relative timing parameters as required. The timing of the designated auxiliary contact types shall be according to Figure 2 below. The auxiliary switch shall be a truly maintenance free device for the life of the equipment.

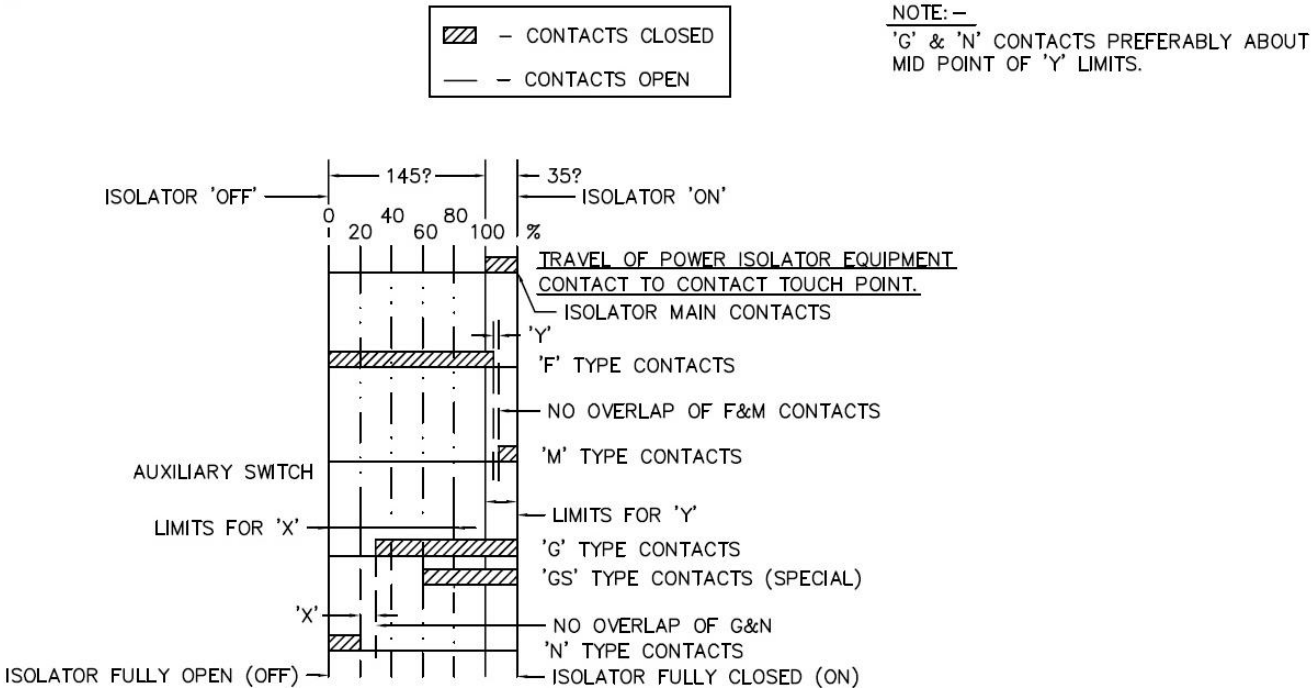


Figure 2: Disconnector auxiliary contact timing diagram

14.9.5.9 Convention/Practice

The convention to be adopted is that auxiliary contacts, limit switches, relay contacts and the like are in the normal condition when:

- Disconnector and/or earth switch main contacts are open.
- Relay coils are de-energised.

14.9.6 Rating plates

Every disconnector and/or earth switch shall be provided with a rating plate mounted on an earthed vertical flat surface so that a normally sighted person standing at ground level can easily read the details.

The rating plate shall be affixed by an approved method such as riveting or screws.

Rating plates and their fixings shall be weather and corrosion proof.

Ratings of the equipment, using the symbols according to the relevant standard, shall be indicated on the nameplate, as well as the manufacturer's name and equipment type designation, to include also the following information:

- Rated voltage, normal current and short time current values.
- Serial number.
- Year of manufacture.
- Standard to which equipment complies, e.g. SANS 62271-102.

14.9.7 Operating Labels

The support structure shall make provision for the attachment of operating equipment labels. The position and orientation of the labels shall be visible from the operating point.

14.9.8 Mechanical Features

14.9.8.1 Base Frames

Base frames of equipment shall be fixed to the support structure in such a manner as to avoid distortion or excessive deflection when in operation.

Base frames shall be designed to prevent bird nesting. The accessibility of birds into mechanical parts of the disconnector will be assessed by the *Employer*.

14.9.8.2 Bearings

Base bearings and bearings requiring protection from the elements shall be of the sealed type. Bearing housings shall be designed to prevent internal condensation and accumulation of moisture.

Bearings shall be appropriate for the application, i.e. high thrust and cantilever loads. Cognisance shall be taken of vibrations occurring in service, which may influence the performance of such bearings.

Bearings shall be of a standard and type that is commercially available from various manufacturers and local agencies.

14.9.8.3 Bushes

Where bushes are provided that will require periodic lubrication, standard type grease nipples shall be provided.

Should bushes be proposed, which are reputed to require no periodic lubrication, further substantiations, including proven track records, shall be provided.

14.9.8.4 Gears

All gearing arrangements used on operating mechanism shall be adequately covered and protected against the elements.

All interlocking arrangements that are enclosed shall be protected to a rating of IP2X.

14.9.8.5 Linkages

Inter-phase linkages and other motion transfer arrangements shall transmit the operating forces in an efficient and stress-free manner.

Self-aligning features shall be provided at the ends of linkages to accommodate changes in direction during linkage movement and, if adjustable, must also be lockable.

Linkage rod ends shall be self-lubricated and shall be in continuous galvanic contact with the earthed portions of the equipment to prevent development of induced voltages.

When the pole centres exceed 3000 mm, inter-phase linkages shall operate in tension only to avoid buckling. A concession to this requirement may be granted if successful performance of an ice-breaking test on a fully representative gang-operated three pole unit has been undertaken and the results are accepted by the *Employer*.

14.9.9 Active Parts

i. *Current Paths*

Current paths shall be designed for a minimum maintenance interval of twelve (12) years.

For conventional disconnectors, current path assemblies shall consist of top mechanism having minimum sub components, with preferably one solid piece current path with replaceable contacts.

Bird nesting shall not interfere with the functionality of the disconnector.

ii. *Main Terminals*

Main terminals shall be of the flat pad type.

Temperature rise and short-time current type tests for the equipment shall be carried out with the same type of terminal as will be supplied.

iii. *Insulators*

Post insulators of the ceramic type complying with IEC requirements are the preferred solution, except where conditions requiring alternative technologies are deemed necessary or specified.

Employment of alternative insulator technologies, such as toughened glass or composite materials, is subject to full approval by the *Employer* and shall include KIPTS testing evidence where applicable.

Insulators from the same supplier and type shall be supplied per item of equipment.

Mixing of insulator makes and type per item of equipment is not permitted.

Details of the insulator, such as manufacturer, type designation, creepage dimensions and shed profile, shall be submitted at tender stage.

The standard colour for post insulators shall be dark brown, if porcelain.

There shall be exact interchangeability between insulators, irrespective of the supplied creepage distance.

iv. *Indicating Devices*

A mechanical indicating device shall be provided at each mechanism to indicate the open or closed position. The following symbols shall be used:

- Device closed “ON” in white lettering on a red background.
- Device open “OFF” in white lettering on a green background.

Lettering size shall be at least 20 mm.

14.10 Electro-Magnetic Compatibility (EMC)

EMC requirements for the equipment shall be in accordance with SANS 62271-102.

14.11 Lubricants such as Greases and Similar Compounds

The *Contractor*/OEM shall provide proof that the performance of lubricants, such as greases and similar compounds, are adequate for the intended purpose and application.

The *Contractor* shall list the lubricants and/or compounds to be used and shall submit details, in the form of test results, to prove the effectiveness of the products in providing an adequate barrier against atmospheric influence and/or inhibit corrosion.

The source of these lubricants and compounds, preferably including South African sources, shall be provided.

14.12 Transport, Storage and Erection

14.12.1 General

Equipment shall be appropriately treated and packed to take account of all conditions arising during transport, storage and erection at Site.

14.12.2 Requirements

Shafts, bearings and machined surfaces exposed during transport shall be treated with a temporary anti-corrosive coating.

Equipment shall be protectively packed to prevent damage during transport and storage at Site.

Each disconnector shall be unit packed, i.e. the component parts making up a complete disconnector shall be delivered to Site in one or more packing cases. These packing cases shall contain only component parts for one individual disconnector or earth switch.

Packing cases shall be clearly marked to indicate the contents. If components of the same disconnector are contained in more than one packing case, the cases shall be marked accordingly. The marking shall at least include the following text:

- Make, type and serial number of the equipment.
- Indication of the number of boxes for one disconnector, e.g. 1 of 4, 2 of 4, etc.

Equipment shall preferably not require any maintenance whilst it is in storage. If any equipment requires maintenance or attention during storage, this shall be clearly stated.

Failure to comply with the above shall render the *Contractor* liable for any damage owing to incorrect storage.

14.13 Tests

Manufacture, factory inspection, shipping, off-loading, erection and Site tests shall be done in accordance with an approved quality assurance plan.

Copies of typical type-test reports/certificates and a typical routine test report/certificate shall be submitted at tender stage.

The *Contractor* shall submit the necessary quality control plans, indicating all inspection hold points to which the *Employer* may add their witness, and hold points for inspection by the *Employer* or appointed representative. The *Contractor* shall make due allowance for these hold points.

The *Employer* will not accept responsibility for late delivery in respect of delays caused by issues arising from these hold points.

14.13.1 Type tests

Equipment shall be type tested in accordance with the requirements of SANS 62271-102. These tests shall include, but may not be limited to, the following:

- Power frequency withstand voltage test.
- Lightning impulse withstand voltage test.
- Radio interference voltage test.
- Temperature rise test.
- Measurement of the resistance of the main circuit.
- Short-time and peak withstand current test.
- Mechanical endurance test.
- Bus transfer current switching.

Type tests carried out more than seven (7) years ago are not deemed to be valid.

The disconnector shall have been type tested in accordance with the KIPTS natural ageing and pollution performance test procedure for outdoor insulator products.

14.13.2 Routine tests

Routine test reports and results shall be submitted for each disconnector in MS Excel or MS Word format, and shall be in English.

i. *General*

Routine testing shall be carried out at the *Contractor's/*OEM's premises prior to shipment to Site.

ii. *Wiring Checks*

The secondary wiring shall be verified in accordance with the approved wiring diagram. The resistance of heater circuits, coils of contactors, resistors and the like shall be checked and verified.

iii. *Voltage Tests*

Tests in accordance with SANS 60694 shall be performed on the secondary circuits.

iv. *Resistance of Main Circuit*

The main circuit resistance shall be measured in accordance with IEC 60694 and recorded in the routine test report.

v. *Pre-Commissioning Tests*

The following tests/inspections shall be done on completion of erection and prior to handing over of the equipment:

- Current path resistance measurement.
- Contact travel, end position and alignment.
- Complete operational check, including auxiliary switch function. (5 open and 5 close operations).
- Operating force measurement for manual type drives.
- Operating forces measurements of motor drives (in electrical and mechanical units).

The above shall be recorded on a test record sheet and signed off by the *Contractor's* representative.

14.13.3 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the outdoor isolators offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered outdoor isolators before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add the necessary inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer's premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

15.0 11 kV OUTDOOR SERIES REACTORS

15.1 General

If series reactors are specified to be supplied and installed, reactors shall be of the air core type, suitable for outdoor operation and shall be supplied with all the necessary accessories as required and as specified.

The purpose of the 11 kV series reactors is to act as a fault current limiting device, to ensure that the existing electrical infrastructure's fault withstand capabilities are not exceeded. If specified to be installed, the 11 kV series reactors are to be installed between the 132-66/11 kV power transformers and the 11 kV double busbar switchgear at the New Main Intake Substation. The 11 kV series reactors shall have a life expectancy of 40 years.

15.2 Technical Schedule

The 11 kV outdoor series reactors shall be in accordance with the Technical Schedule shown in Table 29 below.

Table 29: Technical Schedule for 11 kV Outdoor Series Reactors

Item	Description	Specified
1	**Service Conditions**	
1.1	Altitude	1800 m
1.2	Climate conditions	Coastal
1.3	Ambient Temperature	-10 °C to 45 °C
1.4	Level of pollution that equipment will be subjected to	Very Heavy
1.5	Pollution classification	31 mm/kV
1.6	Lightning area	Yes
2	**System Details**	
2.1	Rated Nominal Voltage	11 kV
2.2	Maximum System Voltage	12 kV
2.3	Nominal System Frequency	50 Hz
2.4	System Three-phase Fault Level	To be provided by *Employer*
3	**Type**	
3.1	Application of Reactor	Current Limiting
3.2	Rated Power	40 MVA
3.3	Short-time withstand current	31.5 kA
3.4	Fault duration	3 s
4	**Reactor Details**	
4.1	Type of Cooling	AN
4.2	Rated positive sequence impedance	8%
5	**Reactor Insulation**	
5.1	Rated Power Frequency Withstand Voltage	28 kV
5.2	Rated Lightning Impulse Withstand Voltage	75 kV
5.3	External voltage grading (specific creepage)	31 mm/kV

15.3 Design and Construction

15.3.1 Reactor Construction

The complete winding assembly shall be encapsulated to provide full protection against extreme weather, direct sunlight and temperature variations.

The reactor shall be finished with a uniform RTV coating on its exposed surfaces. This coating shall be tested in accordance with IEC 62217, for accelerated weathering.

The *Contractor* shall submit evidence that the material can withstand prolonged exposure to sunlight and ambient conditions.

The reactor spiders/clamping structures shall be prepared according to the applicable corrosion standards. The equipment shall be constructed such that:

- It is not affected by normal handling during transport.
- Maintenance can be carried out conveniently and safely.
- The finish of all components is free from surface blemishes and sharp edges.

Each reactor shall be mounted on outdoor-type insulators with mechanical and electrical characteristics suitable for continuous operation under the specified conditions.

The reactor shall be supplied complete with all the necessary support structures and hardware and shall be designed for mounting outdoors with its longitudinal axis in the vertical plane.

Connections between the winding and the line terminals, as well as connections between concentric cylinders of the winding, shall be welded. No joints will be permitted internal to the winding.

Line terminals shall consist of terminal pads complying with IEC 60518. The terminals shall be made of corrosion-resistant, high-conductivity aluminium. Terminals other than aluminium terminals may be used only with prior approval from the *Employer.*

Steel support structures shall be galvanised, complying with applicable SANS standards and those of these specifications.

Each reactor shall be supplied complete with stainless steel mounting bolts. All nuts and bolts shall be fitted with approved anti-vibration locking devices. All fasteners shall be stainless steel Grade 316L stainless steel bolts, nuts and washers. Thread lubrications shall be applied to all bolts and nuts. Any good quality, high temperature grease is acceptable, but silicon-based grease is preferred.

The holding-down bolts on supports or concrete foundations shall be suitable for a 15 mm thick supporting structure top plate in the case of steel and for grouting in the case of concrete.

The following fittings shall be provided:

- Rating and diagram plates.
- Structural earthing terminals for 50mm x 3 mm copper strap.
- Lifting lugs.
- Pedestal insulator.

All structural and fence metalwork, including foundations, shall be designed to avoid, as far as possible, metallic loops and parallel circuits in which induced currents can run.

Each reactor shall be designed and constructed so that maintenance can be carried out safely and conveniently.

15.3.2 Reactor Crating

The reactor shall be placed in a non-returnable crate, suitable for handling by overhead crane and forklift truck. The crate shall bear permanent markings for: “correct side up”, “centre of gravity”, “sling connections” and “total weight” (crate and reactor).

The crate shall be constructed of a material that is suitable for long-term (> 10 years), outdoor storage. Any special storage and maintenance requirements shall be specified.

15.3.3 Audible Sound Level

The sound level emanating from the reactors shall be less than 77 dB from the surface of the reactors, with no octave band measurement being above the specified sound pressure level.

If the equipment does not meet the specified sound levels, the *Contractor*/OEM shall provide sound abatement measures to reduce the sound levels to the specified level. Installation of such measures may not compromise the maintainability of the reactor or the circuit in which it operates. If required, fire retardant materials shall be used for sound abatement purposes.

15.3.4 Vibration

The reactor shall be designed to minimise all vibration and to minimise transmission of vibration to other equipment.

The vibration level shall be less than 100 µm.

The reactor shall be designed so that the reactor's mechanical resonant frequency does not coincide with the system frequency or its lower order harmonics.

15.4 Tests

The following tests shall be performed in accordance with the latest IEC specifications at the specified test levels:

15.4.1 Routine Tests

- Measurement of winding resistance.
- Measurement of impedance at rated continuous current.
- Measurement of incremental inductance.
- Measurement of losses at ambient temperature. The referenced standardized specification for the test method shall be confirmed, to include documentation qualifying the accuracy of the proposed method. The test reports and results shall also be submitted to the *Employer*. All metal parts forming part of the support structure of the reactor shall be in place during the tests and measurement.
- Measurement of harmonic current loss.
- Turn-to-turn overvoltage test.
- Lightning impulse test.
- Switching impulse test.
- Overvoltage/overload.

15.4.2 Type Tests

Temperature rise tests shall be conducted at the rated continuous current. The test shall be carried out on each reactor at the maximum continuous rating. During this test the following shall be measured:

- Total losses, current and reactance.
- Measurement of acoustic sound levels.
- Measurement of loss and quality factor.

15.4.3 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the 11 kV series reactors offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered 11 kV series reactors before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer's premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

16.0 11 kV OUTDOOR NECRTs

This specification covers the combined, oil-immersed, three-phase neutral electromagnetic couplers with neutral - earthing resistors and auxiliary transformers (NECRTs). NECRTs shall be installed to provide earthing points for the 11 kV system and to limit the current during line-to-earth faults on these systems.

The purpose of the neutral earthing resistor is to limit the current flow to earth under fault conditions. The purpose of the auxiliary transformer is to provide the secondary voltage to supply local auxiliary loads at the new Main Intake Substation.

16.1 General

The NECRT shall comply with all the requirements of SANS 60076-6, with amendments and additional requirements as described below. All units shall be designed for both overhead and cable connection.

The units shall have a life expectancy of 40 years.

16.2 Technical Schedule

The 11 kV outdoor NECRTs shall be in accordance with the Technical Schedule shown in Table 30Table 30 below.

Table 30: Technical Schedule for 11 kV Outdoor NECRTs

Item	Description	Specified
1	**Electrical conditions**	
1.1	Nominal system voltage	11 kV
1.2	Maximum system voltage	12 kV
1.3	Frequency	50 Hz
2	**Minimum Insulation Requirements**	
2.1	Impulse withstand voltage for line terminal (primary)	95 kV
2.2	Sixty second, power frequency withstand voltage	28 kV
3	**Rated Requirements**	
3.1	Nominal short time (10s) current of NEC and NER	360 A r.m.s
3.2	Nominal continuous current of NEC and NER	10 A r.m.s
3.3	Zero sequence reactance (Xo)	23,7 to 28,4 Ω/phase
3.4	Zero sequence resistance (Ro) at 100°C	47,3 to 56,8 Ω/phase
4	**Auxiliary Transformers**	
4.1	Nominal Rating	315 kVA
4.2	Primary nominal voltage	11 kV
4.3	No load secondary voltage	400 V
4.4	Vector Group	Dyn11
4.5	Percentage impedance	5%
4.6	Tapping Range	+5% -5%, 2.5% per tap
5	**Material**	
5.1	NEC winding	Cu
5.2	Aux HV Winding	Cu

Table 30: Technical Schedule for 11 kV Outdoor NECRTs

Item	Description	Specified
5.3	Aux LV Winding	Cu
6	**Housing and corrosion protection**	
6.1	Tank Colour	Light Grey (SANS 1091 'G29')
7	**Inter-Turn Winding Insulation**	
7.1	Enamel Grade	Grade 3 or better
8	**HV Bushings**	
8.1	Minimum creepage	31 kV/mm
8.2	Type	Outdoor
8.3	Stem Size (diameter and length)	26mm x 125 mm
9	**Neutral Bushing**	
9.1	Minimum creepage	31 kV/mm
9.2	Type	Outdoor
9.3	Stem Size (diameter and length)	26mm x 125 mm
10	**Cable Connection**	
10.1	400 V side	As per drawings
11	**Indicating and Protective Devices**	
11.1	Buchholz relay	Yes
11.2	Oil temperature thermometer	Yes
11.3	Winding temperature thermometer	Yes
11.4	Dehydrating Breather	Yes
11.5	Oil Level Indicator	Yes

16.3 Design and Construction

The 11 kV NECRT shall be:

- Naturally cooled.
- Free-breathing / sealed unit.
- Outdoor type.
- Oil-immersed.
- Fully-insulated.
- Zigzag connected.
- Three-phase 50 Hz neutral electromagnetic couplers (NECs).
- Combined with a neutral earthing resistor and three-phase 400/240 V auxiliary power transformer.
- All contained in the same tank.
- With only one common set of HV terminals.
- 11/0.4 kV 315 kVA auxiliary transformer, designed and constructed in accordance with SANS 780.
- The core and winding assembly shall be correctly located at the tank bottom and adequately braced.
- Be adequately braced in the two horizontal directions and fixed at the level of the upper yoke clamps.
- Not have core and winding assemblies suspended from the tank cover.
- Have access hand holes in the tank sides to facilitate connection of leads to the lower ends of the bushings.

With the 11 kV bus bars of the substation regulated by the HV/MV OLTS transformer tap change controller, the MV voltage is expected to be between 100% and 105% of rated voltage. The auxiliary transformer shall provide an output of 400 V with the regulated MV at nominal rated voltage.

16.3.1 Auxiliary Power Output

The auxiliary transformer LV connections shall be brought out through two, moulded-case, air-insulated circuit-breakers (MCCBs). The MCCB's shall be rated as follows:

Main Feed to Control Building:

- Rated Current : 550 A
- Breaking Capacity : 15 kA
- Voltage : 440 V

16.3.2 Tank Construction

The tank, complete with fittings and conservator tank shall be capable of withstanding the effects of full vacuum at sea level. The tank under-base shall be at least 10 mm thick. The tank cover shall be bolted.

The oil conservator shall be mounted off one end of the unit, transversely to its major axis. A 15 mm brass drain valve shall be provided at the base of the conservator tank. The valve opening shall be sealed by means of a threaded plug. The electrical clearance from any part of the conservator to the line of approach of a horizontal conductor, supported on a line bushing terminal and approaching in a direction normal to the transformer major axis, shall be not less than 430 mm.

A drain valve shall be provided at the lowest point on the main tank. The valve shall be of the gate valve type, double flanged, with a nominal bore of 25 mm and manufactured of brass. The valve shall be fitted with a blanking plate and gasket on the outlet. Four symmetrically placed lifting lugs shall be provided so that it will be possible to lift the complete unit when filled with oil without structural damage to any part of the unit. The factor of safety at any one point shall not be less than 2.

The lifting lugs shall be so arranged and located as to be accessible for use when the transformer is loaded on the transport vehicle, and so as not to cause fouling of any of the transformer fittings and accessories.

All brass fittings must be painted with the same coating as the tank.

16.3.3 Oil

Each unit shall leave the factory:

- Filled to the normal level.
- With appropriate action being taken to maintain the oil dryness during transportation and to avoid oil pollution of the dehydrating breather prior to delivery at Site.
- Oil sampling point to be labelled as main tank, Buchholz etc.
- Transformer oil supplied in the NECRT shall be compliant with the NRS 079-1 specification.

Poly Chloride Biphenyls (PCB) content shall be as follows:

- All oils used in the NECRT shall be free of PCBs (zero ppm).
- A formal test certificate to this effect shall be included in the NECRT manual.

16.3.3.1 Oil Sampling Points

A single oil sample point shall be provided for oil sampling. The sample pipe shall be connected to the top of the Buchholz relay and routed to ground level. The sample point must be clearly labelled "Routine Oil Sampling Point".

The sample point shall be easily accessible from ground level, approximately 200 mm from the base of the NECRT. Sample pipes shall comprise of copper tubing, with 10 mm outer diameter and 7 mm inner diameter. Sample pipes shall be sufficiently long to allow the sample point to be approximately 200 mm from the base of the NECRT and the Buchholz. SAE 45 flared connections shall be used as.

Only corrosion resistant needle valves shall be used as sample valves. The open end of the valves shall be sealed by means of threaded plugs.

16.3.4 HV Terminals

The NECRT shall be suitable for MV overhead and LV cable connections.

16.3.5 Bushings

All units shall be provided with outdoor bushings, complying with SANS 60137.

Bushings shall be subjected to the KIPTS natural ageing and pollution performance tests.

HV bushings shall be vertically mounted on the tank.

Bushings shall be spaced in order to accommodate a standard K-type cross-clamp (bolted-bolted) and still meet the requirements of SABS 780. It can be assumed that the clamps will extend a maximum of 120 mm to each side of the bushing centre.

All bushings 11 kV and higher must be clamped at the base of the bushing. The bushing design drawings must include the wall thickness for which the bushing is suitable for and for which it has been tested.

The phase-to phase clearances between the centre lines of the neighbouring bushings shall not be less than 700 mm.

16.3.6 Secondary Wiring and Terminals

16.3.6.1 Secondary Wiring

The secondary circuits and other auxiliary circuits, shall:

- Be wired with either 2,5 mm² wire or 4 mm² wire, unless otherwise specified or instructed.
- Have oil and moisture-proof insulation and, where the temperature exceeds that of ambient air, thermal characteristic insulation at least equal to Class A in terns of IEC 60085.
- In the case of external wiring, be protected, either in the form of armoured cable, which shall be supported on rails clear of the tank surfaces, or by a conduit consisting of a metal protective channel. Mineral insulated copper sheathed cables will not be acceptable.
- Be suitably braced, clipped and/or laced to prevent vibration.
- Unless otherwise specified, be fitted with crimped terminations, compatible with the terminals with which they are associated. Only the required minimum of wiring insulation shall be removed for making wiring terminations, leaving the conductor strands clean and undamaged.
- If situated inside the tank (internal wiring), be connected to the terminals of the terminal box.
- Have, at each end of each lead, an interlocking type ferrule with permanent black characters, impressed, on a white background, which displays the same designation marked on the apparatus terminal to which each end (of a lead) is connected.

Terminations without lugs will not be acceptable. The wiring designation, marked on the ferrules, shall be read from terminal to insulation, independent of the direction of entry into any devices (vertical or horizontal terminal strips, relay apparatus and instruments). All terminals and wiring identification devices shall be easily accessible after wiring and cabling has been completed.

16.3.6.2 Secondary Terminals

The secondary terminals shall be type “B” only (i.e. rail-mounted, screw clamp, spring-loaded insertion type).

16.3.7 Current Transformers

Current transformer shall be provided with ratings as shown in Table 31.

Table 31: CT Cores in NECRTs

Position	Function	Class	Ratio	Turns Ratio	Im (mA) (Max)	Vk (V) (Min)	Rs (Ω) (Max)
Neutral	RE/F	TPS	2400/1	1/2400	25	2400	9.6
Neutral	E/F	10P10	100/1	1/100			

16.3.8 Protection Devices

16.3.8.1 Pressure Relief Device

The NECRT shall be provided with a pressure relief device of sufficient capacity to limit internal pressure under internal low current arcing fault conditions, so that tank rupture does not occur.

NECRTs shall be equipped with pressure relief devices to relieve excessive pressure in the tank due to internal arcing. The device shall be fitted directly to the side wall of the tank at a level as near as possible to the top of the windings.

16.3.9 Alarms and Trip Signals

All transformers shall be provided with the following alarm contacts:

- High oil temperature (top oil).
- Low oil level: (main conservator tank).
- Gas actuated relay (Buchholz) alarm.
- LV circuit breaker trip alarm.

All transformers shall be provided with the following trip signalling:

- High oil temperature (top oil).
- Gas actuated relay (Buchholz) trip - gas and surge.

16.4 Tests

The combined NEC/NER auxiliary transformer units shall be tested as prescribed in the relevant standards listed in the normative references. Failure of a unit to pass any listed test will constitute non-compliance with this specification. In addition to the combined test certificate, separate test certificates must be provided for each of the NECRT components, i.e. the auxiliary transformer, compensator winding (zigzag configuration) and resistor for type and special tests.

16.4.1 Type Tests

Unless certified records of previous tests performed on identical units are available, test reports for the following type and special tests will be required:

- Temperature rise test.
- Vacuum test.
- Accelerated ageing test for composite bushings.

16.4.2 Routine Tests

- Zero sequence impedance test.
- Applied voltage test.
- Partial discharge test.
- Dielectric tests in accordance with SANS 60076-3.
- Measurement of zero sequence impedance.

The following routine tests shall be conducted on the 11/0.4 kV 315 kVA auxiliary transformers:

- Measurement of no-load loss and no-load current.
- Measurement of impedance voltage and short-circuit impedance and load loss.

- Measurement of voltage ratio and check of voltage vector relationship.

16.4.3 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the 11 kV NECRTs offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered 11 kV NECRTs before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer’s premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

17.0 66 kV AND 11 kV OUTDOOR SURGE ARRESTERS

17.1 General

The surge arresters shall be designed for protection of the HV Yard equipment from switching surges and lightning surges.

Surge arresters shall be mounted on a custom made bracket, suitably positioned on the power transformers, adjacent to the 66 kV and 11 kV bushings. Purpose made support brackets shall be provided for this purpose and shall be included in the supply rate of the power transformers.

Details of the proposed mounting arrangement shall be provided with the *Contractor*/OEM's power transformer outline drawings.

The surge arresters shall be immune to the effects of live spray washing. A test report proving this shall be submitted for approval.

Only single column (series stack) arresters are acceptable.

Internal components shall be dry at the time of assembly and arresters shall be permanently sealed. If elastomer gaskets or seals are used, precautions shall be taken to ensure adequate compression and that such gaskets or seals do not deteriorate in service as a result of exposure to the environment or electrical stresses.

All ferrous, non-current carrying components exposed to the atmosphere shall be hot-dip galvanized in accordance with SANS 121.

Arresters shall withstand short-circuit currents without violent shattering and shall have the ability to self-extinguish any fire caused by an arc.

Any design changes shall be verified by testing and shall be subject to written approval.

The surge arresters shall be of the gapless Metal (Zinc) Oxide (ZnO) type, unless specified or instructed otherwise.

17.2 Technical Requirements

The 66 kV outdoor surge arresters shall be in accordance with the Technical Schedule shown in Table 32 below.

Table 32: Technical Schedule for 66 kV Outdoor Surge Arresters

Item	Description	Specified
1	**Operating Conditions**	
1.1	Altitude	up to 1800 m
1.2	Average Humidity	30 to 90
1.3	Intensity of Solar Radiation	1,1 kW/m²
1.4	IEC pollution level	Coastal HVH (31 mm/kV specific creepage)
1.5	Lightning activity	High
1.6	System earthing	Effective
1.7	System configuration	3-phase, 3-wire
1.8	Nominal system voltage (U_n)	66 kV
1.9	Maximum system voltage (U_m)	72.5 kV

Table 32: Technical Schedule for 66 kV Outdoor Surge Arresters

Item	Description	Specified
1.10	Supply frequency	50 Hz
1.11	BIL of equipment to be protected	350 kV peak
2	**Electrical Characteristics of Arrester**	
2.1	Arrester classification	Station class
2.2	IEC line discharge class	Class 2
2.3	Nominal lightning discharge current (8/20 µs)	10 kA
2.4	Minimum energy absorption capability for a single high current impulse, 100 kA 4/10 µs in per unit of MCOV	3,4 kJ/kV
2.5	Minimum continuous operating voltage MCOV (U_c)	48 kV
2.6	Maximum residual voltage (U_{res}) at 10kA (8/20 µs)	165 kV
3	**Arrester housing**	
3.1	Minimum external creepage distance:	2263 mm
4	**Arrester housing profile design**	
	IEC 60815 annex D parameters:	
4.1	c	≥ 20
4.2	s/p	≥ 0,65
4.3	Ld/d	≤ 5
4.4	P1 – P2	≥ 15
4.5	CF	≤ 3,5
4.6	PF	≥ 0,7
5	**Arrester mounting details**	
5.1	Orientation	Vertical
5.2	Method of mounting	Tripod base
5.3	PCD	110mm – 255 mm
5.4	Supplied with: 3 bolts, 3 nuts, 3 tapered washers and 6 flat washers.	Yes
6	**Arrester line terminal**	
6.1	Type	Stem
6.2	Diameter	26 mm
6.3	Minimum length	100 mm
6.4	Orientation	Vertical

The 11 kV outdoor surge arresters shall be in accordance with the Technical Schedule shown in Table 33 below.

Table 33: Technical Schedule for 11 kV Surge Arresters

Item	Description	Specified
1	**Operating Conditions**	
1.1	Altitude	up to 1800 m
1.2	Average Humidity	30 to 90
1.3	Intensity of Solar Radiation	1,1 kW/m²
1.4	IEC pollution level	Coastal HVH (31mm/kV specific creepage)
1.5	Lightning activity	High
1.6	System earthing	Effective
1.7	System configuration	3-phase, 3-wire
1.8	Nominal system voltage (U_n)	11 kV
1.9	Maximum system voltage (U_m)	12 kV
1.10	Supply frequency	50 Hz
1.11	BIL of equipment to be protected	95 kV peak
2	**Electrical Characteristics of Arrester**	
2.1	Arrester classification	Station class
2.2	IEC line discharge class	Class 2
2.3	Nominal lightning discharge current (8/20 µs)	10 kA
2.4	Minimum energy absorption capability for a single high current impulse, 100 kA 4/10 µs in per unit of MCOV	3,4 kJ/kV
2.5	Minimum continuous operating voltage MCOV (U_c)	12 kV
2.6	Maximum residual voltage (U_{res}) at 10 kA (8/20 µs)	45 kV
3	**Arrester housing**	
3.1	Minimum external creepage distance:	372 mm
4	**Arrester housing profile design**	
	IEC 60815 annex D parameters:	
4.1	c	≥ 20
4.2	s/p	≥ 0,65
4.3	Ld/d	≤ 5
4.4	P1 – P2	≥ 15
4.5	CF	≤ 3,5
4.6	PF	≥ 0,7
5	**Arrester mounting details**	
5.1	Orientation	Vertical
5.2	Method of mounting	Base

Table 33: Technical Schedule for 11 kV Surge Arresters

Item	Description	Specified
6	**Arrester line terminal**	
6.1	Type	Threaded
6.2	Diameter	M12
6.3	Minimum length	50 mm
6.4	Orientation	Vertical

17.2.1 Arrester housing

Surge Arresters shall be polymer housed. Surge arresters with ceramic housings are not acceptable.

The creepage distance of the surge arrester insulation shall be 31 mm/kV.

The surge arrester housing profile characteristics shall comply with the guidelines of Annex D of SANS 60815.

17.2.2 Mounting

The 66 kV and 11 kV surge arresters shall be arranged for base mounting and shall be compatible with the drilling plan specified in the detail inset as shown on the layout drawings.

The mounting bracket shall be 15mm thick, with 14mm diameter mounting holes, arranged for a 127 mm PCD for mounting purposes.

Three mounting bolts shall be supplied per arrester. Each mounting bolt shall be supplied complete with a nut, tapered washer and two flat washers.

17.2.3 Terminals

On surge arresters equipped for service there shall be no visible permanent deformation of the terminals of the arrester when a force of 100 N is applied for 1 min to the tip of the terminal.

If dissimilar metals are used for the surge arrester terminals and conductor clamping arrangements, proof shall be provided of the galvanic compatibility of these materials.

17.2.4 Line Terminals

The line terminals of both the 66 kV and 11 kV surge arresters shall comprise of a 26 mm x 100 mm aluminium stem (for application of a bolted K-clamp). The surge arrester shall not be subject to undue stress due to the weight of the conductor.

17.2.5 Earth Terminals

An earth terminal shall be provided for the 66 kV arresters. The earth termination shall accommodate a 50 mm x 3 mm copper strap.

17.3 Tests

17.3.1 General

Type and routine tests on arresters shall be conducted in accordance with SANS 60099-4.

Single copies of type test reports, in English, shall be submitted by the *Contractor* for review.

Type tests reports from in-house testing laboratories will be accepted, subject to proof of the long-term, in-service performance of the product range. The *Contractor* shall, upon request by the *Employer,* provide further test reports from an accredited testing laboratory to verify the validity of any in-house test reports.

An accredited testing laboratory is defined as a laboratory that holds valid certification issued by ILAC (International Laboratory Accreditation Corporation) or one of its members.

The *Employer* reserves the right to appoint a representative to inspect the arresters at any stage of manufacture and to witness and verify any tests.

17.3.2 Type Tests

The *Contractor* shall provide copies of the following type tests:

- Insulation withstand test of the surge arrester housing.
- Residual voltage test.
- Long duration current impulse withstand test.
- Operating duty tests.
- Power frequency voltage versus time characteristic.
- Short-circuit test.
- Natural ageing and pollution performance test. Surge arresters shall be tested in accordance with the Koeberg Insulator Pollution Test Station (KIPTS) natural ageing and pollution performance test procedure for outdoor insulator products, with particular reference to Section 3: Particular Requirements for Surge Arresters: Section 34-215.
- Internal partial discharge test.
- Moisture ingress test.
- Bending moment test: The manufacturer's declared values for the specified long-term bending loads shall be stated.

17.3.3 Routine Tests

The following routine tests that shall be conducted:

- Measure reference voltage (U_{ref}).
- Residual voltage test.
- Internal partial discharge test.

17.3.4 Factory Acceptance Testing

The *Employer* reserves the right to inspect and evaluate all manufacturing and testing facilities relating to the outdoor surge arresters offered, both before and at any time during manufacturing.

The *Employer* reserves the right to inspect any ordered outdoor surge arresters before shipment, or at any stage of manufacture. This inspection will entail a thorough check to ensure complete compliance with this standard, technical schedule and the approved manufacturer's drawings.

The *Contractor* shall submit the quality control plans to the *Employer*, indicating all inspection hold points. The *Employer* may add inspection hold and/or witness points. The *Contractor* shall make due allowance for these activities in the manufacturing programme and, to avoid delays, shall give sufficient, agreed upon, advanced notice of the date of inspection. The *Employer* will not accept late delivery on the basis of inspection delays.

The *Contractor* shall obtain a written clearance from the *Employer* prior to despatch of the equipment from the OEM/manufacturer’s premises to Site. This clearance shall be confirmed on the routine test certificates. No clearance shall be given where there are any outstanding defects resulting from Factory Acceptance Testing (FAT).

18.0 MV CABLES

18.1 General

All MV cables shall be of the XLPE insulated 6.35/11 kV Cu, fire retardant, self-extinguishing, SWA/AWA or unarmoured type, as applicable, in accordance with SANS 1339 and further applicable contract documentation and drawings. All cables shall bear the SABS/SANS mark of approval. The sizes, ratings and core numbers shall be as specified in the bills of quantities and/or drawings. All medium voltage cables shall be rated for 6.35/11 kV, including the cables that will be operated at 3.3 kV.

In addition to the above, all MV cables within the substation buildings shall be of the zero toxic emission type. Indoor MV cables (between 11 kV switchgear and 11/3.3 kV transformers, 11/0.4 kV transformer and 3.3 kV switchgear) inside the substations shall be of the un-armoured single core type. All outdoor MV cables, including cables exiting the new Main Intake Substation, Substation M and Substation N, shall be of the 3-core armoured type, unless otherwise specified or shown on the drawings or BoQ. The aforementioned shall in particular be taken note of at the Main Intake Substation from the 11 kV cable end support structures to the indoor MV switchgear etc.

Cables shall be transported and stored in accordance with SANS 10198-6. Stored cables shall have the cable ends thoroughly sealed prior to termination to prevent the ingress of moisture.

Damaged cables and/or drums delivered to Site will not be accepted. Where the drum and/or cable are damaged, the entire cable reel will be rejected and shall be replaced at the *Contractor's* expense. The *Employer* may, at his sole discretion and at the *Contractor's* expense, request appropriate tests to be performed on the delivered cables to prove that no ingress of moisture or any other form of damage to the cables has occurred.

The *Contractor* shall furnish all relevant factory certificates for the cables whenever requested to do so by the *Employer*.

All un-terminated, exposed cable ends shall be capped by manufacturer-prescribed heat shrink end-caps to prevent moisture ingress. The *Contractor* shall furnish all relevant factory certificates for the cables whenever requested to do so by the *Employer*.

All final, selected cable routes shall be set out by a qualified, experience and registered professional surveyor. The positions of finally installed cables shall also be surveyed by the surveyor for as-built information/record purposes. The *Contractor* shall include all survey costs in his tender pricing.

18.2 MV Cable Installation

The installation of cables shall be in accordance with SANS 10142-1, SANS 10142-2, SANS 10198-8, as well as all other applicable contract documentation and drawings. The *Contractor* shall ensure that only appropriate tools and equipment are used for the installation of cables. Cables shall only be pulled over cable rollers that have been firmly fixed. A pulling sock shall be used when pulling cables. The *Contractor* shall be responsible for making off of cables at both ends.

The *Contractor* shall be responsible for the planning of all cable routes. This applies in particular to buried cables. The *Contractor* shall take account of other services and shall at all stages endeavour to identify and optimise the cable routes. The *Contractor* shall work closely with Others to ensure that the installed cables do not interfere or adversely impact upon other services.

The final routes shall be confirmed with the *Employer* and the *Contractor* shall submit a detailed cabling diagram, showing all cable feeds, sizes, location and the like, for approval. No cable installations, with associated excavations, shall be done in environmentally no-go areas. The *Contractor* shall consult with the *Employer* to identify such areas prior to fixing belowground cable routes.

During installation the *Contractor* shall ensure that the maximum tensile forces and bending radii of the cables, as prescribed by the cable manufacturer, are not exceeded. Cables shall be buried below ground or installed on trays, ladders and racks as applicable. Trays, ladders and racks carrying MV cables shall be provided with suitable coverings. MV cables shall not be installed on wire meshes or in ducts, unless specific approvals have been granted by the *Employer.* Under no circumstances shall MV cables be installed in conduits.

Where MV cables are installed on trays, ladders, wire meshes or racks, the cables shall be strapped/fixed with heavy duty 316L stainless steel bandit strapping, unless otherwise instructed by the *Employer*. Where steel bandit strapping is used to fix cables, extra cable insulation shall be placed between the cable and the steel strapping to prevent damage to the cable.

The spacing of the strapping fixings shall not be greater than 500 mm, to avoid sagging of the cables. The *Contractor* may propose alternate fixing spacings for consideration and approval by the *Employer.* Such alternate proposals shall be accompanied by a proper analysis and calculations covering the cable loads on trays, wire meshes, ladders or racks. Proof shall also be provided that the manufacturer's requirements will in all cases be adhered to.

MV cables shall not be installed in or along the same cable management systems as the LV conductors or data/communications/signalling and control cables, unless specific approvals have been granted by the *Employer*. Different voltage level cables shall also not be installed in or along the same cables management systems.

Where MV cables are to be installed below ground, they shall be installed at a final depth of 1000 mm below finished ground level, measured to the top of the cable (laid on a 150 mm bedding layer and covered by a 150 mm layer of padding material). Suitable concrete cover slabs/tiles, shall be installed on the final compacted padding layer on-top of the MV cables for the entire underground length of the cables.

450 mm wide, 150 m micron thick PVC electrical danger warning tape shall be installed above all MV electrical cables 300 mm below finished ground level. The electrical warning/danger tape shall, as a minimum, include the wording "DANGER/INGOZI/GEVAAR" and shall have a black thunder flash symbol and be orange in colour.

The following minimum clearances/spacing shall be adhered to, unless specified, instructed or shown otherwise on the drawings (Note: The *Contractor* may request approval from the *Employer* for relaxation on the below clearances where deemed necessary by the *Contractor*. The *Contractor* may not implement any reduced clearances unless specific approval has been obtained from the *Employer*):

- Between electrical and electronic cables (horizontally): At least 650 mm.
- Between electrical and electronic cables (vertically): At least 650 mm.
- Between electrical/electronic cables and other services (horizontally): At least 650 mm.
- Between electrical/electronic cables and other services (vertically): At least 650 mm.
- Between MV cables (horizontally and vertically): At least 300 mm.
- Between MV and LV cables (horizontally and vertically): At least 300 mm.

The designs for the installation of the same voltage rating cables on trays, ladders and racks etc., allow for the cables to be in contact with one another. The *Contractor* is however strongly advised to provide the maximum possible spacing between cables.

In trenches, where electrical cables cross other electrical cables of different voltage levels, or telecommunications cables, or other services, protective concrete slabs shall be installed up to 2 m to either side of the crossing. Concrete slabs shall be placed between the cables or other services, as specified in SANS 10198-8. Where such crossings occur, protective sleeves shall also be provided and cover tiles shall be placed in conjunction with the protective slab. Reference shall be made to all associated contract documentation and drawings for further requirements.

No electronic and LV cables or other services shall be installed in the same trench as the MV electrical cables, unless specific approval has been granted by the *Employer* or shown differently on the drawings.

All further requirements included in SANS 10198-8 and other relevant standards shall be adhered to. Details of the adopted measures for providing minimum clearances and protection shall be subject to approval by the *Employer*.

Only one MV cable may be installed within a single sleeve.

The cable types (armoured/non-armoured) and coating of cables and joints shall be as indicated in Table 34 below, unless otherwise specified or instructed by the *Employer*. All coating of cables shall be of the intumescent, zero toxic emission, fire stopping type, to be applied in strict accordance with the manufacturer's recommendations.

Table 34: Coating of MV Cables

<table>
<tr><th rowspan="2">Cable Size</th><th colspan="2">Cable Type</th><th rowspan="2">Extent of Coating</th></tr>
<tr><th>External of Building</th><th>Internal of Building</th></tr>
<tr><td rowspan="4">MV Cables</td><td colspan="2">Armoured :
zero toxicity</td><td>None</td></tr>
<tr><td colspan="2">Armoured :
high toxicity
(Only upon specific approval)</td><td rowspan="2">Full length of cable, from outside of building up to equipment

Full length of joint plus 1.0 m either side of joint including entire cable entering the building</td></tr>
<tr><td>Armoured :
high toxicity</td><td>Non-Armoured :
zero toxicity</td></tr>
</table>

MV cables installed inside concrete trenches shall be fixed to suitable cable trays, racks or ladders as required, unless specified or instructed otherwise by the *Employer*. MV cables within the outdoor yard section of the Main Intake Substation's shall be installed as per Eskom standards. This includes cables and connections onto or through foundations and the like.

18.3 MV Cable Terminations

The *Contractor* shall timeously notify the *Employer* of the dates upon which terminations are to be carried out, so that the necessary inspection can be arranged as required. The *Employer* shall witness all MV terminations. Any cable termination not inspected by the *Employer* because of insufficient notice being given by the *Contractor* may be rejected and the *Employer* may order the *Contractor* to redo the termination at the *Contractor*'s expense.

The ends shall be terminated strictly in accordance with SANS 10198-11 and all other applicable specifications, taking account also of the cable manufacturer's requirements for such terminations. The terminations shall be capable of withstanding the same test voltages as the rest of the MV cable.

18.3.1 Indoor Switchgear Terminations

All terminations within the medium voltage gas insulated switchgear shall either be of the L-shape screened separable connector, T-shaped screened separable connector or inner cone plug-in type terminations, as applicable.

The *Contractor* shall provide proof in writing that the MV cable terminations for the respective MV switchgear are approved by the MV switchgear OEM. All terminations shall be fully functional and compatible with the switchgear to which they connect.

The terminations shall include minimal, if any, insulating or stress relieving tapes. The use of electrical stress control and insulating tubing, which is heat-shrunk onto the terminations, is preferred above other methods. The kits shall include suitable boots for the covering of the terminal studs on the equipment.

Terminations shall have traceable markings, indicating as a minimum the manufacturer's name, specific details of the product and the batch numbers. The full name, ID number and contact details of the individual installing the terminations shall also be indicated on the termination. The *Contractor* shall present to the *Employer* samples of the wording, including the actual label, for approval.

Core identification shall be by shrink boot marker pencil. Insulation tape markings will not be accepted. All MV terminations shall only be undertaken and installed by a person who is registered and approved as a MV termination installer by the manufacturer of the brand of the MV terminations used.

Only glands of the correct size, matching the cable to which it must be fixed to, shall be used. Glands shall be for indoor and outdoor use and shall have suitable corrosion protection coatings to cater for a highly corrosive environment.

Only MV cable terminators, which are approved by the MV switchgear and terminations OEM's, as applicable, may be used. Duly authorised representatives of both the MV switchgear and terminations

OEM's shall also witness each MV termination undertaken and installed. Allowances for the aforementioned shall be made in the tender rates. Failure to comply with these requirements shall result in the *Contractor* having to redo the respective termination, or terminations as applicable, at his own expense.

18.3.2 Indoor Transformer Terminations

All 11 kV and 3.3 kV MV cable terminations within the indoor dry-type transformers shall be of the plug-in type on top of the MV-side of the transformer enclosure box.

The *Contractor* shall provide proof in writing that the MV cable terminations for the respective dry-type transformers are approved by the dry-type transformers OEM. All terminations shall be fully functional and compatible with the transformers to which they are connected.

The terminations shall include minimal, if any, insulating or stress relieving tapes. The use of electrical stress control and insulating tubing, which is heat-shrunk onto the terminations, is preferred above other methods.

Terminations shall have traceable markings, indicating as a minimum the manufacturer's name, specific details of the product and the batch numbers. The full name, ID number and contact details of the individual installing the terminations shall also be indicated on the termination. The *Contractor* shall present to the *Employer* samples of the wording, including the actual label, for approval.

Core identification shall be by shrink boot marker pencil. Insulation tape markings will not be accepted. All MV terminations shall only be undertaken and installed by a person who is registered and approved as a MV termination installer by the manufacturer of the brand of the MV terminations used.

Only MV cable terminators, which are approved by the transformers and terminations OEM's as applicable, may be used. Duly authorised representatives of both the transformers and terminations OEM's shall also witness each MV termination undertaken and installed. Allowances for the aforementioned shall be made in the tender rates. Failure to comply with these requirements shall result in the *Contractor* having to redo the respective termination, or terminations as applicable, at his own expense.

18.3.3 Outdoor Terminations

All terminations within the outdoor HV yard of the new Main Intake Substation shall be of the heat shrinkable type for 6.35/11 kV cable, or approved equivalent. The termination kits shall be suitable for the specific application and shall consist of torque-shear connectors. Crimping type connectors will not be accepted. The terminations shall be of the manufacturer-prescribed, SABS/SANS approved heat shrink type.

The terminations shall include minimal, if any, insulating or stress relieving tapes. The use of electrical stress control and insulating tubing, which is heat-shrunk onto the terminations, is preferred above other methods.

Terminations shall have traceable markings, indicating as a minimum the manufacturer's name, specific details of the product and the batch numbers. The full name, ID number and contact details of the individual installing the terminations shall also be indicated on the termination. The *Contractor* shall present to the *Employer* samples of the wording, including the actual label, for approval.

Core identification shall be by shrink boot marker pencil. Insulation tape markings will not be accepted. All MV terminations shall only be undertaken and installed by a person who is registered and approved as a MV termination installer by the manufacturer of the brand of the MV terminations used.

Only glands of the correct size, matching the cable to which it must be fixed to, shall be used. Glands shall be for indoor and outdoor use and shall have suitable corrosion protection coatings to cater for a highly corrosive environment. For outdoor environments, glands shall have a minimum ingress protection rating of IP66 to prevent ingress of moisture or any other foreign material. Where glands are used outdoors, they shall be equipped with a protective PVC UV-stabilised black colour shroud.

The *Contractor* shall provide proof in writing that the outdoor MV cable terminations are approved by the equipment OEM to which the terminations will connect onto. All terminations shall be fully functional and compatible with the equipment to which they are connected.

Only MV cable terminators, which are approved by the respective equipment OEM(s), may be used. Duly authorised representatives of the respective equipment OEM's shall also witness each MV termination

undertaken and installed. Allowances for the aforementioned shall be included in the tender rates. Failure to comply with this requirement shall result in the *Contractor* having to redo the respective termination, or terminations as applicable, at his own expense.

18.4 MV Cable Jointing

The designs call for normal in-line joints and trifurcating joints (3 core cables to single core cables). Further reference shall be made to the associated contract documentation and drawings for additional information. Should any cable be damaged during installation, the *Contractor* shall replace the entire length of the cable at his own expense.

Trifurcation joints, or others as specified, shall only be used indoors and shall be coated with intumescent fire stopping zero toxic emissions paint, as described in this specification. The *Contractor* shall submit samples of the intumescent paint to be used for approval by the *Employer.*

The *Contractor* shall, as far as reasonably possible, ensure that the minimum number of joints are used. Only cable manufacturer-prescribed, SABS/SANS approved heat shrink joints shall be used, unless specific approval of a proposed alternative has been granted by the *Employer*. Should such joints be approved by the *Employer*, the *Contractor* shall provide proof in writing that all MV cable joints are approved by the cables OEM(s). All joints shall be fully functional and compatible with the cables to which they will connect.

The *Contractor* shall timeously notify the *Employer* of the dates upon which cable jointing is to be carried out, so that the necessary inspection can be arranged as required. Any cable joints not inspected by the *Employer* because of insufficient notice being given by the *Contractor* may be rejected and the *Employer* may order the *Contractor* to redo the cable joint at the *Contractor*'s expense.

Duly authorised representatives of the cables and joints OEM's shall also witness each MV joint undertaken and installed. Allowances for the aforementioned shall be made in the tender rates. Failure to comply with this requirement shall result in the *Contractor* having to redo the respective joint, or joints as applicable, at his own expense.

The jointing shall be installed in accordance with SANS 10198-11 and other applicable specifications, taking account also of the cable manufacturer's specifications and requirements for such terminations. The joints shall be capable of withstanding the same test voltages as the rest of the MV cable.

Joints shall be of the heat shrinkable type for 6.35/11 kV cable, or approved equivalent. The jointing kits shall be suitable for the specific application and shall consist of torque shear connectors. Crimping type connectors will not be accepted. Each kit shall be accompanied by an illustrated set of installation instructions and provided to the *Employer* for acceptance.

The joint shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing, which is heat-shrunk onto the respective insulating stages on the cores, is preferred above other methods.

Joints shall have traceable markings, indicating as a minimum the manufacturer's name, specific details of the product and the batch numbers. The full name, ID number and contact details of the individual installing the joints shall also be indicated on the termination. The *Contractor* shall present to the *Employer* samples of the wording, including the actual label, for approval.

Core identification shall be by shrink boot marker pencil. Insulation tape markings will not be accepted. All MV joints shall only be undertaken and installed by a person registered and approved as a MV joint installer by the manufacturer of the brand of the MV joints and cables used accordingly.

18.5 Labelling

Labelling of the MV cables, joints and terminations shall be by means of white Traffolyte labels, fastened by black UV resistant cable ties, with engraved black wording, sized accordingly for the specific application. All cabling shall, as a minimum, be labelled at both termination points.

Prior to fixing the labels, the *Contractor* shall present samples, including the wording, to the *Employer* for approval. The fixing positions of the labelling on the cables, joints and terminations shall be confirmed on-Site in conjunction with the *Employer*.

18.6 Testing

When cable reels are unrolled from the drums immediately prior to installation, the cables shall be tested to ensure electrical and structural integrity. The *Employer* may, at his sole discretion, request that appropriate tests be performed on the delivered cables to prove that no ingress of moisture or any other types of damage to the cables has occurred. Such tests will be at the expense of the *Contractor* and shall be provided for in the tendered rates.

During the commissioning stages all MV cables shall be tested to determine phase rotation, insulation and continuity, and to verify the correctness of all connections, along with any other tests required in accordance with the applicable SANS standards. Test certificates shall be issued to the *Employer* immediately after testing.

Further tests and/or information may be required by the *Employer* to demonstrate compliance with the relevant SANS standards or to verify the standards of materials and workmanship for the cables and cable systems. Allowance shall be made in the tendered rates for these tests.

All tests shall be carried out by competent persons using fit-for-purpose, correctly calibrated equipment.

The above requirements do not absolve the *Contractor* of his responsibility to ensure that all cables are tested in accordance with SANS 1339, SANS 10142-2, SANS 10198-13, other relevant standards and the requirements of this specification.

Note: Under no circumstances will DC Pressure/Over-voltage commissioning tests be allowed on XLPE cables, unless specific approval has been granted by the *Employer*. Only the following AC Pressure/Over-voltage commissioning tests will be allowed, unless otherwise instructed by the *Employer*:

- Sinusoidal VLF.
- Cosine rectangular VLF.
- Power frequency with a sinusoidal waveform of frequency in the range 20 Hz to 300 Hz.

Table 35: Commissioning Test Voltages for Newly Installed Individually Screened MV Cables

Cable Operating Voltage (kV)	VLF Test Voltage Sine (kV)	VLF Test Voltage Cosine Rectangular (kV)	Power-frequency Test Voltage (kV)
11	19	27	13

19.0 YARD CONDUCTORS, TUBULAR BUSBARS AND CLAMPS

Substation clamps are critical components within a substation, as they are generally connected in series with the current path. The reliability of the power network may be compromised by the failure of clamps that are not properly designed, manufactured or adequately tested to operate under normal and abnormal conditions.

This specification covers the requirements for clamps and connectors to be used in the new Main Intake Substation (Ystervark) and Iscor Substation. The specification applies to bolted-bolted and bolted-crimped type clamps/connectors, intended for electrical connections in the substations.

The overhead conductors at the HV section of the switchyard at the Main Intake Substation include the supply and installation of 415 mm² "Centipede" and 865 mm² "Bull" All Aluminium Conductor (AAC), as well as 120Ø x 4 mm wall thickness tubular busbar and associated clamps and connectors.

19.1 General

Aluminium or aluminium alloy clamps/connectors and conductors are required for the connections between various arrangements of stranded conductors, tubes, solid terminal stems and pads. McWade Productions (Pty) Ltd are the pre-approved supplier for these clamps. Should the *Contractor* wish to propose an alternative supplier, full details of comparative designs, functionalities, guarantees and the like shall be provided, including any further information required by the *Employer* to enable a full assessment of such an alternative supplier. Acceptance an alternative supplier will be at the sole discretion of the *Employer*.

The standard dimensions for items to be used for the *works* shall be as follows:

Table 36: Dimensions of Aluminium Conductors and Stems

Type	Diameter (mm)	Length (mm)	Remarks
Stranded All Aluminium Conductor	26.46 mm	-	Centipede
Stranded All Aluminium Conductor	38.34 mm	-	Bull
Aluminium Tubular Busbar	120 mm OD	12,2 m each unless otherwise indicated	4 mm Wall Thickness
Stems	26 mm	125 mm	-
	38 mm	125 mm	-
	60 mm	125 mm	-

19.2 Type 'EX' Clamps

The 'EX' clamp is a bolted-bolted 'cross' clamp and shall be configured so that connections can be made either inline or at an angle of 90° at either end of the clamp. The clamp section for bolting onto a solid stem shall be smooth machined, whilst the clamp section for bolting onto a stranded conductor shall be serrated machined.

'EX' clamps are generally only to be used in non-current carrying applications, e.g. for connections on support post insulators, voltage transformers and surge arresters. Each half-clamp shall be fitted with two independent clamping saddles.

Types, dimensions and ratings of 'EX' clamps are shown in Table 37.

Table 37: Bolted-Bolted Cross Clamps (Type EX)

Type Designation	Diameter (mm)		Rated Current (Arms)	Maximum Voltage (kVrms)
	A	B		
EX-B	26 mm	26.5 mm	900 A	300 kV

19.3 Type 'EXC' Clamps

These bolted-compression clamps are intended for making connections between a solid terminal stem and a stranded conductor. The bolted end (smooth machined) is intended for bolting to a solid stem, whilst the compression end is intended for crimping onto a stranded conductor. The bolted end shall be fitted with two independent clamping saddles.

Types, dimensions and current ratings of 'EXC' clamps are shown in Table 38.

Table 38: Bolted-Compression Clamps (Type EXC)

Type Designation	Equipment Terminal - A	Conductor Diameter (mm)	Angle of off-set	Rated Current (Arms)	Maximum Voltage (kVrms)
EXC-A	26 mm	26.5 mm	0º	900 A	300 kV
EXC-B	38 mm	26.5 mm	0º	900 A	300 kV

19.4 Type 'ETC' Clamps

These bolted "Tee"-compression clamps are intended for making connections from a stranded conductor "Run", which is under tension, onto a stranded conductor "Tee" connecting to equipment. The bolted "Run" section of these clamps shall be fitted with at least three independent clamping saddles.

Types, dimensions and ratings of 'ETC' clamps are shown in Table 39.

Table 39: Tee-Compression Clamps (Type ETC)

Type Designation	"A" - Run	"B" - Tap	Angle	Rated Current @ 90ºC (Arms)	Maximum Voltage (kVrms)
ETC-A	23,5 mm	26,5 mm	0º	650 A	300 kV
ETC-C	26,5 mm	26,5 mm	0º	900 A	300 kV
ETC-J	38,3 mm	26,5 mm	0º	900 A	300 kV

19.5 Type 'EY' Clamps

These clamps shall be of the bolted-bolted type designed for making a connection onto a single solid terminal stem from a pair of stranded conductors. These clamps can be used as a single tap off from a twin conductor bundle.

The clamps are used for both current-carrying applications (connections on current transformers and isolators) and non-current carrying applications (connections on support post insulators, voltage transformers and surge arresters). 'EY' clamps shall not be used on end connections. Two clamping saddles shall be provided for each connection.

Types, dimensions and ratings of 'EY' clamps are shown in Table 40.

Table 40: Bolted-Bolted Clamps (Type EY)

Type Designation	Equipment Terminal - A	Conductor Diameter (mm)	Angle of off-set	Rated Current (Arms)	Maximum Voltage (kVrms)
EY-B	38,3 mm	38,3 mm	0º	2500 A	420 kV
EY-H	26 mm	38,3 mm	0º	1000 A	420 kV

19.6 Type 'EYC' Clamps

These clamps shall be similar to the bolted-bolted 'EY' clamps. However, on the pair of stranded conductor side, the clamp section shall be a compression type with a 0°, 45° or 90° orientation. Two clamping saddles shall be provided for the bolted connection.

Types, dimensions and ratings of 'EYC' clamps are shown in Table 41.

Table 41: Bolted-Bolted Clamps (Type EYC)

Type Designation	Equipment Terminal 'A'	Conductor diameter (mm)	Angle	Rated Current @ 90ºC (Arms)	Maximum Voltage (kVrms)
EYC-B	38 mm	38,3 mm	0º	2500 A	400 kV
EYC-R	8 Bolt Pad to IEC 62271-301	38,3 mm	0º	2700 A	420 kV
EYC-S	8 Bolt Pad to IEC 62271-301	38,3 mm	45º	2700 A	420 kV

19.7 Type 'EPC' Clamps

Palm-compression clamps are intended for making connections from flat terminal pads onto single stranded conductors, the palm being bolted directly onto the terminal pad and the conductor end connected with a compression fitting.

Types, dimensions and ratings of 'EPC' clamps are shown in Table 42.

Table 42: Palm-Compression Clamps (Type EPC)

Type Designation	Conductor Diameter (mm)	Tube Outside Diameter	Angle of off-set	Rated Current (Arms)	Maximum Voltage (kVrms)
EPC-A	26,5 mm	4 x 14 Dia holes 50 x 50 Centres	0º	900 A	245 kV
EPC-B	26,5 mm	4 x 14 Dia holes 50 x 50 Centres	45º	900 A	245 kV
EPC-C	26,5 mm	4 x 14 Dia holes 50 x 50 Centres	90º	900 A	245 kV
EPC-26 (EEPC-A)	26,5 mm	26 mm PEG	0º	900 A	300 kV
EPC-38 (EEPC-B)	38,3 mm	38 mm PEG	0º	900 A	420 kV

19.8 Type 'ES' Spacers (Non-current Carrying)

Spacers are required to keep standard conductors at specified distances apart and shall be designed to withstand the forces that occur under wind and short circuit conditions.

Types, dimensions and ratings of 'ES' spacers are shown in Table 43.

Table 43: Spacers (Type ES)

Type Designation	Conductor Diameter (mm)	Spacing 'S' (mm)	Number of Conductors	Minimum Compression Forces (kN)
ES-B	38,3 mm	150 mm	2	8,5 kN

19.9 Type 'KCP' Clamps

The 'KCP' clamp is a bolted-PCD (directly mounted to post insulator) clamp and shall be such that connections can be made inline of the clamp. The clamp section for bolting onto the stranded conductor shall be serrated machined.

'KCP' clamps are generally only to be used in non-current carrying applications, e.g. through connections on support post insulators. Each half-clamp shall be fitted with two independent clamping saddles.

Types, dimensions and ratings of 'KCP' clamps are shown in Table 44.

Table 44: Bolted Conductor Clamp – Post Insulator Mounted (Type KCP)

Type Designation	Conductor Diameter (mm)	PCD (mm)
KCP-26/127	26,6 mm	127 mm

19.10 Type 'F-SUPT P' Clamps

The 'F-SUPT P' clamp is a bolted-PCD (directly mounted to post insulator) clamp and shall be such that connections can be made inline of the clamp. The clamp section for bolting onto the 2 x stranded conductor shall be serrated machined.

'F-SUPT P' clamps are generally only to be used in non-current carrying applications, e.g. through connections on support post insulators. Each half-clamp shall be fitted with two independent clamping saddles.

Types, dimensions and ratings of 'F-SUPT P' clamps are shown in Table 45.

Table 45: Bolted Conductor Clamp – Post Insulator Mounted (Type 'F-SUPT P)

Type Designation	Conductor Diameter (mm)	PCD (mm)
P38/127/150	2 x 38.3 mm	127 mm

19.11 Type 'ESC-PI-F' Tubular Clamps

The 'ESC-PI-F' clamp is a bolted tube to PCD (directly mounted to post insulator) clamp. The clamp is a fixed type, which does not allow for movement of the tube in the clamp. This clamp is normally used for a tube end section.

Types, dimensions and ratings of 'ESC-PI-F' clamps are shown in Table 46.

Table 46: Coupling Clamp – Post Insulator Mounted - Fixed (Type ESC-PI-F)

Type Designation	Tube Diameter "A" (mm)	PCD (mm)	Minimum Rated Current @ 90°C (A)	Maximum Voltage [Um] (kVrms)
ESC-PI-F-F	120 mm	127 mm	3150 A	145 kV

19.12 Type 'EEC-PI-FS' Tubular Clamps

The 'EEC-PI-FS' clamp is a bolted tube to PCD (directly mounted to post insulator) clamp. The clamp comprises of two parts, including a fixed type, which does not allow for movement of the clamp, and a sliding section, which makes allowance for tube movement. This is a current carrying clamp which connects two tube sections.

Types, dimensions and ratings of 'EEC-PI-FS' clamps are shown in Table 47.

Table 47: Expansion Clamp – Post Insulator Mounted – Fixed/Slide (Type EEC-PI-FS)

Type Designation	Tube Diameter "A" (mm)	PCD (mm)	Minimum Rated Current @ 90°C (A)	Maximum Voltage [Um] (kVrms)
EEC-PI-FS-F	120 mm	127 mm	3150 A	145 kV

19.13 Type 'ESC-PI-S' Tubular Clamps

The 'ESC-PI-S' clamp is a bolted tube to PCD (directly mounted to post insulator) clamp. The clamp is a sliding type, which allows for movement of the tube in the clamp. This clamp is normally used for a tube end section.

Types, dimensions and ratings of 'ESC-PI-S' clamps are shown in Table 48.

Table 48: Support Clamp – Post Insulator Mounted – Slide (Type ESC-PI-S)

Type Designation	Tube Diameter "A" (mm)	PCD (mm)	Minimum Rated Current @ 90°C (A)	Maximum Voltage [Um] (kVrms)
ESC-PI-S-F	120 mm	127 mm	3150 A	145 kV

19.14 Type 'EEC-PL' Tubular Clamps

The 'EEC-PL' clamp is a tube end cap, which is bolted to the inside of the tube at one end of the tube.

Types, dimensions and ratings of 'EEC-PL' clamps are shown in Table 49.

Table 49: End Cap Plain – Tubular Busbar (Type EEC-PL)

Type Designation	Tube Diameter "A" (mm)	Maximum Voltage [Um] (kVrms)
EEC-PL-C	120 mm	145 kV

19.15 Type 'EEC-DC' Tubular Clamps

The 'EEC-DC' clamp is a tube end cap, which is bolted to the inside of the tube at one end of the tube. This clamp includes a bolted connection for the damping conductor to be installed in the tubes.

Types, dimensions and ratings of 'EEC-DC' clamps are shown in Table 50.

Table 50: End Cap with Damping Conductor Fixing – Tubular Busbar (Type EEC-DC)

Type Designation	Tube Diameter "A" (mm)	Conductor Diameter "B"(mm)	Maximum Voltage [Um] (kVrms)
EEC-DC-C	120 mm	26 mm	145 kV

19.16 Type 'ETP-TE-IL2' Tubular Clamps

The 'ETP-TE-IL2' clamp is an inline tube bolted to twin conductor compression clamps.

Types, dimensions and ratings of 'ETP-TE-IL2' clamps are shown in Table 51.

Table 51: Clamp – Tube end Tap-off – Inline – Two Conductors (Type ETP-TE-IL2)

Type Designation	Tube Diameter "A" (mm)	Conductor Diameter (mm)	Conductor Spacing (mm)	Angle of off-set	Minimum Rated Current @ 90ºC (A)	Maximum Voltage [Um] (kVrms)
ETP-TE-IL2-F0	120	2 x 38 mm	150 mm	0º	2700 A	145 kV

19.17 Type 'ETP-IL1' Tubular Clamps

The 'ETP-IL1' clamp is a tap-off tube bolted to a single conductor compression clamp.

Types, dimensions and ratings of 'ETP-IL1' clamps are shown in Table 52.

Table 52: Clamp – Tap-off – Inline – One Conductor (Type ETP-IL1)

Type Designation	Tube Diameter "A" (mm)	Conductor Diameter (mm)	Minimum Rated Current @ 90ºC (A)	Maximum Voltage [Um] (kVrms)
ETP-IL1-H	120	1 x 26 mm	900 A	145 kV

19.18 Type 'ETP-IL2' Tubular Clamps

The 'ETP-IL2' clamp is a tap-off tube bolted to twin conductor compression clamps.

Types, dimensions and ratings of 'ETP-IL2' clamps are shown in Table 53.

Table 53: Clamp – Tap-off – Inline – Two Conductors (Type ETP-IL2)

Type Designation	Tube Diameter "A" (mm)	Conductor Diameter (mm)	Conductor Spacing (mm)	Angle of off-set	Minimum Rated Current @ 90ºC (A)	Maximum Voltage [Um] (kVrms)
ETP-IL2-T	120 mm	2 x 38 mm	150 mm	90º	2700 A	145 kV

19.19 Type 'ETP-PL-1H' Tubular Clamps

The 'ETP-PL-1H' clamp is a tap-off tube bolted to palm with a single hole clamp. This clamp is normally used to lug MV cables.

Types, dimensions and ratings of 'ETP-PL-1H' clamps are shown in Table 54.

Table 54: Clamp – Tap-off – Palm – Single Hole (Type ETP-PL-1H)

Type Designation	Tube Diameter "A" (mm)	Hole Diameter (mm)	Minimum Rated Current @ 90ºC (A)	Maximum Voltage [Um] (kVrms)
ETP-PL-1H	120 mm	1 x 14 mm	1350 A	145 kV

19.20 Technical Requirements

19.20.1 Tubular Busbars

The tubular busbars shall be aluminium alloy with the following technical requirements:

- Aluminium Alloy Tubing – Grade 6061-T6 (D65S).
- 120 mm Outside Diameter.
- 112 mm Inside Diameter.
- 4 mm Wall Thickness.
- Rated Current 2300 A.
- Centipede conductor shall be installed inside the tube for at least two-thirds of its length, to suppress Aeolian vibrations.
- The Centipede conductor shall be fixed to the end cap on one side only. One side of the bar shall have a sliding type clamp for expansion.

19.20.2 Clamps

19.20.2.1 Materials

All items shall be made of aluminium or aluminium alloys having characteristics that suit the particular application. The alloy, which must not contain more than 0.1 % Cu, must not be prone to stress corrosion, cracking or layer corrosion. The manufacturing method (e.g. cast or wrought) and the alloy must fulfil the requirements relating to tensile strength, hardness and resistivity. The clamp materials shall be resistant to atmospheric corrosion.

19.20.2.2 Machining

The contact areas of all clamps used for current-carrying purposes are to be machined to create true cylindrical surfaces. The contact surfaces of the current-carrying ends of the clamp, that bolt onto the stranded conductor, shall be grooved, with each end of the groove equipped with a so-called "serve spot" to allow easy embedding of the served stranded conductor. The manufacturer shall provide specially designed grooves or ridges on the contact surface. Pads are to be serrated machined. The surfaces that interface with solid cylindrical conductors, e.g. aluminium tubes, shall be smooth machined.

The damage caused to the conductor by the clamps, e.g. by grooves that cut into the conductor, shall be such that the conductor strength is not reduced to less than 90 % of the ultimate strength, nor shall the electrical conductance be impaired.

19.20.2.3 Bolted Connections

Bolted clamps shall be equipped with two or more independent saddles, in accordance with the specified requirements. Bolts shall have hexagonal heads and shall be made from hot-spun galvanised high tensile steel (Grade 8.8), unless otherwise specified. Bolts shall be of a quality that enables the required torque levels to be achieved without compromising the clamp contact surface pressure.

The specific mounting force shall not be less than 120 N per transmitted ampere in the case of stranded conductors.

No bolt shall have a diameter of less than 10 mm, unless otherwise approved. The design torque that is to be applied to the bolts for optimum performance shall be adhered to, as well as the minimum torque at which operation is guaranteed.

Flat washers shall be provided under the bolt head only if the bolt head is free to move and captive nuts are provided. Alternatively, if captive bolts are provided and the nuts are free to move, flat washers shall be provided under the nut. Spring washers are not required.

After the bolts have been tightened, the gap between the saddle and the clamp body shall be not less than 2 mm.

The maximum tightening torque on bolts shall be as follows:

- Not exceed 75 Nm.
- Not exceed 50 % of the value at which fracture of permanent distortion of the bolts, or fracture of the clamp, occurs. Bolt fracture shall occur before the threads strip.
- The maximum specific surface pressure under flat washers shall not exceed 120 N/mm².

19.20.2.4 Compression Connections

A compression clamp shall be any conductor clamp requiring a compression tool capable of exerting a compressive force sufficient to deform the clamp sleeve and all layers of the conductor so that an electrical and mechanical joint is achieved.

Welding of compression sleeves onto clamp bodies shall be of a quality and type that will ensure “fusing” between the materials. Welding jigs shall be used to ensure correct alignment of the sleeves. If line boring or drilling techniques are used in the manufacture of the sleeves, the tolerance on the wall thickness shall not exceed 5%. The compression sleeves shall be manufactured from extruded tubing having bore sizes to suit conductors, as shown in Table 55.

Table 55: Conductor Maximum and Minimum Diameter

Conductor	Minimum Diameter (mm)	Maximum Diameter (mm)
Centipede (400 mm²)	26,46 mm	26,73 mm
Bull (865 mm²)	38.25 mm	38.63 mm

19.20.2.5 Electrical Joint Compound

The *Contractor* shall submit, for approval by the *Employer*, particulars of the proposed cleaning treatment to be adopted, the type of compound to be used and its properties, which shall be designed to minimise contact resistance due to oxidation of the aluminium surfaces. The following details shall be provided:

- Temperature rating, particularly under short-circuit conditions.
- Degree of adhesion.
- Performance in wet or salt-water conditions.
- Suitability for use in bolted and / or compression clamps.
- Need for replenishment.
- Availability and sources of supply.

All compression clamp sleeves shall be pre-greased and the conductor opening shall have a dust cap applied.

19.20.2.6 Current Rating

The clamps and connectors shall be capable of continuously carrying the current as specified, without exceeding a temperature rise of 30 ºC above an ambient temperature of 45 ºC. When a connection is made between two conductors of different sizes, the current rating of the current-carrying clamps/ connectors used must exceed that of the highest rated conductor.

19.20.2.7 Corona Characteristics

The clamp/connector assemblies shall be capable of operating at the stipulated voltages (U_m) without any signs of visible corona, at altitudes of up to and including 1800 m.

20.0 EARTHING

The earthing of the equipment shall comply with the relevant Eskom earthing standards. The substation earthing is covered within the Low Voltage Installation Specifications.

21.0 FIRE STOPPING

The *Contractor* shall employ suitable fire stopping methods as stipulated in these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer's* specifications or any other applicable standards and documents pertaining to the *works*.

All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and approved standards. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localised and contained and not propagate via any electrical and/or electronic infrastructure. The *Contractor* shall fully comply with these requirements.

22.0 CORROSION PROTECTION

22.1 General

Corrosion protection of steel materials shall be as per these specifications, the *Employer's* standards and applicable minimum requirements included in the relevant SANS standards and specifications. The protection of the specified steel materials shall make allowance for the harsh, coastal environment at the Site.

Any equipment not strictly complying with the above requirements shall be rejected. The *Contractor* shall furnish written confirmation that all equipment complies with the specifications. Should the *Contractor* fail to furnish such confirmation, the *Employer* reserves the right to reject the equipment.

22.2 Galvanic Corrosion Protection

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer.*

The table below provides a general indication of which metals can be connected to each other without the need of special measures to avoid corrosive interaction, and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The table below is intended as a guide only. The responsibility will remain with the *Contractor* to avoid bimetal/galvanic corrosion between different metal equipment.

Table 56: Combination of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	StSt	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Copper	Not Permissible	Not Permissible	Permissible	Permissible	Not Permissible	Permissible
StSt	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

Where equipment has been exothermically welded together, 3 thick layers of bitumen shall be applied afterwards, unless otherwise specified by the *Employer.*

23.0 WILDLIFE AND ASSET PROTECTION

The *Employer* may instruct the *Contractor* to provide wildlife and asset protection equipment to mitigate adverse impacts on the local wildlife and to protect the outdoor yard equipment. Provision is made in the bill of quantities for the following provisional items:

- Medium voltage fusion tape.
- Medium voltage conductor cover for outage prevention.

A final decision and instructions for the supply and installation of this equipment by the *Contractor* will be issued during the construction stage.

24.0 LABELLING

All respective high and medium voltage installations shall be labelled in accordance with these specifications, drawings, *Employer* standards and, where applicable, Eskom requirements, unless otherwise specified or instructed.

The *Contractor* shall submit label samples and schedules to the *Employer* for approval prior to manufacture. The necessary allowances shall be made in the tender rates.

25.0 PACKAGING, TRANSPORTATION AND HANDLING

The following general items are applicable to all equipment forming part of the *works:*

- If any equipment requires maintenance or attention during storage, this shall be clearly stated and the *Employer* shall be made aware of this requirement.
- Crates supplied for transport shall be suitable for Site storage for a period up to 6 months.
- The *Contractor* shall be responsible for the transportation and off-loading from the OEM premises to offloading of the equipment on Site. Off-loading includes transportation from the point of off-loading the equipment on Site after transportation to the point of final installation.

25.1 Transformers

Impact recorders shall be installed during transportation. The impact recorder report shall be provided to the *Employer* and shall include written confirmation that the vibration caused by transport has not damaged the transformer in any way and has not invalidated the warranty or the factory test results.

The *Contractor* shall be responsible for providing the recorder and for recording the results, together with an interpretation of the results.

An impact recorder shall be attached to each transformer being transported. The impact recorder shall provide a continuous recording of the acceleration of the transformer in three directions, perpendicular to each other. The main direction shall be in the direction of transport.

Recording shall start before lifting of the transformers at the OEM premises and shall continue uninterruptedly, until the transformers are off-loaded on Site. The traces shall be inspected as part of the quality control processes.

The acceleration limit in any direction shall be 2 g. The *Employer* shall be notified if this limit is exceeded.

Where sea transport is required, the *Contractor* shall make all necessary arrangements for suitable slings and apparatus to be available for off-loading at the quayside.

25.2 11 kV Series Reactors

The reactor shall be placed in a non-returnable crate, suitable for handling by overhead crane and forklift truck. The crate shall bear permanent markings for: “correct side up”, “centre of gravity”, “sling connections” and “total weight” (crate and reactor).

The crate shall be constructed of a material that is suitable for long-term (> 10 years), outdoor storage. Any special storage and maintenance requirements shall be specified.

25.3 Medium Voltage Switchgear

The switchgear panels shall be suitable for handling and removal and shall include mechanism for lifting by crane hooks without causing any damage. The electrical components shall be packaged so that any damage during transportation is prevented. The components of the switchgear shall be clearly marked, to be readily identifiable.

25.4 132 kV and 66 kV Post Insulators

The insulators shall be packaged in robust wooden crates, individually protected and suitably supported, in order to protect the insulators from abnormal stresses during transport and handling between the point of despatch and the point of final installation. The crates shall be designed so that inspections can be undertaken without damaging the crate.

The lifting points shall be clearly marked on the crates and fixtures for the attachment of lifting hooks and/or slings shall be provided. Any special handling and storage requirements shall be clearly indicated on the packaging and shall be communicated by the OEM to the *Contractor* prior to delivery.

The packaging shall not disintegrate due to exposure to rain or direct sunlight during outdoor storage and shall have a durability of at least 18 months.

If insulators are packed in boxes or crates on pallets, the gross weight of the pallets shall not exceed 1800 kg. Pallets shall be suitable for handling by forklift trucks, capable of lifting from both sides. Each pallet shall be fitted with a shock indicator to indicate if the pallet was subjected to high impacts during transit.

25.5 132 kV Isolator

The equipment shall be designed, manufactured and packaged to allow for any conditions that may arise during shipping and handling, including corrosion of exposed parts. The *Contractor*/OEM shall demonstrate the effectiveness of these measures by performing the following tests:

- Shipping test: this test shall cover all the conditions to be encountered during transportation from factory to the designated Site, including loading/off-loading from one mode of transport to another.
- Vibration test: this test shall be used to supplement actual shipping tests to check for unexpected shortcomings in the equipment and packaging.
- Weather-proof test: this test shall demonstrate the adequacy of the packaging to prevent ingress of moisture and water from weather or sea conditions.

Should the *Contractor*/OEM provide conclusive evidence that demonstrates the effectiveness of prior equipment designs and precautionary measures for shipping, as outlined above, the above tests may be waived at the *Employer's* sole discretion.

26.0 SPARES, TOOLS AND CONSUMABLES

The *Contractor* shall provide critical and recommended spares, as prescribed by the specialist subcontractors/OEMs, for all systems, including, but not limited to, transformers, isolators, switchgear, cables, outdoor circuit breakers, surge arresters, insulators and all other relevant equipment.

26.1 Spares, Tools and Consumables required prior to Final Handover

The *Contractor* shall supply all spares that are required for start-up and commissioning purposes and for the 12-month period after commissioning, as recommended by the specialist subcontractors/OEMs. This shall include, but not be limited to, spares for transformers, MV switchgear, HV equipment and the like. A comprehensive list, including comprehensive technical data, shall be provided to the *Employer* for all spares that are provided.

The *Contractor* shall also supply all consumables required within 12 months after commissioning and any special maintenance tools, defined as tools that are not readily available from commercial tool suppliers.

Prior to placement of orders, the *Contractor* shall submit his proposed list of spares, consumables and tools to the *Employer* for his review and approval.

Each spare part shall be properly tagged with a weatherproof label, showing the manufacturer's unique part number, description of the part and expiry date for parts having a limited shelf life. Small items with the same part numbers shall be tagged and packed together in a plastic bag or box. The tag shall also be shown on the outside of the bag or box.

The cost of the above spares, consumables and tools shall be included in the rates tendered by the *Contractor*.

26.2 Spares required after Final Handover

The *Contractor* shall also provide to the *Employer* a list of all critical and recommended spares as recommended by the specialist subcontractor/OEMs, which shall cover the operational requirements after final handover of the *works*. These lists shall include the following:

- Description of spare part.
- Supplier contact details.
- Suggested stock levels.
- Prices.
- Lead-times for ordering and delivery of such spares.

26.3 Transformers

Any special tools required for the installation, maintenance, and dismantling of the equipment shall be furnished with the transformer. All tools shall be in new and unused condition and shall become the property of the *Employer.*

Any accessories and/or appliances that are regularly furnished with this class of apparatus or that are necessary for satisfactory operation or servicing thereof and not specifically listed herein shall also be furnished.

All spare parts and spare materials shall be furnished and delivered in heavily constructed wooden boxes with hinged covers. The spare parts and special tools shall be protected from damage due to moisture and dirt accumulation during an extended storage period by use of special coatings, airtight bags and the like.

27.0 O&M MANUALS, TRAINING AND BACK-UP SUPPORT

The *Contractor* shall compile a complete operations and maintenance manual (O&M) for all electrical and electronic installations. Information to be provided as part of the O&M manual(s) shall include, but not be limited to, comprehensive documentation for the operation and maintenance of the equipment as well as all equipment guarantees.

The *Contractor* shall also arrange certified/accredited operational and maintenance training for all systems by the OEMs, for the *Employer's* selected staff. The training shall be undertaken directly after the commissioning of the systems. The *Employer* will confirm the dates and locations for such training.

The *Contractor* shall also provide local operational and maintenance back-up support services to the *Employer*, during the defects and liability period.

27.1 O&M Manuals

Technical, training, maintenance and operating manuals shall be provided for each type and model of equipment. Technical manuals shall include all technical data, construction information, data sheets and leaflets for each individual component that is included with the equipment as provided. Where generic manuals are provided, an addendum shall be provided, indicating the applicable project-specific components. Manuals shall be of a good quality and shall, as a minimum, cover the following:

- Technical descriptions of the equipment and component parts.
- General arrangement drawings.
- Installation instructions with drawings or illustrations.
- Operating and maintenance instructions for all components.
- Detailed parts lists (accompanied by exploded view type drawings clearly detailing the part and its unique identification).
- Spare part ordering instructions.

Any special instructions pertaining to storage of spare parts or their shelf life shall be included in the maintenance manual.

Comprehensive drawings as may be required for component location, dismantling and re-assembly for maintenance purposes shall be included in the maintenance manual.

All special tools required for operating and maintenance of the equipment shall be presented in the form of a schedule in the operating and maintenance manual.

The content of the training manual shall be based on the content of the technical, operating and maintenance manuals.

The *Contractor* shall provide a recommended spare parts list with part descriptions/numbers.

27.2 Switchgear O&M Manuals

The O&M manual(s) for the switchgear shall cover the transport, storage, installation, operation and maintenance of the switchgear, in accordance with the following general requirements:

- The manuals shall be in the English language.
- The manuals shall be specifically compiled for the circuit-breakers that have been supplied and installed.
- Torque wrench settings, clearances, as well as other important settings and information, shall be listed.
- Typical operating times, speed curves and tolerances in synchronism shall be clearly indicated.
- Clear, easily comprehensible descriptions of the operation of the equipment, including appropriate diagrams and descriptions, shall be provided.
- Clear instructions, covering routine inspection, minor and major maintenance procedures, shall be provided, together with a list of lubricants, recommended spares, special tools and the like.
- The manuals shall include high-quality diagrams, showing details of the operating components of the circuit-breakers. Each component shown on the diagrams shall be clearly identified.
- Seals and gaskets requiring replacement during overhaul shall be detailed and the suppliers of these components, together with the part number(s), shall be listed.

- The names and addresses of suppliers of lubricants, oils, gases, compounds and the like shall be listed.

The scope and format of the manuals shall be as follows:

27.2.1 General

- Title page, to include title of equipment, equipment ratings, contract and order numbers, as well as supplier's reference numbers. This information shall also appear on the outside of the binder and on the first page.
- Table of contents: the manual shall be sectionalised and sequentially numbered.
- Equipment make and type.
- List of all drawings, by number and title.
- Description and summary of switchgear and circuit-breaker operation.
- Full details of method adopted for anti-pumping.
- Schematic wiring diagrams of switchgear.

27.2.2 Transport and Storage Instructions

- Packaging requirements.
- Transport instructions.
- Storage instructions, including any special requirements for equipment storage.
- Measures to ensure that all the manufacturer's transportation and storage requirements are met.

27.2.3 Installation Instructions

- Complete step-by-step instructions and detailed drawings, including alignment, installation and dimensional tolerances for preparing the equipment for service.
- Inspection procedures before and after unloading, pre-installation tests, gas-filling and monitoring procedures.
- Levels of expertise required for the O&M team.
- List of special equipment and tools required for unloading and positioning components of the switchgear on Site.
- Tolerances for field assembly.

The supplier shall supply a DVD to supplement installation information given in the installation manual. This visual information may be provided separately or may form part of the maintenance DVD required.

27.2.4 Testing

- Functional testing, dielectric testing, operating instructions, operating limits and starting-up instructions (complete with sketches or drawings).
- Separate set of record sheets, showing measurements and tolerances for each test for separate items of equipment.

27.3 Training

The *Contractor* shall provide training for the *Employer* owned and operated HV and MV equipment. Training covering the equipment within the Ystervark (Eskom) portion of the Main Intake Substation is not required.

The *Contractor* shall provide training covering all MV Switchgear included in the *works,* to be provided for the various categories of the *Employer's* technical staff (operators, maintenance and engineering personnel).

Training provided by the *Contractor* shall be specific to the actual equipment supplied and installed as part of the *works*. Generalised training based on similar equipment is not acceptable.

The *Employer* will provide a suitably sized air-conditioned room for training purposes, as well as trainee and trainer desks, overhead projector and flipchart or white board.

The emphasis shall be on practical hands-on training for each individual trainee. The scope of the training shall include, but not be limited to, the following:

27.3.1 Training of Maintenance Personnel

Maintenance personnel shall be trained in all components and functions of the switchgear, i.e. method of maintenance, fault finding, correction and routine maintenance, including frequency and methods of lubrication. Training will include familiarisation with documentation (maintenance plan, procedures and the like), hardware familiarisation and maintenance, maintenance of protection, control and instrumentation equipment. Maintenance training shall be provided prior to the installation of the switchboards.

27.3.2 Training of Operators

Operators shall be trained and certified as being competent to operate the new systems prior to the equipment being dispatched from the factory. This will include familiarisation with documentation, including drawing configuration logic, as well as operator interface familiarisation, e.g. operational functions, alarms and the like. The *Contractor* shall make allowances for the training of all operators.

27.3.3 Engineering Training

Formal, upfront engineering training shall be provided to cover basic switchgear design, capabilities and procedures, prior to design freeze.

Thereafter on-the-job training shall be provided, extending through the design stage up to final commissioning and handover. The design and control/interface functions shall be covered during this training, to enable the ***Employer's*** engineering team to fully understand the operation and maintenance of the equipment prior to FAT's of the first switchboards.

The ***Employer's*** engineering team will be in attendance throughout the installation and commissioning stages of the *works*. The *Contractor* shall accord the ***Employer's*** engineering team full access to the *works* and shall provide formal training and ad-hoc mentoring to ensure a seamless handover upon completion of the *works*.

27.4 Back-Up Support

Back-up support services, including the provision of on-Site technical support by the specialist subcontractors/OEMs for all installations and equipment, shall be available 24 hours a day, 7 days a week. Contact details for the companies and persons providing these support services shall be provided to the *Employer*. Payment for such back-up support will be subject to the relevant provisions of the contract.

28.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

All documentation, including reports, manuals and the like, shall be in the English language.

29.0 INSPECTIONS, TESTING AND COMMISSIONING

29.1 General

All materials, equipment and components supplied and installed as part of the *works* shall be new, with high reliability, a proven operating history and shall incorporate state of the art engineering and manufacture.

Cognisance shall be taken of the prevailing climatic and environmental conditions and thermal variations arising under operating conditions. The equipment shall be designed and installed to withstand these conditions without distortion, deterioration, undue stresses and strains and the like.

The *Contractor* shall develop quality control procedures, test plans and the like, and shall provide all necessary resources for the management and implementation of these procedures and plans, in accordance with the general requirements as set forth in the accompanying Works Information. The further requirements as detailed below shall form an integral part of these quality management procedures.

All testing and commissioning shall be in accordance with these specifications, all relevant regulatory standards, industry best practices, *Employer* requirements and the like.

The *Contractor* shall supply, operate and maintain all equipment and instruments required to perform all tests, inspections and commissioning, which shall only be undertaken by suitably qualified, experienced and competent persons to be appointed by the *Contractor*, using only fit-for-purpose, correctly calibrated equipment.

The *Employer* may at his discretion instruct the *Contractor* to perform additional testing and/or commissioning activities, as well as provide any additional information as required to prove the functionality and compliance of the units. Allowances shall be made by the *Contractor* in the scheduled rates included in the bill of quantities for such tests.

Should the *Contractor* fail to perform any test or properly commission equipment supplied and installed by the *Contractor*, or should any item of equipment or part of the installations fail any test or commissioning inspection, the *Employer* reserves the right to recover from the *Contractor* any reasonable cost to himself to witness the repeat of such test or commissioning.

The notice period and date(s) to be provided by the *Contractor* to the *Employer* for witnessing any testing or commissioning activities shall be as stipulated in the *Contractor* Document Schedule, unless otherwise instructed or specified.

The *Contractor* shall rectify any defects noted during the final inspection prior to final hand-over.

29.2 Quality Control Plans

The *Contractor* shall compile and submit comprehensive quality control documentation, including quality control plans (QCPs). The QCPs shall cover the design, fabrication, transport, installation and commissioning of equipment and shall include hold points for the inspection, witnessing and approvals to be undertaken by the *Employer*. These QCPs shall be subject to review and approval by the *Employer*, who may also add further hold points as deemed appropriate.

The *Contractor* is advised to timeously submit all quality control documentation, including QCPs, to the *Employer* for review and approval, prior to commencement of the *works*, to prevent subsequent delays in the inspection and approval processes. Any delays in this regard will be to the *Contractor's* account. Reference is made also to the submittal processes as detailed in the Works Information. The scope of QCPs to be submitted shall include, but is not limited to, the following:

- Design reviews.
- Type testing approval.
- Factory acceptance testing (FAT).
- Transport and delivery to Site.
- Erection and installation.
- Site acceptance testing (SAT).
- Manuals and drawings.
- Commissioning.

29.3 Test Equipment and Certificates

Test and commissioning reports and/or certificates shall be issued for all tests and commissioning that is conducted by the *Contractor*. These certificates shall be signed by the *Contractor* and the manufacturer/ test laboratory (as applicable). The number of copies to be issued to the *Employer* shall be as per the *Contractor* Document Schedule and these specifications.

Test certificates to be provided include, but are not limited to, the following:

- Compaction tests on backfilled trenches.
- All earth resistance and continuity tests.
- Lightning protection testing and measurements.
- Lighting test certificates.
- Certificates for integration tests.
- All tests in accordance with SANS 10142-2.
- Certificates of Compliance.

29.4 Site Inspections

During construction, the *Contractor* shall notify the *Employer* at least seven (7) working days in advance of the dates for Site inspections. These shall include, but not be limited to:

- Inspection of cable trenches after excavation and prior to the installation of bedding material and/or cables.
- Inspection of cable trenches after installation of bedding material and prior to the installation of cables.
- Compaction tests on backfilled trenches.
- Testing of cable polarity and insulation resistance.
- All further cable tests as described in these specifications.
- All earth resistance and continuity tests.

The *Contractor* shall at all times provide unimpeded access to the *Employer* to monitor the *works* and to attend or witness any test or event as may be required by the *Employer*.

29.5 Cable Testing

Prior to cables being unrolled from the drums for installation, they shall be tested to ensure electrical and structural integrity.

The *Contractor* shall undertake and compile records of all tests which are to be conducted for all cables. The *Employer* shall be given adequate prior notice and shall be afforded the opportunity of witnessing such tests at his discretion.

Certificates with the following minimum information shall be issued to the *Employer* immediately after tests:

- Verification that all cables are correctly connected.
- Phase rotation.
- Insulation resistance test.
- Continuity test, including test between core to core and core to earth.
- Floating earth test for IS loops.
- Continuity test for shields and earthing.
- Loop resistance test.

The *Contractor* shall also ensure that all cables are tested in accordance with SANS 10142-1 and SANS 10198-13 etc.

29.6 Inspection and Testing of Electrical Equipment

The following procedures shall apply to the approval, manufacture and inspections of electrical equipment:

29.6.1 Preparations for Inspections and Testing of Electrical Equipment

Preparations for inspections and testing of electrical equipment shall be undertaken as follows:

- *Contractor* shall appoint a specialist subcontractor/OEM to fabricate, supply and install (if so instructed by the *Contractor*) the electrical equipment.
- The *Contractor* provides the project and technical requirements to the specialist subcontractor/ OEM.
- The specialist subcontractor/OEM undertakes the design of the equipment/systems and submits drawings plus any other associated technical information for approval to the *Contractor*. Under no circumstances will the *Employer* enter into any direct discussions with the OEM. All communication with the OEM shall be via the *Contractor* only.
- *Contractor* checks the drawings and associated technical information as provided, for compliance with all the requirements of the specifications, Works Information, drawings and the like and submits three copies, signed off as checked, to the *Employer* for approval.
- *Employer* returns two copies as approved, or for resubmission, to the *Contractor*.
- Manufacture of equipment commences after approval of the drawings by the *Employer*.

29.6.2 Factory Acceptance Testing (FAT)

Factory acceptance testing shall follow the following process:

- FATs shall be undertaken prior to shipment of equipment to Site, to demonstrate the functionality of the equipment.
- The *Contractor* shall ensure that a full copy of the specifications and approved signed copies of the drawings are at hand during all inspections.
- *Contractor* checks and inspects the manufactured equipment/systems at the specialist subcontractor/ OEMs premises during all stages, including prior to FATs testing and delivery to Site.
- *Contractor* presents the *Employer* with written confirmation that the equipment/systems are in full compliance with the project requirements and have been checked, inspected and fully tested. This confirmation, signed and dated by both the *Contractor* and the specialist subcontractor/OEM, is to accompany a written request for the *Employer* to witness the FATs.
- The *Contractor* shall provide the *Employer* with at least two weeks' notice prior to such FATs inspections.
- During the *Employer's* inspections, a fault list shall, if necessary, be drawn up and handed to the *Contractor.* The *Employer* shall be given unencumbered access to inspect all equipment and panels prior to and during FATs testing and manufacture.
- After satisfactory rectification of the fault list, and subsequent to re-inspection and acceptance by the *Contractor* and *Employer*, the *Contractor* shall present to the *Employer* written confirmation that the equipment is in full compliance with the specification. The boards may then be dispatched to Site.
- The *Employer* shall be provided with copies of all signed-off FAT documentation.

Notwithstanding the routine tests included in this specification, the following but not limited to, tests and checks will be conducted by the *Contractor*:

- Visual inspections to verify the mechanical and/or physical integrity of the plant and compliance with the specifications for the major and/or active components.
- A check of all nameplates and connections shall be undertaken.
- Dielectric test of current transformers, voltage transformers, auxiliary wiring and control circuitry.
- Current transformer test to prove the ratio, polarity, resistance and magnetising curves.
- Voltage transformer test to prove the ratio and polarity.
- Functional circuit breaker and motor switching device tests to check operation of auxiliary contacts, relay coils, trip and close circuitry, spring rewind motor and circuitry and the indication circuitry.
- Checks include MCB ratings, labelling, ferrule numbers, crimping and tightness of all connections including lugs.
- Checking mechanical tripping and closing devices, mechanical spring rewind and all mechanical interlocks.
- Manual electrical operation test of the circuit breakers and motor switching devices including checks of electrical interlocks (if applicable).

- Verification of the functionality of the different circuit protection schemes integrated in the MV switchboards. The verification to include continuity checks on the circuits.
- Verification of the functionality of the different components and systems.

29.6.3 Site Acceptance Tests (SAT)

Site acceptance tests (SAT) shall be conducted to demonstrate that the equipment is operational after transportation and to certify that any changes agreed to at the FATs have been properly implemented. The following further procedures shall apply:

- Upon delivery to Site of the equipment/systems, the *Contractor* shall request the *Employer* in writing to witness the SATs, as applicable.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval by the *Employer*, the equipment/systems may be installed.
- After the tests, written confirmation by the *Contractor* shall be provided to the *Employer* that the equipment/systems are in full compliance. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.

29.6.4 Commissioning Inspections

- Once the equipment has been installed, tested for complete functionality, operability and compliance, the *Contractor* shall request the *Employer* in writing to witness the commissioning of the installed equipment/systems.
- The installed equipment/systems shall be re-tested during commissioning, so that the *Employer* may verify the functionality, operability and compliance requirements. A fault list shall, if necessary, be drawn up by the *Employer* and handed to the *Contractor.*
- Should the *Employer* determine that the final product does not fully meet the project requirements, functionality, operability and/or compliance requirements, the *Contractor* shall undertake the necessary repairs and re-testing, all at his own expense.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval received from the *Employer*, the equipment/systems shall be formally handed over to the *Employer*.
- After successful installation and testing, and upon approval by the *Employer,* written confirmation shall be provided by the *Contractor* to the *Employer* that the equipment/systems are in full compliance and have been commissioned correctly. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.

29.7 Final Testing and Commissioning

Prior to practical completion and handover of the *works*, the *Contractor* shall arrange a final inspection with the *Employer*.

The *Contractor* shall give at least fourteen (14) working days' notice of the date of the final inspection, unless otherwise instructed or specified. Documentation to be submitted by the *Contractor* to the *Employer* at the final inspection shall include, but not be limited to, the following:

- O&M manuals.
- Compaction test certificates.
- Results of polarity and insulation tests, including test voltage, time duration, insulation resistance, leakage current and the like.
- Results of earth resistance and continuity tests.
- Lightning safety reports.
- As-built documentation and drawings.
- Certificate of Compliance(s).
- Final readings of all kWh meters.
- SABS/SANS approval documentation for light fittings.

The *Contractor* shall rectify any defects noted during the inspection prior to the hand-over inspection.

30.0 HANDOVER DOCUMENTATION

30.1 As Built Documentation

30.1.1 General

The *Contractor* shall maintain records and prepare as-built documentation for all design documents, drawings, quality control records, tests, pre-commissioning reports, commissioning reports, operation and maintenance manuals and the like. The as-built documents shall be comprehensive and shall demonstrate compliance with the project specifications and drawings. Reference shall also be made to the further requirements as detailed in the accompanying Works Information. The following details shall apply:

- The scope and format, including the required indexing, of the "as-constructed" information shall be discussed and agreed with the *Employer* prior to compilation and submission of the final documentation.
- All as-built documents shall be signed off by the *Contractor* and submitted to the *Employer* for approval, as these are developed and at completion of the *works*.
- All as-built documents shall be furnished to the *Employer* in both hard and soft copy formats.
- As-built documents shall be submitted as per the requirements as set out in the *Contractor* Document Schedule, appended to the accompanying Works Information, and the further requirements as detailed below.

The information to be submitted shall include, but not be limited to, the following:

30.1.2 As-Built Drawings

During construction the *Contractor* shall keep a separate set of project drawings for marking up changes to the original design as the *works* progress. All mark-ups shall be drafted with the revision status clearly indicated. These drawings shall include the drawings issued by the *Employer* as well as any drawings compiled by the *Contractor*/OEM.

The *Contractor* shall meticulously and regularly mark up all relevant as-built information on the dedicated set of drawings.

Positions of equipment shall be measured and given from fixed reference points such as kerbs, erf pegs, building grid lines and the like. As-built drawings shall reflect the actual lengths, positions and quantities of all associated equipment.

The final, as-constructed drawings shall be signed off by the *Contractor* and submitted to the *Employer* for approval at completion of the *works*. Software copies of the as-built drawings shall be as specified in the contract documentation.

30.1.3 Data Packs

Data packs for all equipment and materials shall be provided by the *Contractor* in electronic and hard-copy format and shall be neatly indexed and referenced to facilitate easy navigation by the *Employer* between documents. This shall include, but not be limited to, the following:

- Final design calculations, including native software files if applicable.
- All test certificates.
- Type test and routine test certificates.
- Results of polarity and insulation tests, including test voltage, time duration, insulation resistance, leakage current and the like.
- Results of earth resistance and continuity tests.
- Certificates of Compliance.
- Other SANS certificates, where appropriate.
- Manufacturers' manuals.
- Equipment specification sheets.
- Wiring diagrams.

- Equipment and material installation standards applicable to the relevant equipment or material supply.
- All calibration certificates.
- Material certificates.
- All test and calibration certificates.

30.1.4 Other As-Built Documentation

The following further information shall be provided:

- Comprehensive operation and maintenance manuals, as detailed below.
- Health and safety records.
- Copies of final configured software programmes of equipment/systems.
- All equipment guarantees, which shall be ceded to the *Employer* upon completion of the *works*.
- All software licences and programming of software, which shall be ceded to the *Employer* upon completion of the *works*.
- List of recommended, and if applicable critical, spare parts lists, including suggested stock levels.

30.2 Operation and Maintenance Manuals

Prior to the final inspection the *Contractor* shall compile complete operation and maintenance (O&M) manuals for all electrical and electronic installations, which shall include, but not be limited to, the following equipment and installations:

- MV switchgear.
- Dry-type transformers.
- Oil-filled power transformers.
- Voltage and current transformers.
- 132 kV and 66 kV circuit breakers.
- 132 kV isolators.
- NECRT's.
- All other relevant equipment.

The indexing and format of these manuals shall be subject to approval by the *Employer*.

30.3 Operation and Maintenance DVD

It is anticipated that maintenance intervals for the MV switchgear circuit-breakers will be very long, i.e. several years. The instruction manuals shall therefore be supplemented and supported by a maintenance-orientated video recording. The video recording shall be converted into a suitable DVD format.

A written commitment from the supplier regarding the submission of the DVD shall be provided with the tender documentation. The DVD shall be supplied after approval of the operating and maintenance manuals by the *Employer*.

The DVD shall provide a record of the maintenance requirements and procedures for the equipment supplied. The DVD and related operating and maintenance manuals shall be detailed enough to enable a trained maintenance crew, with some general knowledge of the equipment, to perform all inspections and maintenance required on the equipment. The operating and maintenance manuals shall list the maintenance activities that are required. The DVD shall show how such maintenance is achieved.

30.4 Eskom Handover Documentation

The *Contractor* shall provide all the relevant information required in Eskom Document No 34-1238, including any associated others if so required by Eskom. The *Contractor* shall provide all requested technical information as required by the relevant Eskom standards for all the HV equipment installed within the Eskom portion of the Main Intake Substation (Ystervark).

30.5 Document Storage

The following records shall be safely stored by the *Contractor* for a minimum period of seven years following final completion of the *works*:

- Construction, layout and component approvals.
- Type and routine test certificates.
- Construction drawings and approvals.

After expiry of this period the *Contractor* shall notify the *Employer* (in writing), who will advise on the retrieval or disposal of this information.

31.0 MEASUREMENT AND PAYMENT

31.1 General

The tendered rates shall be deemed to include all and every cost item required for the completion, handover and commissioning of the scope of the *works* in full compliance with these specifications, the Works Information and the drawings, including, but not limited to, the following:

- Design (including shop drawings), supply and installation of all transformers, medium voltage switchgear, outdoor circuit breakers, isolators, VTs. CTs, power VTs, post insulators, surge arresters, conductors, clamps, including all cabling, racking and ancillary *works* that are required to deliver a complete, fully functional and fully compliant system.
- Supply of installation and commissioning spares and operational spares required for normal wear and tear during plant operation for the period of one year after commissioning.
- Supply of special tools required for maintenance purposes.
- All testing and commissioning activities that are required to get the installed equipment ready for operations.
- Compilation and submission of all handover documentation as described in these specifications.
- Training of *Employer's* operational staff, as detailed in these specifications.

Allowances to be made in the tendered rates are as described below.

31.2 132-66/11 kV Power Transformers

The scheduled rates for the 132-66/11 kV power transformers shall cover all costs for the design, supply, transport, delivery, off-loading, handling, inspection, installation and commissioning of the transformers. The rates shall allow for silica gel, breathers, conservator tank, cooling equipment, oil, oil filling, vacuum OLTS, HV and MV bushings, indicating and protective devices.

All cabling between tap changer controls and the transformer marshalling interface box (MIB) shall be included in the rates.

31.3 Dry Type Transformers

The scheduled rates for the dry type transformers shall cover all costs for the design, supply, transport, delivery, off-loading, handling, inspection, installation and commissioning of the transformers. The rates shall allow for enclosures, OCTS and all other associated equipment.

31.4 132 kV Circuit Breakers

The scheduled rates for the 132 kV circuit breakers shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning of the circuit breakers. The circuit breaker support structures are covered by separate pay items in the bill of quantities.

31.5 132 kV Isolators

The scheduled rates for the 132 kV isolators shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning of the isolators. The 132 kV isolator support structures are covered by separate pay items in the bill of quantities.

31.6 132 kV Current Transformers

The scheduled rates for the 132 kV current transformers shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning. The 132 kV current transformer support structures are covered by separate pay items in the bill of quantities.

31.7 132 kV Post Insulators

The scheduled rates for the 132 kV post insulators shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning. The 132 kV post insulator support structures are covered by separate pay items in the bill of quantities.

31.8 66 kV Voltage Transformers

The scheduled rates for the 66 kV VT shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning. The 66 kV VT support structures are covered by separate pay items in the bill of quantities.

31.9 66 kV Surge Arresters

The scheduled rates for the 66 kV surge arrester shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning. The 66 kV surge arrester support structures are covered by separate pay items in the bill of quantities.

31.10 66 kV Circuit Breakers

The scheduled rates for the 66 kV circuit breakers shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning. The 66 kV circuit breaker support structures are covered by separate pay items in the bill of quantities.

31.11 66 kV Post Insulators

The scheduled rates for the 66 kV post insulators shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning. The 66 kV post insulator support structures are covered by separate pay items in the bills of quantities.

31.12 11 kV Series Reactors

The scheduled rates for the 11 kV series reactors shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning.

31.13 11 kV NECRTs

The scheduled rates for the 11 kV NECRTs shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning.

31.14 MV Switchgear

The scheduled rates for the 11 kV and 3.3 kV medium voltage switchgear shall cover all costs for the design, supply, transport, handling, inspection, installation and commissioning including base frames, arc exhaust ducting.

31.15 MV Cables

The scheduled rates for cables shall cover all costs for the supply, transport, handling, inspection, laying in trenches, pulling through ducts, installing on cable tray, bedding in, cutting, temporary sealing and testing of cables, including suitable fire stopping material where required.

The scheduled rates for danger tape shall cover all costs for the supply, storage and handling and the installation and cutting thereof.

31.16 MV Joints and Terminations

The scheduled rates for the medium voltage joints and terminations shall cover all costs for the supply, transport, handling, inspection, installation and commissioning.

31.17 HV Clamps

The scheduled rates for the HV clamps shall cover all costs for the supply, transport, handling, inspection, installation and commissioning.

31.18 Wildlife and Asset Protection

The scheduled rates for the wildlife and asset protection products shall cover all costs for the products as supplied and installed. The *Employer* will provide a written instruction should the wildlife and asset protection need be required and installed.

32.0 MATERIAL SPECIFICATIONS

Reference shall be made to Eskom's latest list of accepted products (LAP) and Eskom national contract (ENC) equipment to ensure compliance with all Eskom requirements for material and equipment for the Eskom portion of the *works*.

Table 57: Material/Equipment

Component / Material	Make /Type or Equivalent Approved
HV Equipment	
132-66/11 kV Power Transformers	Powertech
132 kV Circuit Breakers	ABB
132 kV Isolators	Actom
132 kV Current Transformers	Actom
132 kV Post Insulator	Actom
66 kV Surge Arresters	ABB
66 kV Voltage Transformers	ABB
66 kV Power Voltage Transformers	Actom
66 kV Post Insulators	Actom
HV Clamps	McWade Productions (Pty) Ltd
MV Equipment	
11 kV Series Reactors	Trench Group
11 kV NECRTs	Actom
11 kV Surge Arresters	Powertech
11/3.3 kV Transformers (dry-type)	ABB
11/0.4 kV Transformers (dry-type)	ABB
11 kV Switchgear	ABB
3.3 kV Switchgear	ABB
MV Cabling	
6.35/11 kV XLPE cables	Aberdare, CBI
11 kV Terminations	Raychem/Tyco, ABB, NKT, Pfisterer, Euromold, Südkabel, Cellpack and associated others as respectively approved by equipment OEM's and *Employer.*
11 kV Joints	Raychem
Wildlife and Asset Protection	
Wildlife and Asset Protection Equipment	Raysulate

Technical Specification Tippler 3 Bulk Power Supply -

66 kV Branch Line to New Main Intake

Substation

Document Number 1924701-2-300-E-SP-0007

Document Details

Ref (SA)	1924701-2-300-E-SP-0007
Date	27 June 2018
Prepared by	Brett Sansom, Francois van Loon
Reviewed by	Colin Pym
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	27 June 2018	Issued Construction	Colin Pym	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

Integral to the new bulk electrical supply infrastructure *works* is the provision of a new 66 kV tee-off overhead line to supply the New Main Intake Substation (connecting onto Eskom's "Ystervark" section). The t-off will be taken from the existing Eskom two single circuit Blouwater-Iscor 66 kV overhead lines immediately before Eskom's existing Iscor substation.

In addition to the aforementioned, a new 16 kA/1s 48 core greased OPGW conductor from Eskom's existing Blouwater substation to structure 24 with associated hardware assemblies, on the existing Blouwater-Iscor 66 kV overhead line circuit 1, has to be installed. This will include the removal of the existing shield wire and hardware assemblies.

This specification sets out the minimum technical requirements for quality and workmanship for the design (where specified), manufacture, supply, installation, construction, testing and commissioning of the new 66 kV overhead branch line, replacement of the existing shield wire with new OPGW plus all associated *works* as required. Note: All *works* shall comply fully to Eskom's standards and requirements.

1.2 General Requirements

The *Contractor* shall supply all materials required for the *works*, including, but not limited to, the following:

- New masts.
- New phase conductors, shield conductors (where applicable) and OPGW.
- Silicone rubber insulators and hardware for masts.
- All materials required for concrete foundations.

All detailed designs (where specified), installations, materials and the like shall be to Eskom standards and requirements.

Should the *Contractor* appoint a specialist or other subcontractors for the execution of any portion of the *works*, the *Contractor* shall submit full details of the subcontractor(s), for the *Employer's* approval. For the purposes of these specifications, distinctions are not made between the *works* to be executed and the responsibilities to be discharged, by the *Contractor* or his appointed subcontractor(s).

It will be the responsibility of the *Contractor* to ensure that the specialist subcontractor(s) fully cooperates, coordinates and furnishes all technical support and associated technical information to the *Employer* and Others as required, to ensure that the new infrastructure are fully and correctly integrated.

All *works* shall be performed under the direct supervision of qualified electricians, engineers, riggers and the like, registered with the relevant, responsible institutions and in accordance with the applicable Eskom requirements and codes.

The *Contractor* will be responsible for all installations, until such time as the installations are formally handed over to and accepted by the *Employer* and Eskom. The *Employer* may request additional tests to be performed by the *Contractor* (entirely at the expense of the *Contractor*), to prove compliance and successful operation of the infrastructure.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site information.
- Drawings.
- Eskom Final Design Package (FDP): Copy shall be issued to the *Contractor*.

Any errors, omissions and discrepancies between the abovementioned shall be brought to the immediate attention of the *Employer* for resolution.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
A	Ampere
AAAC	All Aluminium Alloy Conductor
AC	Alternating Current
ACSR	Aluminium Conductor Steel Reinforced
ADSS	All dielectric Self-Supporting
AIA	Authorised Inspection Authority
Al	Aluminium
BB	Busbar
BS	British Standards
BoQ	Bill of Quantities
CD	Compact Disc
CoC	Certificate of Compliance
Cu	Copper
ECSA	Engineering Council of South Africa
EMPr	Environmental Management Programme
FAT	Factory Acceptance Tests

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
HDPE	High-Density Polyethylene
Hz	Hertz
I.D	Inner Diameter
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IP	Ingress Protection
ISO	International Standards Organisation
kA	Kilo Amp
Kg	Kilogram
kN	Kilo Newton
kNm	Kilo Newton Meter
kPA	Kilo Pascal
kV	Kilo Volts
kW	Kilo Watt
LV	Low Voltage
m	Meter
mm	Millimetre
MV	Medium Voltage
MVA	Mega Volt Ampere
MW	Mega Watt
Native	Original electronic file format of documentation
O.D	Outer Diameter
OEM	Original Equipment Manufacturer
OHL	Overhead Line
OHS	Occupational Health and Safety
O&M	Operating and Maintenance
OPGW	Optical Ground Wire
OTDR	Optical Time Domain Reflectometer
ºC	Degree Celsius
PC	Personal Computer
PVC	Polyvinyl chloride
QA	Quality Assurance
SABS	South African Bureau of Standards
SANAS	South African National Accreditation System

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
SANS	South African National Standards
SAT	Site Acceptance Tests
SHE	Safety, Health and Environment
TCP	Transnet Capital Projects
TFR	Transnet Freight Rail
TGC	Transnet Group Capital
TNPA	Transnet National Ports Authority
TPT	Transnet Port Terminals
UV	Ultra-violet
W	Watt
XLPE	Cross Linked Polyethylene

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

All infrastructure forming part of the 66 kV branch line, including those to be installed on sections of the existing 66 kV Blouwater - Iscor overhead line, at the Eskom 'Ystervark' portion of the new Main Intake Substation as well as Eskom's existing Blouwater and Iscor substations, shall comply fully to Eskom's standards, specifications and requirements.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer's premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on-Site quality control dossiers and the as constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 South African and International Standards

The *Contractor* shall also ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standards shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required, unless in certain circumstances required otherwise by Eskom.

The South African standards shall include, but are not necessarily limited to, the following.

Table 3 : South African Standards

Civil and Structural Engineering *Works*: SANS 1200 Standards

Code	Standard Title
SANS 1200 A (1986)	General
SANS 1200 AB (1986)	Engineer's Office
SANS 1200 C (1980)	Site Clearance
SANS 1200 D (1988)	Earthworks
SANS 1200 F (1983)	Piling
SANS 1200 G (1982)	Concrete (Structural)
SANS 1200 H (1990)	Structural Steelwork
SANS 1200 HC (1988)	Corrosion Protection of Structural Steelwork

Table 4 : South African Standards

Further Standards for Civil, Structural and Electrical Engineering *Works*

Code	Standard Title
COLTO	Standard Specifications for Road and Bridge Works for State Road Authorities 1998
SANS 121 (2011)	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
SANS 282 (2011)	Bending dimensions and scheduling of steel reinforcement for concrete
SANS 675 (2011)	Zinc-coated fencing wire
SANS 878 (2012)	Ready-mixed concrete
SANS 920 (2011)	Steel Bars For Concrete Reinforcement
SANS 1083 (2017)	Aggregates from natural sources - Aggregates for concrete
SANS 2001-CC1 (2012)	Construction works Part CC1: Concrete works (structural)
SANS 2001-CC2 (2007)	Construction works Part CC2: Concrete works (minor works)
SANS 2001-CS1 (2017)	Construction works Part CS1: Structural steelwork
SANS 4001-BT1 (2014)	Civil engineering specifications Part BT1: Penetration grade bitumen
SANS 5860 (2006)	Concrete tests - Dimensions, tolerances and uses of cast test specimens

Further Standards for Civil, Structural and Electrical Engineering *Works*

Code	Standard Title
SANS 5861-1 (2006)	Concrete tests Part 1: Mixing fresh concrete in the laboratory
SANS 5861-2 (2006)	Concrete tests Part 2: Sampling of freshly mixed concrete
SANS 5861-3 (2006)	Concrete tests Part 3: Making and curing of test specimens
SANS 5862-1 (2006)	Concrete tests - Consistence of freshly mixed concrete - Slump test
SANS 5862-2 (2006)	Concrete tests - Consistence of freshly mixed concrete - Flow test
SANS 5862-3 (2006)	Concrete tests - Consistence of freshly mixed concrete - Vebe test
SANS 5862-4 (2006)	Concrete tests - Consistence of freshly mixed concrete Part 4: Compacting factor and compaction index
SANS 5863 (2006)	Concrete tests - Compressive strength of hardened concrete
SANS 5865 (1994)	Concrete tests - The drilling, preparation, and testing for compressive strength of cores taken from hardened concrete
SANS 6245 (2006)	Potential reactivity of aggregates with alkalis (accelerated mortar prism method)
SANS 10044-1 (2004)	Welding Part 1: Glossary of terms
SANS 10100-1 (2000)	The structural use of concrete Part 1: Design
SANS 10100-2 (2014)	The structural use of concrete Part 2: Materials and execution of work
SANS 10144-1 (2012)	Detailing of steel reinforcement for concrete
SANS 10162-1 (2011)	The structural use of steel Part 1: Limit-states design of hot- rolled steelwork
SANS 10162-2 (2011)	The structural use of steel Part 2: Cold-formed steel structures
SANS 10162-4 (1997)	Structural use of steel Part 4: The design of cold-formed stainless steel structural members
SANS 10167 (2004)	The quality evaluation of fusion welded joints in steel structures
SANS 17025 (2005)	General requirements for the competence of testing and calibration laboratories
SANS 50025-1 (2009)	Hot rolled products of structural steels Part 1: General technical delivery conditions
SANS 50025-2 (2009)	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels
SANS 50025-3 (2009)	Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
SANS 50025-4 (2009)	Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels
SANS 50025-5 (2009)	Hot rolled products of structural steels Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance

Further Standards for Civil, Structural and Electrical Engineering *Works*

Code	Standard Title
SANS 50025-6 (2009)	Hot rolled products of structural steels Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition
SANS 50197-1 (2013)	Cement Part 1: Composition, specifications and conformity criteria for common cements
SANS 50197-2 (2000)	Cement Part 2: Conformity evaluation
SANS 50413-1 (2014)	Masonry cement Part 1: Composition, specifications and conformity criteria
SANS 50413-2 (2006)	Masonry cement Part 2: Test methods
SANS 50450-1 (2014)	Fly ash for concrete Part 1: Definition, specifications and conformity criteria
SANS 50450-2 (2011)	Fly ash for concrete Part 2: Conformity evaluation
SANS 51008 (2006)	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
SANS 53263-1 (2011)	Silica fume for concrete Part 1: Definition, specifications and conformity criteria
SANS 53263-2 (2011)	Silica fume for concrete Part 2: Conformity evaluation
SANS 55167-1 (2011)	Ground granulated blast furnace slag for use in concrete, mortar and grout Part 1: Definitions, specifications and conformity criteria
SANS 55167-2 (2011)	Ground granulated blast furnace slag for use in concrete, mortar and grout Part 2: Conformity evaluation
SANS 10280-1	Overhead power lines for conditions prevailing in South Africa Part 1: Safety
SANS 1063	Earth rods, couplers and connections
SANS 10199	The design and installation of earth electrodes
SANS 10313	Protection against lightning - Physical damage to structures and life hazard
SANS 62305	Protection against lightning - All applicable parts
SANS 60794	Optical fibre cables - All applicable parts
SANS 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - All applicable parts
SANS 61109	Insulators for overhead lines - Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria
SANS 60383-2	Insulators for overhead lines with a nominal voltage above 1 000 V Part 2: Insulator strings and insulator sets for a.c. systems - Definitions, test methods and acceptance criteria

International standards shall include, but are not necessarily limited to, the following.

Table 5 : International Standards

Code	Standard Title
IEC 60826	Loading and strength of overhead transmission lines
ASCE Standard 48-11	Design of Steel Transmission Pole Structures
IEEE Standard 81-2012	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System

3.4 Eskom Standards

The *Contractor* shall also ensure that all *works* undertaken at the Eskom sections, as applicable, comply with all their standards, specifications and requirements. The latest edition of such standards, specifications and requirements shall apply, which shall include, but not be limited to, the following.

Table 6 : Eskom Standards

Code	Standard Title
34-1202	Sub Transmission Lines Section 1: General
240-75884074	Standard Sub Transmission Lines Section 9: Steel Mono Pole 132kV Compact Line Tower Series
240-47172520	The Standard for the Construction of Overhead Powerlines
240-75883378	Specification for Steel Pole Overhead Line Supports
240-75883830	Steel Grades and Welding Requirements for Steelwork and Overhead Line Hardware Components
240-75883896	Outdoor Post and Long Rod Insulators for New and Refurbished Powerlines for 66 kV and 132 kV Standard
240-75883154	Current Carrying Compression Fittings for Overhead Sub-Transmission Systems
240-75883874	Requirements and Tests for Stockbridge Type Aeolian Vibration Dampers
240-98155879	Vibration Dampers for Single Conductor Sub-Transmission Lines
240-75521456	Specification for Phase Conductor for Distribution Lines and Substations
240-46262993	Fibre-Optic Design Standard - Part 1: Lines and Cables
240-46264031	Fibre-Optic Design Standard - Part 2: Substations
240-110403330	OPGW Hardware and Installation Requirements for Overhead Lines
240-102293163	Optical Line Terminating Equipment (OLTE) Specification
240-75880946	Earthing Standard
06TB-08	Bifurcation (Splitting) of Shield Wires

It is the responsibility of the *Contractor* to ensure that he obtains all of Eskom's standards, specifications and requirements (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the specific *works* by the *Contractor* to the standards, specifications and requirements.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 7 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt - laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 SPECIFICATIONS

5.1 Preamble

Descriptions covering the required scope, type and quality of materials and the *works* to be performed by the *Contractor*, to be covered also in the tendered rates, are included in the bill of quantities, these specifications, other technical standards (listed in Clause 3.3 above), the relevant civil, structural, and electrical drawings, the referenced standardized specifications and contract documentation. Any errors, omissions or discrepancies between the documents shall be brought to the immediate attention of the *Employer*.

The specifications to which the *works* are to be provided are as follows:

- Preliminary and General Items: South African Bureau of Standard's Standardized Specifications for Civil Engineering Construction SANS 1200, as listed in Table 3.
- Civil and structural engineering *works*: South African Bureau of Standard's Standardized Specifications for Civil Engineering Construction SANS 1200, as listed in Table 3 and further South African and international specifications as listed in Table 4 and Table 5 respectively.
- Electrical engineering *works*: South African and international specifications as listed in Table 4 and Table 5 respectively as well as Eskom standards as listed in Table 6.

In certain clauses, the standard, standardised and particular specifications allow a choice to be specified in the project specifications between alternative materials or methods of construction and for additional requirements to be specified to suit a particular contract. Details of such alternative or additional requirements applicable to this contract are contained in these specifications, which also contain additional requirements for this particular contract.

The number of the relevant clauses and payment items in the further project specifications consists of the prefix PS, followed by a number corresponding to the number of the relevant clause or payment item in the standard specifications, as and where applicable. The number of a new clause or payment item, which does not form part of a clause or a payment item in the standard specifications and is included here, is also prefixed by PS, followed by a new number. The new numbers follow on the last clause or item number used in the relevant section of the standard specifications.

Where, in the bill of quantities, reference is not made to a standardized or a particular SANS 1200 clause, the descriptions included in the bill of quantities shall be read in conjunction with the relevant drawings and specifications and the item shall be priced accordingly. The tendered rate shall also, for each item, include the supply of materials, installation and construction, testing and commissioning, all as required to render the *works* complete, fit for purpose and fully functional in every aspect upon final handover.

All *works* shall be performed to the specified standards or consistent with recognized, good industry norms and practices, to provide the *works* in a complete, fully functional, operable and compliant manner.

5.2 General Precautionary Measures

These specifications shall be read in conjunction with the project drawings issued for the various disciplines (i.e. civil, structural and electrical) where applicable, the bill of quantities and all other associated contract documentation. Any errors, omissions and discrepancies between the drawings, and/or documents shall be brought to the immediate attention of the *Employer* by the *Contractor*. The *Employer* shall make a final determination.

The *Contractor* shall check all project dimensions, levels and setting out data on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*. No scaling-off of drawings shall be done.

The *Contractor* shall confirm all levels of connection points to existing services on Site beforehand. Any discrepancies shall immediately be reported to the *Employer*.

Where new infrastructure ties into existing infrastructure, the *Contractor* shall cross check and confirm all critical dimensions and levels related to the existing infrastructure, before any construction or manufacturing commences.

Products or construction methods different to those specified in any project document or drawing may only be used subject to the written approval from the *Employer*. Such approval shall be requested in writing by the *Contractor*.

Where conflicting requirements between the drawings, specifications, Eskom requirements and the bill of quantities occur, the *Contractor* shall inform the *Employer* in writing of any such occurrence. The *Employer* will make a final determination.

The *Contractor* shall be required to co-ordinate closely with the *Employer*, Others engaged by the *Employer* and where applicable associated 3rd parties, as well as furnish any technical information as may be required where called upon.

6.0 SCOPE OF *WORKS*

6.1 Specific *Works*

The *Contractor's* scope of *works* shall include the detailed design, as applicable, fabrication, supply, installation, construction, testing and commissioning of the entire new 66 kV branch line, including associated *works*. These *works* shall include, but are not limited to, the following:

- Site clearance.
- Protection of existing underground and aboveground services and infrastructure.
- Excavation and backfilling of new monopole foundations.
- In-situ Geotechnical soil testing and reporting at each monopole foundation structure (strictly in accordance with this specification as well as Eskom's document TRMSCAAC5.3: the Standard for the Construction of Overhead Powerlines).
- Accommodation of traffic.
- The provision of all detailed designs, drawings and documentation as required in terms of this specification.
- All management, personnel, labour and other resources that are required to execute the *Contractor's* scope of *works*, in accordance with the requirements of this specification.
- Coordination between all stakeholders to be maintained to ensure correct and proper integration of the new infrastructure to the existing.
- Quality management, as described in the Works Information and these specifications.
- Pre-commissioning and commissioning of all the new installations, including supporting documentation.
- All as-constructed documentation.
- Compliance with all Eskom standards, specifications and requirements.
- Detailed design, supply and installation of the steel monopoles and associated concrete foundations. All designs shall be undertaken by suitably qualified and experienced professionally registered engineers.
- Detailed design, provision and construction of any temporary steel structures that may be required for the purposes of correctly and safely stringing conductors over roads or other infrastructure, including dismantling and removing of temporary steel structures upon completion of all *works*.
- Provision of all new overhead line material, i.e. single and double circuit monopoles, phase conductors, OPGW, concrete and steel re-enforcing for foundations, hardware assemblies, and the like.
- Removal of existing 1 & 2 BLW/ISC 30 steel self-supporting monopole terminal structures at Iscor substation.
- Demolishing of the two existing 1 & 2 BLW/ISC 30 terminal structures foundations at Iscor substation.
- Installation of new self-supporting strain single circuit T-off structures 1 BLW/ISC 32/1 and 2 BLW/ISC 32/1, with associated hardware assemblies, foundations and earthing.
- Installation of new self-supporting strain double circuit structure 1 BLW/ISC 32/2 - 2 BLW/ISC 32/2, with associated hardware assemblies, foundation and earthing.
- Installation of new self-supporting strain single circuit terminal structures 1 BLW/ISC 32/3 and 2 BLW/ISC 32/3, with associated hardware assemblies, foundations and earthing.
- Re-labelling of 13 existing masts:

  - 1 BLO/ISC 18 - (New Label: 1 BLW/ISC 18).
  - 2 BLO/ISC 18 - (New Label: 2 BLW/ISC 18).
  - 1 BLO/ISC 19 - (New Label: 1 BLW/ISC 19).
  - 2 BLO/ISC 19 - (New Label: 2 BLW/ISC 19).
  - 1 & 2 BLO/ISC 24 - (New Label: 1 & 2 BLW/ISC 24).
  - 1 & 2 BLO/ISC 25 - (New Label: 1 & 2 BLW/ISC 25).
  - 1 & 2 BLO/ISC 26 - (New Label: 1 & 2 BLW/ISC 26).
  - 1 & 2 BLO/ISC 27 - (New Label: 1 & 2 BLW/ISC 27).
  - 1 & 2 BLO/ISC 28 - (New Label: 1 & 2 BLW/ISC 28).
  - 1 & 2 BLO/ISC 29 - (New Label: 1 & 2 BLW/ISC 29).
  - 1 & 2 BLO/ISC 30 - (New Label: 1 & 2 BLW/ISC 30).
  - 1 BLW/ISC 29 - (New Label: 1 BLW/ISC 31).
  - 2 BLW/ISC 29 - (New Label: 2 BLW/ISC 31).

- Removal of existing Oak AAAC shield wire on circuit 1 of the existing Blouwater - Iscor 66 kV line, from Blouwater substation gantry to existing structure 24 (1 & 2 BLO/ISC 24). The applicable existing 24 structures from which the shield wire will be removed are:

  - 1 BLW/ISC 1.
  - 1 BLW/ISC 2.
  - 1 BLW/ISC 3.
  - 1 & 2 BLW/ISC 4.
  - 1 & 2 BLW/ISC 5.
  - 1 & 2 BLW/ISC 6.
  - 1 & 2 BLW/ISC 7.
  - 1 & 2 BLW/ISC 8.
  - 1 BLW/ISC 9.
  - 1 BLW/ISC 10.
  - 1 BLW/ISC 11.
  - 1 BLW/ISC 12.
  - 1 BLW/ISC 13.
  - 1 BLW/ISC 14.
  - 1 BLW/ISC 15.
  - 1 BLW/ISC 16.
  - 1 BLW/ISC 17.
  - 1 BLO/ISC 18.
  - 1 BLO/ISC 19.
  - 1 BLW/ISC 20.
  - 1 BLW/ISC 21.
  - 1 BLW/ISC 22.
  - 1 BLW/ISC 23.
  - 1 & 2 BLO/ISC 24.

  Note: 1 & 2 BLW/ISC or 1 & 2 BLO/ISC represents a single structure with 2 x 3-phase circuits.

- Back staying of respective structures as required, and removal after all stringing *works*.
- Removal of existing Oak shield wire related hardware assemblies at Blouwater substation gantry, including on the respective 24 masts, and replace with new hardware assemblies for OPGW.
- Installation of new 16 kA/1 s 48 core greased OPGW in the place of the abovementioned removed Oak shield wire.
- Disconnection of the existing 12 kA/1 s 24 core OPGW from existing dome joints at structure 1 & 2 BLO/ISC 24 and existing structure 12 of the Duferco 66 kV OHL line.
- Removal on existing mast 1 & 2 BLO/ISC 24, the existing mast point OPGW connection and termination infrastructure, including associated equipment.
- Provision on existing mast 1 & 2 BLO/ISC 24, new mast point OPGW connection and termination infrastructure, including associated equipment.
- Removal of redundant OPGW between 2 BLW/ISC 13 and structure 12 of the Duferco line, including redundant hardware assemblies, and make electrical connection on OPGW/shield wire at both sides of 2 BLW/ISC 13.
- Re-establish existing OPGW fibre optic connections at existing dome joint at structure 12 of the Duferco 66 kV OHL line.
- Connection of new 16 kA/1 s 48 core greased OPGW onto new dome joint at structure 1 & 2 BLO/ISC 24.
- Connection of new 16 kA/1 s 48 core greased OPGW onto new dome joint at Blouwater substation gantry.
- Installation of complete new gantry point OPGW/fibre optic connection and termination infrastructure at Blouwater substation gantry, including fibre optic cable to substation control room and termination onto existing patch panel.
- Remove existing Chicadee phase conductors on both circuit 1 and 2, from Iscor substation gantry to structures 1 BLW/ISC 29 and 2 BLW/ISC 29 respectively.
- Remove on circuit 2 existing 12 kA/1 s 24 core OPGW, from Iscor substation gantry to structure 2 BLW/ISC 29.
- Removing of existing phase hardware assemblies on eastern side of structures 1 BLW/ISC 29 and 2 BLW/ISC 29 respectively, including on Iscor substation gantry.
- Installation of new phase hardware assemblies on eastern side of structures 1 BLW/ISC 29 and 2 BLW/ISC 29 respectively, including on Iscor substation gantry.
- Removing on circuit 1 existing OPGW hardware assemblies (for 16 kA/1 s 48 core OPGW) on both sides of structure 1 BLW/ISC 29 with corresponding assembly on Iscor substation gantry.
- Removing on circuit 2 existing OPGW hardware assemblies (for 12 kA/1 s 24 core OPGW) on both sides of structure 2 BLW/ISC 29 with corresponding assembly on Iscor substation gantry.

- Installation of new OPGW hardware assemblies on both sides of structure 1 BLW/ISC 29.
- Installation of new OPGW hardware assembly on Iscor substation gantry.
- Installation of new Oak AAAC shield wire hardware assemblies on both sides of structure 2 BLW/ISC 29. Note: One side to cater for existing 12 kA/ 1 s 24 core OPGW.
- Installation of new Oak AAAC shield wire assembly on Iscor substation gantry.
- Disconnecting of existing 16 kA/1 s 48 core greased OPGW, on circuit 1, at Iscor gantry dome joint, provide sufficient slack and re-string from structure 1 BLW/ISC 29 onto T-off structure 1 BLW/ISC 32/1 to Iscor substation gantry including re-connection of fibre optics at dome joint.
- Installation of new greased Chicadee phase conductors on circuit 1, from structure 1 BLW/ISC 29 onto T-off structure 1 BLW/ISC 32/1 to Iscor substation gantry.
- Installation of new greased Chicadee phase conductors on circuit 2, from structure 2 BLW/ISC 29 onto T-off structure 2 BLW/ISC 32/1 to Iscor substation gantry.
- Installation of new Oak AAAC phase shield wire on circuit 2, from structure 2 BLW/ISC 29 to 2 BLW/ISC 32/1, including making electrical connection on structure 2 BLW/ISC 29.
- Removal of existing gantry point OPGW/fibre optic connection and termination infrastructure at Iscor substation gantry, including associated equipment.
- Installation of 2 x complete new gantry point OPGW/fibre optic connection and termination infrastructure at Iscor substation gantry, including fibre optic cable to substation control room and termination onto existing patch panel.
- Installation of complete new gantry point OPGW/fibre optic connection and termination infrastructure at Ystervark substation gantry, including fibre optic cable to substation control room and termination onto new patch panel.
- Installation of new OPGW and Oak AAAC shield wire hardware assemblies on Ystervark substation gantry.
- Installation of new greased Chicadee phase conductors on circuit 1, from T-off structure 1 BLW/ISC 32/1 to 1 & 2 BLW/ISC 32/2 to terminal structure 1 BLW/ISC 32/3 to Ystervark substation gantry, and make electrical connections as required.
- Installation of new greased Chicadee phase conductors on circuit 2, from T-off structure 2 BLW/ISC 32/1 to 1 & 2 BLW/ISC 32/2 to terminal structure 2 BLW/ISC 32/3 to Ystervark substation gantry, and make electrical connections as required.
- Installation of new Oak AAAC shield wire on circuit 1, from T-off structure 1 BLW/ISC 32/1 to structure 1 & 2 BLW/ISC 32/2 to terminal structure 1 BLW/ISC 32/3 onto Ystervark substation gantry. Bifurcation of shield wires to be implemented at T-off structure 1 BLW/ISC 32/1, 1 & 2 BLW/ISC 32/2, including at terminal structure 1 BLW/ISC 32/3 onto Ystervark substation gantry to ensure adequate lightning protection.
- Installation of new 16 kA/1 s 48 core greased OPGW on circuit 2, from Iscor substation gantry to T-off structure 2 BLW/ISC 32/1 to terminal structure 2 BLW/ISC 32/3 onto Ystervark substation gantry. Additional Oak AAAC shield wire to be installed from terminal structure 2 BLW/ISC 32/3 onto Ystervark substation gantry, via bifurcation methods, to ensure adequate lightning protection.
- Connection of new 16 kA/1 s 48 core greased OPGW onto new dome joints at Iscor and Ystervark substations gantries respectively.
- Associated ancillary *works*.

Particular attention shall be given to *works* done in close proximity to live power lines, as well as roads and rail crossings, taking account also of the permitting requirements of the responsible road and rail authorities etc. The *Contractor* shall appoint a full-time Eskom registered/authorised 'close proximity *works*' specialist for this project.

In addition all other respective personnel of the *Contractor* shall be registered / authorised by Eskom as per their requirements. **Only Eskom approved installers shall be used to install all new OPGW and Fibre Optic conductors/cables and associated *works*.**

6.2 Material

All materials supplied by the *Contractor* shall be new and unused and also in accordance with Eskom requirements. Any redundant material such as steel monopoles, hardware assemblies, conductors and the like shall be taken to the Eskom premises in Brackenfell, unless required otherwise by them. This forms part of the scope of *works* to be undertaken by the *Contractor*.

Particular note shall be taken of the following:

- All redundant conductors, shield wires and OPGW shall be rolled onto cable drums and labelled accordingly.
- All hardware assemblies shall be disassembled into their individual components, which shall be separated per type and placed in properly labelled crates for shipment to the Eskom premises.

- All masts shall be carefully lowered, taking account of any surrounding obstacles and activities, disassembled into transportable units and transported to the Eskom premises.

The *Contractor* shall provide all logistics and crainage on Site and at the Eskom premises in Brackenfell. It is noted that all the above - and aforementioned *works* shall be included in the tendered rates.

A detailed inventory list shall be compiled by the *Contractor* for the redundant materials delivered to Eskom's premises, whereby duly authorised personnel of Eskom shall sign the aforementioned upon receipt and copies issued to both the *Employer* and Eskom accordingly.

6.3 Foundations

Once the soils have been nominated by the *Contractor* and approved by the *Employer* and Eskom, the final size and type of foundation shall be chosen for the specific structure type and loadings, in accordance with amongst others the Eskom classification 240-47172520: The Standard for the Construction of Overhead Powerlines, as well as the geotechnical investigation report.

The *Contractor* shall provide a foundation record report, covering all mast foundations, which is to be signed off by a suitably qualified and experienced professionally registered engineer (to be approved by the *Employer*). The report shall verify that the soil was nominated and that the *Contractor* has assumed responsibility for the final foundation designs and construction.

The *Contractor* shall ultimately be responsible for the final foundation designs. The foundations shall be designed to withstand the maximum combinations of induced factored moment, compression and torsion loads including any other applicable requirements imposed by Eskom and statutory regulations and standards. Construction of the foundations may not commence until such time the *Contractor* has obtained all relevant approvals from the *Employer* and Eskom respectively.

The standard Eskom foundation drawings as listed below can be used as a baseline to develop the final designs. It is to be noted that the foundations for terminal structures 1 BLW/ISC 32/3 and 2 BLW/ISC 32/3 shall cater for the future end state loads, as provided in Table 15.

These maximum loadings are envisaged to be imposed on the foundations ones the future planned 132 kV overhead lines are implemented and the current 66 kV OHL system removed. The anticipated maximum future conductor entrance angle on the two terminal structures respectively is 60 degrees (with ± 300m spans).

The aforementioned angle shall be based on a 180 degree radius entrance allowance on the north - east - south axis of the terminal towers. At this stage the exact angle of entry of the future incoming lines is not known, therefore these masts and subsequently there foundations is to be designed to accommodate an incoming line at any angle within the 180 degree segment described.

Given this, these two foundations shall be square pads and not rectangular. Due to the criticality of these two foundations, special attention shall be given in order to ensure the correct final designs.

Table 8 : Eskom Standard Foundations

Foundation	Eskom Drawing No.
2000 kNm for strain monopoles	D-WC-7602-07-02-03
2500 kNm for strain monopoles	D-WC-7602-07-11-01
3000 kNm for strain monopoles	D-WC-7602-07-03-03
4500 kNm for strain monopoles	D-WC-7602-07-05-03
5000 kNm for strain monopoles	D-WC-7602-07-06-01

6.4 Structures

The *Contractor* shall ultimately be responsible for the structures/masts final designs. The structures shall be designed to withstand the maximum/ultimate forces which will be imposed on them, including any other applicable requirements dictated by Eskom and statutory regulations and standards. Reference shall also be made to the further details included in this document. Prior to the commencement of the final designs, the *Contractor* shall confirm all applicable data as provided in Table 15 again with the *Employer*.

Manufacturing of the structures may not commence until such time the *Contractor* has obtained all relevant design approvals from the *Employer* and Eskom respectively. Note: As part of the structures shop drawings to be approved, the *Contractor* shall also provide shop drawings showing the complete hardware and insulator assemblies on the structures.

Additionally, no manufactured structure or its applicable components may be sent for galvanising until the *Employer* and Eskom have completed their factory acceptance tests on the units and furnished approval. It is to be noted that the *Employer* and Eskom reserve the right to undertake further factory acceptance tests as needed in order to verify any corrections made to defects, galvanising and the like.

The structures shall not be dispatched to Site until the *Contractor* has obtained all approvals from the *Employer* and Eskom.

6.5 Hardware an Insulator Assemblies

All hardware assemblies shall be assembled as per the relevant Eskom standards and drawings. Only Eskom approved suppliers and products will be accepted. **With regards to insulators, the line is close to the coast and high creepage insulators must be used, with a minimum 31 mm/kV creepage distance rating (Specific provisions for OPGW and shield wire insulators shall apply where necessary)**.

Prior to commencement of the final hardware installations, a sample of each type of assembly shall be made up on-Site, for review and approval by the *Employer* and Eskom. Additional samples of each type of assembly shall also be provided for the FAT inspection(s) of the structures, in order to fit them onto the structures to confirm correctness. These requirements shall be taken into account in the tendered rates.

Reference shall also be made to the further details included in this document.

6.6 Special Tests

The following special tests shall be conducted, unless otherwise instructed, in accordance with Eskom's requirements and where applicable by a SANAS accredited test facility:

- Testing of OPGW equipment.
- Testing of compression crimps.
- Stay pull testing via an approved stay test rig.

The *Employer* and Eskom reserve the right to instruct the *Contractor* not to undertake one or more of the tests. The *Contractor* shall confirm well in advance with the *Employer* and Eskom if any of the mentioned tests should not be undertaken.

6.7 Designs, Calculations and Drawings by the *Contractor*

6.7.1 General

The *Contractor* shall, as a minimum, provide the following, calculations, designs (where specified), drawings (design and construction), reports and the like, to be approved by the *Employer* and where required Eskom:

- Masts.
- Foundations.
- Any applicable temporary *works*.

Documentation, and native software files, to be produced by the *Contractor* shall be compiled and submitted in accordance with the procedures included in the Works Information as well as the further requirements as detailed below. All documents, for which prior approvals are required, shall be timeously submitted to the *Employer* for review and approval, prior to placement of orders, fabrication or manufacture.

The *Contractor* shall, as necessary, undertake the designs (where specified), calculations and drawings, which shall be prepared and checked by suitably qualified and experienced professional engineers, registered with the Engineering Council of South Africa (ECSA) or an equivalent institution recognised by ECSA.

The design engineers shall be subject to approval by the *Employer* and if required by Eskom. Designs, calculations and drawings shall not be prepared and checked by the same person and shall be reviewed by the *Employer* (and where necessary Eskom) before the commencement of fabrication/manufacture and installation.

The *Employer* will provide the *Contractor* with the necessary formats for documents that are to be submitted for approval. The *Employer* may, at his sole discretion, request additional design calculations, drawings and associated information, as deemed necessary for verification of the correctness and compliance of the designs. The cost of providing such additional information shall be deemed to be included in the tendered rates, i.e. further payments for such information will not be made.

6.7.2 Designs and Calculations by the *Contractor*

The *Contractor* shall submit all required calculations in a neat and legible manner. Where calculations are performed using specialised software programs, the *Contractor* shall also furnish copies of the final native software files, without any exclusions. The calculations shall be provided in a professional, neat format, to include, but not be limited to, the following, in the order as stated below:

- Summary of assumptions and conclusions.
- Table of contents.
- List of all associated drawings.
- List of compliancy standards.
- List of all text and references used.
- Nomenclature.
- Calculations.

6.7.3 Drawings by the *Contractor*

All design and construction drawings shall be submitted in hard and soft copies. Soft copies shall be in 'rvt', 'dgn', 'dwg', 'dxf' and PDF formats as required by the *Employer*. Three hard copies are to be provided, which shall be fully signed off, unless specified otherwise.

The *Contractor* shall be solely responsible for the submission of any drawings that are to be provided by his specialist subcontractors and/or OEMs.

6.8 Safety

Reference is made to the environmental and safety requirements as detailed in the Works Information and the particular requirements as described below.

The *Contractor* shall take all necessary safety precautions to prevent static electricity discharge, sparking and any other unsafe condition, which could pose a safety risk to personnel, property and/or equipment.

If applicable, the location and extent of potentially explosive atmospheres are to be identified and indicated on hazardous area classification drawings. In conjunction with the aforementioned, all electrical equipment and instruments for use in hazardous classified areas shall be supplied with a hazardous area certificate issued by a certifying authority approved by SABS/SANS/IEC.

All *works* shall be performed under strict lockout/disconnection conditions and a register shall be kept of all isolated circuits. The *Employer's* and Eskom's requirements shall also be incorporated in all safety procedures.

6.9 South African Electrical Compliance

Any equipment designed and fabricated/manufactured overseas shall have an electrical certificate of compliance to South African Regulations, unless otherwise specified or required by the *Employer* or Eskom, before it is delivered and operated in South Africa. These certificates shall be issued by an accredited South African professional engineer, or approved other party.

6.10 *Employer* QA Representative

The *Contractor*'s QA requirements shall be as set out in the accompanying Works Information. The *Employer* may choose to appoint a QA/QC representative to monitor and report on some or all aspects of the production and fabrication processes.

Full cooperation shall be extended to the appointed QA/QC representative. Associated costs for such services will be borne by the *Employer*.

6.11 *Contractor*'s Subcontractor Declaration

Where *works* are to be performed by a subcontractor/OEM, the *Contractor* shall provide notices and obtain the *Employer's* (and where necessary Eskom's) approval prior to the appointment of the subcontractor. This shall include all subcontractors/OEMs providing design, fabrication, assembly, installation and related services.

7.0 MATERIAL SPECIFICATIONS

7.1 Conductors

7.1.1 Phase Conductors

. Table 9 : Phase Conductor Details - Chicadee ACSR

Characteristics	
Conductor overall diameter (mm)	18.87
Area aluminium (mm²)	200.93
Area Total (mm²)	212.09
Aluminium wire stranding/diameter (mm)	18/1/3.77
Steel wire stranding/diameter (mm)	1/3.77
Conductor linear mass (kg/km)	643
Ultimate Tensile strength (kN)	44.9
Resistance dc @ 20 °C (ohms/km)	0.1427
Modulus elasticity final (GPa)	66.2
Coefficient of Linear expansion (1/°C)	21.44×10^{-6}
Greased conductor requirements	Greased

Table 10 : Phase Conductor Details - Kingbird ACSR

Characteristics	
Conductor overall diameter (mm)	23.90
Area aluminium (mm²)	323.01
Area Total (mm²)	340.96
Aluminium wire stranding/diameter (mm)	18/1/4.78
Steel wire stranding/diameter (mm)	1/4.78
Conductor linear mass (kg/km)	1038
Ultimate Tensile strength (kN)	71.32
Resistance dc @ 20 °C (ohms/km)	0.0891
Modulus elasticity final (GPa)	66.2
Coefficient of Linear expansion (1/°C)	21.69×10^{-6}
Greased conductor requirements	Greased

7.1.2 OPGW

Table 11 : 16 kA/1 s 48 Core OPGW Details

Characteristics	
Approximate cable diameter (mm)	17.7
Approximate cable weight (kg/km)	663
Rated tensile strength (kN)	54
Ultimate tensile strength (kN)	≥ 60
Maximum load without fibre elongation (kN)	40
Crush resistance (kg/10 cm)	> 2040
Coefficient of linear expansion (1/^{o}C)	19 x 10^{-6}
Minimum bending radii on pulley blocks (mm)	400
Minimum bending radii on tensioner devices (mm)	700
Minimum bending radii after clamping - slack cable (mm)	300
Operating temperature (^{o}C)	Between - 30 ^{o}C and + 70 ^{o}C
Electrical resistance at 20^{o}C (ohm/km)	0.2
Short circuit rating for 1 second (kA)	16
Short circuit rating from 40^{o}C for 1 second (kA^{2}s)	254.5
Greased OPGW requirements	Greased

7.1.3 Shield Wire

Table 12 : Shield Wire Details - Oak AAAC

Characteristics	
Conductor overall diameter (mm)	13.95
Area aluminium (mm²)	118.9
Aluminium wire stranding/diameter (mm)	7/4.65
Conductor linear mass (kg/km)	325
Ultimate Tensile strength (kN)	33.33
Resistance dc @ 20 °C (ohms/km)	0.279
Modulus elasticity final (GPa)	61
Coefficient of Linear expansion (1/°C)	23 x 10^{-6}
Greased conductor requirements	Greased

7.2 Hardware Equipment and Components

The *Contractor* is to note that where reference is made to an Eskom drawing in the table below, it may not constitute the only requirements for the specific equipment/component(s) specified i.e. additional Eskom drawings, standards, specifications and requirements may also apply to which reference should be made.

All equipment/component(s) shall be provided complete with any associated equipment, accessories and the like. **Prior to ordering of the hardware equipment and components, the *Contractor* shall, in conjunction with the *Employer* and Eskom, verify all required hardware equipment and components, in particular for where an assembly make-up is required.**

Table 13 : List of Equipment/Components

Equipment/Component	Eskom Drawing
Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	D-DT-7029
Insulator (Long Rod): 132 kV, 31 mm/kV, 120 kN	D-DT-7014
Line Post Insulator - Horizontal: 66 kV, 31 mm/kV, 5.3 kN	D-WC-7600-01-06, D-WC-7600-01-13, D-DT-7031
Insulator - Shield Wire/OPGW Strain: 120 kN	D-DT-7012
Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	D-DT-3017, D-WC-7066
AGS Suspension Unit	D-DT-7033
Armour Rod	D-DT-7034
D-Shackle (Straight Bolt Type): 120 kN	D-DT-7017
Socket -Tongue (Bolt Type): 120 kN	D-DT-6061
Clevis - Ball: 120 kN	D-DT-6059
Twisted Tongue Oval Eye: 120 kN	Buy Out - To Suite
Socket - Clevis: 120 kN	D-DT-7021
Sag Adjustor: 120 kN	D-DT-7042
Thimble Clevis: 120 kN	D-DT-3007
Clevis - Tongue: 120 kN	D-DT-6084
Terminal Lug	D-DT-3074
Dead End Clamp (Compression Type)	D-DT-7000
Mid - Span Joint (Compression Type)	D-DT-7001, D-DT-3073
Extension Link 350 mm (Single): 120 kN	D-DT-7041
Ball Eye Oval: 120 kN	D-DT-7008

Pistol Grip Clamp: 120 kN	D-DT-7022
PG Clamp	D-DT-3058
Preformed Helically Dead End	Buy Out - To Suite
Top Groove Tie: Coastal	D-DT-3081
Crosby Clamp (Up to 16 mm Diameter Wire Rope)	D-DT-7032
Thimble	D-DT-3026
Turnbuckle - Eye Tongue: 120 kN	D-DT-7007
Yoke Plate - Triangle: 120 kN	D-DT-7015
EUT-B Clamp	D-DT-6099
Multi-Frequency Vibration Damper	D-DT-7005
Spiral Vibration Damper	D-DT-3175 or Buy Out - To Suite
Stay Assembly (Non - Adjustable): 115 kN	D-DT-7310
OPGW/Fibre Connection and Termination Point on Gantry (**Insulated Type**). Note: Main Equipment too and for Control Room Included: • Insulated Rotating Slack Bracket • Mounting Plate • Insulated Down Lead Clamps • Insulated Dome Joint • 50 mm x 2 mm Stainless Steel Pipe • Stainless Steel Strapping • Class 6 HDPE Pipes (Yellow Colour) • U-clamps • Cable racks and wire meshes • 48 Core Unarmoured Duct Fibre Optic Cable • Fibre Optic Terminations	Eskom Document: 240-46264031, See also applicable drawings from Preformed Line Products
OPGW/Fibre Connection and Termination Point on Gantry (**Non-Insulated Type**). Note: Main Equipment too and for Control Room Included: • Rotating Slack Bracket • Mounting Plate • Down Lead Clamps • Dome Joint • 50 mm x 2 mm Stainless Steel Pipe • Stainless Steel Strapping • Class 6 HDPE Pipes (Yellow Colour) • U-clamps • Cable racks and wire meshes • 48 Core Unarmoured Duct Fibre Optic Cable	Eskom Document: 240-46264031, See also applicable drawings from Preformed Line Products

• Fibre Optic Terminations	
OPGW Connection and Termination Point on Mast (**Insulated Type**). • Insulated Rotating Slack Bracket • Insulated Down Lead Clamps • Insulated Dome Joint • Fibre Optic Terminations	Buy Out - To Suite

Table 14 : Structure Assemblies

Structure	Item	Quantity
Blouwater Gantry OPGW Strain On Gantry	D-Shackle (Straight Bolt Type): 120 kN	2
	Extension Link 350 mm (Single): 120 kN	1
	Thimble Clevis: 120 kN	1
	Preformed Helically Dead End	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	1
Blouwater Gantry OPGW/Fibre Connection and Termination Point on Gantry (Non-Insulated Type):	Rotating Slack Bracket	1
	Mounting Plate	As needed
	Down Lead Clamps	
	Dome Joint	1
	50 mm x 2 mm Stainless Steel Pipe	As needed
	Stainless Steel Strapping	
	Class 6 HDPE Pipes	
	Duct Unarmoured Fibre Optic Cable	
	Fibre Optic Terminations	
1 BLW/ISC 1: OPGW Strain Closing Span Configuration	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 2: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
	D-Shackle (Straight Bolt Type): 120 kN	7

Structure	Item	Quantity
1 BLW/ISC 3: OPGW Strain Normal Configuration	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 4: OPGW Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 5: OPGW Intermediate Suspension Type	D-Shackle (Straight Bolt Type): 120 kN	2
	AGS Suspension Unit	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 6: OPGW Intermediate Suspension Type	D-Shackle (Straight Bolt Type): 120 kN	2
	AGS Suspension Unit	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 7: OPGW Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2

Structure	Item	Quantity
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 8: OPGW Intermediate Suspension Type	D-Shackle (Straight Bolt Type): 120 kN	2
	AGS Suspension Unit	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 9: OPGW Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 10: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 11: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 12: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
	D-Shackle (Straight Bolt Type): 120 kN	7

Structure	Item	Quantity
1 BLW/ISC 13: OPGW Strain Normal Configuration	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	PG Clamp - Electrical Connection	1
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 14: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 15: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 16: OPGW Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 17: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2

Structure	Item	Quantity
1 BLW/ISC 18: OPGW Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 19: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 20: OPGW Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 21: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 22: OPGW Intermediate Post Insulator Type	Post Insulator (Porcelain Type with Spark Gap) - 22 kV: 10 kN	1
	Top Groove Tie: Coastal	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	2

Structure	Item	Quantity
1 BLW/ISC 23: **OPGW Strain Closing Span Configuration**	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 24: **OPGW Strain Closing Span Configuration (Section Only)**	D-Shackle (Straight Bolt Type): 120 kN	2
	Thimble Clevis: 120 kN	1
	Preformed Helically Dead End	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	Insulated Rotating Slack Bracket	1
	Insulated Down Lead Clamps	As needed
	Stainless Steel Strapping	
	Fibre Optic Terminations	
	Insulated Dome Joint	1
	Multi-Frequency Vibration Damper - for OPGW	1
1 BLW/ISC 31: **OPGW Strain Normal Configuration**	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
2 BLW/ISC 31: **OPGW Strain Closing Span Configuration (Section Only)**	D-Shackle (Straight Bolt Type): 120 kN	2
	Thimble Clevis: 120 kN	1
	Preformed Helically Dead End	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	PG Clamp - Electrical Connection	1

Structure	Item	Quantity
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	1
2 BLW/ISC 31: **Shield Wire Strain Closing Span Configuration (Section Only)**	D-Shackle (Straight Bolt Type): 120 kN	3
	Dead End Clamp (Compression Type)	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	Multi-Frequency Vibration Damper - for Shield Wire	1
1 BLW/ISC 32/1: **OPGW Strain Closing Span Configuration**	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
1 BLW/ISC 32/1: **Shield Wire Strain Normal Configuration (Section Only)**	D-Shackle (Straight Bolt Type): 120 kN	3
	Dead End Clamp (Compression Type)	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	Multi-Frequency Vibration Damper - for Shield Wire	1
	PG Clamp - Bifurcation	1
2 BLW/ISC 31/1: **OPGW Strain Normal Configuration**	D-Shackle (Straight Bolt Type): 120 kN	7
	Sag Adjustor: 120 kN	1
	Thimble Clevis: 120 kN	2
	Preformed Helically Dead End	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW	2
2 BLW/ISC 32/1: **Shield Wire Strain Normal Configuration (Section**	D-Shackle (Straight Bolt Type): 120 kN	4
	Sag Adjustor: 120 kN	1
	Dead End Clamp (Compression Type)	1

Structure	Item	Quantity
Only)	Insulator - Shield Wire/OPGW Strain: 120 kN	1
	Multi-Frequency Vibration Damper - for Shield Wire	1
	PG Clamp - Bifurcation	1
Iscor Gantry OPGW Strain On Gantry (Circuit 1)	D-Shackle (Straight Bolt Type): 120 kN	2
	Extension Link 350 mm (Single): 120 kN	1
	Thimble Clevis: 120 kN	1
	Preformed Helically Dead End	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	1
Iscor Gantry OPGW Strain On Gantry (Circuit 2)	D-Shackle (Straight Bolt Type): 120 kN	2
	Extension Link 350 mm (Single): 120 kN	1
	Thimble Clevis: 120 kN	1
	Preformed Helically Dead End	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	1
Iscor Gantry OPGW/Fibre Connection and Termination Point on Gantry - Circuit 1 (Non-Insulated Type):	Rotating Slack Bracket	1
	Mounting Plate	As needed
	Down Lead Clamps	
	Dome Joint	1
	50 mm x 2 mm Stainless Steel Pipe	As needed
	Stainless Steel Strapping	
	Class 6 HDPE Pipes	
	Duct Unarmoured Fibre Optic Cable	
	Fibre Optic Terminations	
Iscor Gantry OPGW/Fibre Connection and Termination Point on Gantry - Circuit 2 (Non-Insulated Type):	Rotating Slack Bracket	1
	Mounting Plate	As needed
	Down Lead Clamps	
	Dome Joint	1
	50 mm x 2 mm Stainless Steel Pipe	As needed

Structure	Item	Quantity
	Stainless Steel Strapping	
	Class 6 HDPE Pipes	
	Duct Unarmoured Fibre Optic Cable	
	Fibre Optic Terminations	
1 BLW/ISC 31: **Phase Conductor Strain Normal Configuration (Section Only)**	D-Shackle (Straight Bolt Type): 120 kN	6
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	3
	Socket - Clevis: 120 kN	3
	Dead End Clamp (Compression Type)	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
2 BLW/ISC 31: **Phase Conductor Strain Normal Configuration (Section Only)**	D-Shackle (Straight Bolt Type): 120 kN	6
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	3
	Socket - Clevis: 120 kN	3
	Dead End Clamp (Compression Type)	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
1 BLW/ISC 32/1: **Phase Conductor Strain Normal Configuration**	D-Shackle (Straight Bolt Type): 120 kN	9
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	6
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	6
	Socket - Clevis: 120 kN	6
	Dead End Clamp (Compression Type)	6
	Multi-Frequency Vibration Damper - for Phase Conductor	6
1 BLW/ISC 32/1: **Phase Conductor Strain Normal Configuration (Section Only)**	D-Shackle (Straight Bolt Type): 120 kN	6
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	3

Structure	Item	Quantity
	Socket - Clevis: 120 kN	3
	Dead End Clamp (Compression Type)	3
	EUT-B Clamp	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
2 BLW/ISC 32/1: Phase Conductor Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	9
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	6
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	6
	Socket - Clevis: 120 kN	6
	Dead End Clamp (Compression Type)	6
	Multi-Frequency Vibration Damper - for Phase Conductor	6
2 BLW/ISC 32/1: Phase Conductor Strain Normal Configuration (Section Only)	D-Shackle (Straight Bolt Type): 120 kN	6
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	3
	Socket - Clevis: 120 kN	3
	Dead End Clamp (Compression Type)	3
	EUT-B Clamp	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
Iscor Gantry Phase Conductor Strain Closing Span Configuration (Section Only) - Circuit 1	D-Shackle (Straight Bolt Type): 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	3
	Socket -Tongue (Bolt Type): 120 kN	3
	Pistol Grip Clamp: 120 kN	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
Iscor Gantry Phase Conductor Strain Closing Span Configuration (Section Only) - Circuit 2	D-Shackle (Straight Bolt Type): 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	3
	Socket -Tongue (Bolt Type): 120 kN	3

Structure	Item	Quantity
	Pistol Grip Clamp: 120 kN	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
1 & 2 BLW/ISC 32/2: OGW Strain (Including Shield Wire Portion) Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	12
	Sag Adjustor: 120 kN	4
	Thimble	2
	Thimble Clevis: 120 kN	2
	Yoke Plate - Triangle: 120 kN - for Bifurcation of Shield Wire	2
	Preformed Helically Dead End - for OPGW	2
	Preformed Helically Dead End - for Shield Wire	2
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Multi-Frequency Vibration Damper - for OPGW and Shield Wire	4
1 & 2 BLW/ISC 32/2: Phase Conductor Strain Normal Configuration	D-Shackle (Straight Bolt Type): 120 kN	18
	Sag Adjustor: 120 kN	6
	Clevis - Ball: 120 kN	12
	Line Post Insulator - Horizontal: 66 kV, 31 mm/kV, 5.3 kN (With trunnion clamps)	6
	Insulator (Long Rod): 66 kV, 31 mm/kV, 120 kN	12
	Socket - Clevis: 120 kN	12
	Dead End Clamp (Compression Type)	12
	Multi-Frequency Vibration Damper - for Phase Conductor	12
1 BLW/ISC 32/3: Shield Wire Strain Closing Span Configuration	D-Shackle (Straight Bolt Type): 120 kN	9
	Sag Adjustor: 120 kN	1
	Thimble	3
	Preformed Helically Dead End - Shield Wire	3
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Multi-Frequency Vibration Damper - for Shield Wire	3
2 BLW/ISC 32/3: OPGW Strain (Including Shield Wire Portion) Closing Span Configuration	D-Shackle (Straight Bolt Type): 120 kN	10
	Sag Adjustor: 120 kN	1
	Thimble	1
	Thimble Clevis: 120 kN	2

Structure	Item	Quantity
	Yoke Plate - Triangle: 120 kN - for Bifurcation of Shield Wire	1
	Preformed Helically Dead End - for OPGW	2
	Preformed Helically Dead End - for Shield Wire	1
	Insulator - Shield Wire/OPGW Strain: 120 kN	2
	Armour Rod	2
	Multi-Frequency Vibration Damper - for OPGW and Shield Wire	3
1 BLW/ISC 32/3: **Phase Conductor Strain Normal Configuration**	D-Shackle (Straight Bolt Type): 120 kN	9
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	6
	Insulator (Long Rod): 132 kV, 31 mm/kV, 120 kN	6
	Socket - Clevis: 120 kN	6
	Dead End Clamp (Compression Type)	6
	Multi-Frequency Vibration Damper - for Phase Conductor	6
2 BLW/ISC 32/3: **Phase Conductor Strain Normal Configuration**	D-Shackle (Straight Bolt Type): 120 kN	9
	Sag Adjustor: 120 kN	3
	Clevis - Ball: 120 kN	6
	Insulator (Long Rod): 132 kV, 31 mm/kV, 120 kN	6
	Socket - Clevis: 120 kN	6
	Dead End Clamp (Compression Type)	6
	Multi-Frequency Vibration Damper - for Phase Conductor	6
Ystervark Gantry Phase Conductor Strain Closing Span Configuration (Section Only) - Circuit 1	D-Shackle (Straight Bolt Type): 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 132 kV, 31 mm/kV, 120 kN	3
	Socket -Tongue (Bolt Type): 120 kN	3
	Pistol Grip Clamp: 120 kN	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
Ystervark Gantry Phase Conductor Strain Closing Span Configuration (Section	D-Shackle (Straight Bolt Type): 120 kN	3
	Clevis - Ball: 120 kN	3
	Insulator (Long Rod): 132 kV, 31 mm/kV, 120 kN	3

Structure	Item	Quantity
Only) - Circuit 2	Socket -Tongue (Bolt Type): 120 kN	3
	Pistol Grip Clamp: 120 kN	3
	Multi-Frequency Vibration Damper - for Phase Conductor	3
Ystervark Gantry Shield Wire Strain On Gantry (Circuit 1)	D-Shackle (Straight Bolt Type): 120 kN	6
	Extension Link 350 mm (Single): 120 kN	2
	Pistol Grip Clamp: 120 kN	2
	Multi-Frequency Vibration Damper - for Shield Wire	2
Ystervark Gantry OPGW Strain On Gantry (Circuit 2)	D-Shackle (Straight Bolt Type): 120 kN	2
	Extension Link 350 mm (Single): 120 kN	1
	Thimble Clevis: 120 kN	1
	Preformed Helically Dead End - for OPGW	1
	Armour Rod	1
	Multi-Frequency Vibration Damper - for OPGW	1
Ystervark Gantry Shield Wire Strain On Gantry (Circuit 2)	D-Shackle (Straight Bolt Type): 120 kN	3
	Extension Link 350 mm (Single): 120 kN	1
	Pistol Grip Clamp: 120 kN	1
	Multi-Frequency Vibration Damper - for Shield Wire	1
Ystervark Gantry OPGW/Fibre Connection and Termination Point on Gantry (Non-Insulated Type):	Rotating Slack Bracket	1
	Mounting Plate	As Needed
	Down Lead Clamps	
	Dome Joint	1
	50 mm x 2 mm Stainless Steel Pipe	As Needed
	Stainless Steel Strapping	
	Class 6 HDPE Pipes	
	Duct Unarmoured Fibre Optic Cable	
	Fibre Optic Terminations	

Table 15 : Mast Structures

Mast No.	1 BLW/ISC 32/1	2 BLW/ISC 32/1	1 & 2 BLW/ISC 32/2	1 BLW/ISC 32/3	2 BLW/ISC 32/3
Phase Conductor: Type 1	Chicadee ACSR	Chicadee ACSR	Chicadee ACSR	Chicadee ACSR (Modelled with 2 x Tern ACSR for Future)	Chicadee ACSR (Modelled with 2 x Tern ACSR for Future)
Phase Conductor: Type 2	-	-	-	Kingbird ACSR for Closing Span (Modelled with 2 x Tern ACSR for Future)	Kingbird ACSR for Closing Span (Modelled with 2 x Tern ACSR for Future)
OPGW Conductor:	16 kA/1 s 48 Core (Existing)	16 kA/1 s 48 Core	16 kA/1 s 48 Core	- (Modelled with weight of Kingbird ACSR for Future)	16 kA/1 s 48 Core (Modelled with weight of Kingbird ACSR for Future)
Shield Conductor:	Oak AAAC	Oak AAAC	Oak AAAC	Oak AAAC (Modelled with weight of Kingbird ACSR for Future)	Oak AAAC (Modelled with weight of Kingbird ACSR for Future)
Vertical Φ - Φ Spacing: (m)	1.5	1.5	1.5	2.35	2.35
Vertical ε - Φ Spacing: (m)	1.5	1.5	1.5	2.7	2.7
Conductor Attachment Height: (m)	24	14	22	11	13
Sides	12	12	12	16	16
Approximate Total Length: (m)	28.5	18.5	26.5	18.4	20.4
Tip Diameter: (mm)	350	300	350	350	350

Base Diameter: (mm)	1050	950	1050	1300	1450
Wall Thickness: (mm)	10	8	10	12	12
Base Plate O.D : (mm)	Manufacturer to confirm				
Base Plate I.D: (mm)	Manufacturer to confirm				
Base Plate Thickness: (mm)	Manufacturer to confirm				
H.D Bolts: (Qty)	Manufacturer to confirm				
H.D Bolts Diameter: (mm)	Manufacturer to confirm				
H.D Bolts PCD: (mm)	Manufacturer to confirm				
Working Tip Load: (kN)	73.80	71.62	78.04	210.16	217.70
Base g.l. Moment: (kNm)	2103	1325	2068	3867	4441
Baseline Eskom Standard Foundation Reference: (kNm)	3000	2000	2500	4500	5000
Approximate Mass: (tons)	5.55	2.73	5.60	4.70	5.66
Approximate Mast Utilisation: (%)	84.5	80.4	84.0	21.7 (Initial) 94.5 (Future)	30.0 (Initial) 94.7 (Future)

8.0 CIVIL SPECIFICATIONS

8.1 PSA: GENERAL

8.1.1 PSA-2: INTERPRETATIONS

PSA-2.2: APPLICABLE EDITION OF STANDARDS

Add the following at the beginning of sub-clause 2.2:

"Unless a specific edition of the standardized specifications as listed under Section 3.0 above is indicated, each ....."

PSA-2.3: DEFINITIONS

Delete the last item under Section c) Measurement and Payment and replace with the following:

“No additional compensation of provisional and general costs will be made, which are attributable to a change in the value of the *works*.”

PSA-2.8: ITEMS IN SCHEDULE OF QUANTITIES

PSA-2.8.1: Principle

In the fourth line of sub-clause 2.8.1 after the word "specification", add "or particular specification".

Add the following:

"The pay item descriptions within the various sections of these specifications are intended to be for the guidance of the *Contractor* only. Detailed descriptions of the required *works* and materials are included in the specifications and the drawings."

8.1.2 PSA-3: MATERIALS

PSA-3.1: QUALITY

Add the following:

"The onus rests on the *Contractor* to produce *works* which will conform in quality and accuracy of detail to the requirements of the drawings, the technical specifications, the Works Information and the bill of quantities and the *Contractor* shall, at his own expense (included in his rates), institute a quality control system and provide experienced technical staff together with all transport, instruments and equipment to ensure adequate supervision and positive control of the *works* at all times. The *Contractor* shall keep the *Employer* fully informed on all aspects of the quality control system.

All materials that are required to comply with a standard specification shall, where applicable, bear the official mark of the appropriate standard. The mark on a pipe or sleeve (to be installed underground) shall be visible from above, after the pipe/sleeve is laid.

Rubber articles shall be stored in a suitable shed/container and kept away from sunlight, oil or grease.

Large items, not normally stored in a building, shall be neatly stacked or laid out on suitable cleared areas on the Site. Grass or vegetation shall not be allowed to proliferate within the storage area and the material shall be kept free of dust and mud and be protected from stormwater.

Every precaution shall be taken to keep cement dry and prevent access of moisture to it from the time it leaves the place of manufacture until it is required for use on the Site. Bags of cement, which show any degree of hydration and setting, shall be removed from the Site and replaced at the *Contractor*'s expense.

Materials shall be handled with proper care at all times. Under no circumstance may materials be dropped from vehicles.

Alternate materials proposed by the *Contractor* shall require the approval of the *Employer* prior to being used as part of the *works.* Further test results may be required prior to the acceptance of such materials by the *Employer*. The costs of these tests shall be borne by the *Contractor*.

Where specified or directed by the *Employer*, the *Contractor* shall submit to the *Employer* samples of the materials that are to be used, for the approval of the *Employer,* prior to their incorporation in the *works*. Samples may also be required to serve as standards to be applied to construction methods, (e.g. surface finishes) for the duration of the contract. The costs of all tests and samples shall be borne by the *Contractor*.

The *Contractor* shall further submit to the *Employer* for approval the relevant written specifications of the material that the *Contractor* intends on delivering and installing on Site.

The *Contractor* shall be responsible for the location and procurement of all imported materials. Rates tendered for all imported material shall include all haulage. Overhaul will not be payable for any materials obtained from commercial sources.

No crushed rubble or crushed concrete materials shall be used in the earthworks or layerworks.

It is the *Contractor*'s responsibility to confirm that all necessary materials are available to successfully complete the *works* within the contract period. No claims based on the non-availability of materials will be considered.

The *Contractor* shall inform the *Employer* of any control testing to be done at least 7 days before such tests are required and must allow in his program for the time necessary for the tests and the processing of the test results.

The *Contractor* shall institute a quality control system in accordance with the requirements of the Works Information. The cost of these obligations is to be provided for in the BoQ rates.

Equipment and materials used, shall be new and of high quality design and manufacture, and shall comply with the relevant specifications and recommendations mentioned in this specification and associated contract documentation.

8.1.3 PSA-4: PLANT

PSA-4.2: *CONTRACTOR'S* OFFICE, STORES AND SERVICES

Replace the third paragraph with the following:

"Upon completion of the *works,* and with the written consent of the *Employer*, the Site establishment shall be removed. The whole area of the Site establishment, including temporary access roads and other working areas, shall be cleared and appropriately re-vegetated where necessary. Where existing road surfaces have been damaged by the *Contractor*, the *Contractor* shall re-surface the road to at least its original state prior to construction, including all applicable layerworks.

Damaged kerbing, edging and channelling shall also be replaced. Walls, fences, hedges and access to other properties, damaged by the *Contractor*, shall also be replaced and/or repaired. The cost of all such remedial *works* shall be deemed to be included in the rate for removal of Site establishment."

Add the following new clause:

"PSA-4.3: CORRECT PLANT TO BE PRICED

The *Contractor* shall familiarise himself with the Site conditions and type of construction *works* that need to be performed and allow in the rates for the correct plant and equipment, with sufficient capacity to carry out the *works*."

8.1.4 PSA-5: CONSTRUCTION

PSA-5.1: SURVEY

PSA-5.1.1: Setting Out of the *Works*

Add the following:

"Before the commencement of construction, the *Contractor* shall be provided with a general survey drawing of the work area and all boundary pegs and/or survey reference marks will be pointed out and handed over to the *Contractor*. These boundary pegs and reference marks shall be protected by the *Contractor* throughout the contract period.

Setting out of the *works* is the sole responsibility of the *Contractor* and shall be done from fixed points as indicated on the drawings. The *Contractor* shall use a SAGC registered surveyor for the setting out and monitoring of the *works*. The *Contractor* shall, within two (2) weeks after the Site has been handed over to him or drawings issued for construction, verify the correctness of all setting out points.

Any discrepancy shall immediately be reported in writing to the *Employer*. Any costs arising from discrepancies not reported to the *Employer* within the aforementioned period shall be for the *Contractor's* account."

PSA-5.1.2: Preservation and Replacement of Beacons and Pegs subject to the Land Survey Act

Add the following:

"All boundary pegs shall be clearly marked by the *Contractor* with a white painted wooden batten protruding 1.0m above natural ground level before commencement of construction *works* and must be retained until completion of the *works*.

Any survey beacons, boundary pegs or survey reference marks that are disturbed, covered or removed by the *Contractor* without the prior consent of the *Employer* shall be replaced by a registered professional land surveyor (registered with the South African Geomatics Council (SAGC)) at the *Contractor's* expense. The *Contractor* shall, in such cases, provide to the *Employer* a certificate, signed by the professional land surveyor, listing the actual beacons, boundary pegs or survey reference marks that have been replaced."

Add the following new sub-clause:

"PSA-5.1.3: As-built Information

The *Contractor* shall appoint a suitable professional SAGC registered surveyor provide as-built information as per the Eskom requirements. Refer to section 13 - HANDOVER DOCUMENTATION.

PSA-5.2: WATCHING, BARRICADING, LIGHTING AND TRAFFIC CROSSINGS

Add the following:

"The minimum requirements for road signs, barricades and delineators, required to control traffic during the execution of the *works*, shall be in accordance with the CSRA-CUTA: Road Traffic Signs Sub-committee; Road Signs Note no. 13, the South African Road Traffic Signs Manual. The *Employer* and Eskom's requirements shall also be taken into account. No *works* may proceed in any section where accommodation of traffic is required until such time as the relevant requirements with regard to signposting are met.

The *Contractor* shall keep sufficient surplus signs, barricades and delineators on Site to allow for the immediate replacement of damaged or missing items.

All arrangements in connection with the accommodation of traffic shall be submitted to the *Employer,* in the form of a method statement(s) and indicative drawing(s), for approval prior to being instituted.

Reference is made to the accommodation of traffic drawing(s) for the Site for the minimum requirements for traffic accommodation. The *Contractor* shall carry out all road crossing *works* (where required) in two stages, i.e. all trench excavations, laying and bedding of services, backfilling and placement of road layerworks shall be carried out in full for one half of the road width, unless specific road crossing *works* such as stringing of lines etc. dictate a different approach, which shall be agreed upon by all applicable stakeholders. The other half of the road width shall remain open to all traffic at all times.

The *Contractor* shall, where necessary, carry out temporary *works* to maintain the normal flow of traffic during the construction of the *works*.

The cost of these temporary *works* shall be included in the preliminary and general Items tendered for under Item PSA-8.8.2: Dealing with Traffic.

The *Contractor* shall further place flagmen on either side of the section of the *works* adjoining each side of the road. These costs shall also be included under PSA-8.8.2: Dealing with Traffic."

PSA-5.3: PROTECTION OF STRUCTURES

Change the heading to read as follows:

"PSA-5.3: PROTECTION OF STRUCTURES AND THE *WORKS*"

Add the following:

"From the start of the *works* (date of Site hand-over to *Contractor*) until the completion of the *works* and hand-over to the *Employer*, the *Contractor* shall be responsible for protecting the *works* (in progress and completed) and surrounding infrastructure from any damage caused by the construction *works*.

This shall include any damage to the *works* and any adjoining structures, civil services infrastructure, layerworks and the like. The cost of any such repairs as a result of the above shall be deemed to be included in the tendered rates."

PSA-5.5: DEALING WITH WATER ON *WORKS*

Add the following:

"The *Contractor*'s attention is drawn to the fact that the Site is located in an area where a high water table may be encountered, especially in areas where deep excavation cuts occur and during the rainy season.

All water, whether from rain, floods, pipeline failures, subsurface water or infiltration (subterranean water), shall be dealt with in such a way as to ensure the safety of the *works*.

The *Contractor* shall take adequate preventive measures and maintain these measures to ensure that the *works* are protected from damage due to water. Should these measures fail to protect the *works*, additional steps shall immediately be taken by the *Contractor* to protect the *works* and prevent further damage to adjoining properties. The cost of these protection *works*, including rectification of damages, shall be borne by the *Contractor*.

The *Contractor* shall be responsible for and shall repair at his expense any damage to new or existing foundations and structures or any part of the *works* caused by floods, water or failure of any part of the dewatering and flood protection *works*. The *Contractor* shall furthermore ensure that the method used to deal with water on the *works* is monitored 24 hours a day and during weekends and holidays. The cost of all flood protection and dewatering measures shall be included in the tendered rates.

In addition to the requirements of sub-clause 5.5 of SANS 1200 A, the *Contractor* shall design, construct and maintain all channels, drains, sumps, pumps, pipework and any other temporary *works* necessary for the dewatering and flood protection of the permanent *works*. All methods of dewatering and flood protection shall be in accordance with the requirements of the environmental management plans, as referenced in the Works Information, and shall be subject to approval by the *Employer*.

The *Contractor* shall supply and maintain all submersible pumps, where required, and have additional pumps, in good working order, available at all times as back-up should any of the primary pumps breaks down or have to undergo maintenance.

The *Contractor* shall supply, install and maintain all pipework as required to safely pump all water collected to the closest stormwater inlet or temporary settlement pond.

The *Contractor* must take note that pipelines, other below-ground installations and structures may become buoyant due to the inflow of stormwater or groundwater. Measures shall be taken by the *Contractor* to mitigate any attendant risks to the *works.*

The *Contractor* shall also implement measures to prevent, reduce and mitigate water contamination, including prevention of contamination by suspended sediments. Water removed during all dewatering operations must be pumped at low pressures into suitable settling ponds for treatment, or through filters for removal of sediments. The concentration of suspended solids within treated water released back into the sea shall not be increased by more than 10% of the ambient concentration (as defined in the Department of Water Affairs' South African Water Quality Guidelines for Coastal Marine Waters, Volume 2 (March 2012). The suspended solid limit value shall apply at the last point where the discharge of wastewater enters into the sea, dilution being disregarded when determining compliance with the limit value.

Notwithstanding the above, the minimum allowable suspended solids to be discharged from the Site into any stormwater infrastructure or onto any part of the *Employer*'s property (or any other property in close vicinity to the Site), shall be equal to or less than 25mg/ℓ, unless instructed otherwise by relevant contract documentation.

The *Contractor* must therefore plan, source, set-up and manage his de-watering and surface water collection systems in such a manner that the above minimum requirement is achieved and maintained. The *Contractor* shall further have the treated water tested for suspended solids on a weekly basis (for the first 2 months) and after that on a monthly basis, by an ISO 17025 accredited SANAS laboratory.

The cost for the installation, operation and maintenance of legally compliant flood protection and dewatering measures as well as to set up a proper filtration and sedimentation system (and maintaining it during the course of the project), including suspended solids testing, as outlined above, shall be included in the tendered rate for dealing with water on Site."

PSA-5.6: POLLUTION

Add the following:

"The onus shall vest solely with the *Contractor* to control sand erosion and dust nuisance. The *Contractor* shall be responsible for all legitimate claims resulting from damage to adjacent property as a result of sand and dust. The *Contractor* shall take due care not to unnecessarily disturb the existing vegetation.

Measures to minimise dust shall include regular and effective treatment and watering of gravel haul and access roads and working areas. No additional payment will be made for such measures and the *Contractor* shall allow for these in his tendered rates.

The *Contractor* shall be responsible for the prevention of material loss by wind erosion and no additional payment will be made for replacing soil lost by wind erosion due to the failure of the *Contractor* to take sufficient and reasonable means to prevent such loss.

The *Contractor* shall ensure that all construction debris (e.g. cement bags, timber, wire, nails, etc.) waste and surplus food, food packaging, litter, organic waste and the like are properly collected and disposed of at a registered waste disposal Site approved by the *Employer*. Waste bins shall be provided on Site as necessary, to collect such debris prior to disposal.

The *Contractor* shall clean up the *Contractor*'s camp and working areas at least once a week."

PSA-5.7: SAFETY

Add the following:

"The *Contractor* shall comply with all health and safety requirements, as stated in the Works Information. The cost of compliance with these requirements shall be provided for in the tendered rates."

PSA-5.8: GROUND AND ACCESS TO *WORKS*

Add the following:

"Before commencement of the *works*, the *Contractor* shall submit a report describing the prevailing Site conditions prior to the commencement of the *works*. The report shall include photos and written statements, highlighting any observed damages or adverse conditions pertaining to existing infrastructure at the Site, including all access roads envisaged to be used by the *Contractor*.

Upon completion of the *works*, the *Contractor* shall restore the ground surface of all areas outside of the new construction footprint that may have been disturbed during the construction activities, to its original condition. Excess materials shall be removed and all temporary excavations and ruts shall be filled with material similar to the adjoining natural ground. Planting of grass and shrubs may also be required to restore any disturbed areas. Boundary fences, which may have been removed or damaged during construction, shall be repaired and reinstated.

All roads used for access to the Site shall be maintained by the *Contractor* and upon completion of the *works*, be left in at least the original condition.

The *Contractor* shall remove from Site all temporary structures and infrastructure used during the performance of construction activities. These items shall be removed to the *Contractor's* permanent offices/yard; alternatively all items shall be removed directly to a registered landfill Site.

Reference is made to Clause PSS: SOIL AND VEGETATION REHABILITATION of the Civil Works Technical Specification document number 1924701-2-300-C-SP-0001 for further details, requirements and specifications pertaining to the restoration/rehabilitation of the soil and vegetation of the Site after the completion of all earthworks, backfilling and construction activities.

Acceptance of the restoration of the Site shall be subject to the *Employer's* approval.

The cost of these restoration *works* shall be provided for in the tendered rates by the *Contractor*."

Add the following new clauses:

"PSA-5.9: FIRE PROTECTION

Every reasonable precaution shall be taken by the *Contractor* to prevent fires. The cost of these precautionary measures shall be provided for in the tendered rates. No fires shall be allowed on Site under any circumstances.

PSA-5.10: FURTHER GENERAL OBLIGATIONS AS STATED IN WORKS INFORMATION

The *Contractor* shall provide all manpower, services, documentation and the like, in compliance with the further general obligations stated in the Works Information, including, but not limited to, the following:

a) Management meetings.
b) Documentation control.
c) Safety risk management.
d) Environmental management.
e) Quality assurance requirements.
f) Programming and progress reporting.
g) Training (where required).
h) Industrial relations management.
i) Factory acceptance tests.
j) Site acceptance tests.
k) Commissioning.
l) Other.

PSA-5.11: NAME BOARDS

The project name boards shall be erected within a month of the commencement date of the contract and shall be placed at the positions indicated by the *Employer*. The detail of the required name boards shall be in accordance with drawing number 1924701-2-510-C-DE-0010-01. The quantity of name boards required shall be indicated in the bills of quantities.

Any damage to these name boards shall be repaired within fourteen days of a written instruction issued by the *Employer*.

The *Contractor*'s attention is drawn to the requirements of Act 21 of 1940 (as amended) whereby it is an offence to display any advertising signboards that are visible from a proclaimed road without the relevant road authority's written permission.

The *Contractor* shall be permitted to erect a maximum of two of his own signboards, at positions approved by the *Employer*. The *Employer* reserves the right to order the removal of these boards if they are not kept in good repair.

PSA-5.12: SURVEY EQUIPMENT

The *Contractor* shall provide the following survey equipment on Site for the full duration of the *works*:

a) 1 Tacheometer capable of reading to 20 seconds of arc, with tripod.
b) 2 Tacheometer staffs with staff bubbles.
c) 2 Automatic levels and levelling staffs complete with tripods and staff bubbles.
d) 2 Measuring tapes of length 50m.

All equipment may be shared by arrangement between the *Contractor* and the *Employer*. The *Contractor* shall insure the equipment against any loss, damage or theft and shall indemnify the *Employer* against any claims in this regard.

The fixed cost of providing the above-listed equipment shall be covered under the payment item 8.3.2.2.f and the time-related cost of maintaining the equipment shall be covered under the payment item 8.4.2.2.f.

The *Contractor* shall maintain the equipment in good working order and keep it clean throughout the contract period. The *Contractor* shall further ensure that the minimum required field, calibration and equipment tests are regularly carried out for each instrument and shall provide the necessary certificates as proof thereof."

8.1.5 PSA-6: TOLERANCES

PSA 6.2: DEGREE OF ACCURACY

Replace this clause with the following:

"All *works* shall be carried out to a degree of Accuracy II as specified in the relevant standard specifications, unless stated otherwise in these specifications or instructed on Site by the *Employer*."

8.1.6 PSA-7: TESTING

PSA-7.1: PRINCIPLES

PSA-7.1.1: Checking

Add the following:

"All required quality control tests shall be performed by a SANAS-registered service provider. The *Contractor* is not required to provide an approved field laboratory on Site. The tendered rates shall include full compensation for all quality control tests."

8.1.7 PSA-8: MEASUREMENT AND PAYMENT

Change payment item 8.3 to read as follows:

"PSA-8.3: SCHEDULED FIXED-CHARGE ITEMS"

PSA-8.3.2: Establishment of Facilities on the Site

Change payment item 8.3.2.1 to read as follows:

"PSA-8.3.2.1: Facilities for *Employer*"

PSA-8.3.2.1.c): Name boards (2 No.) ……..Unit: Sum

Add the following to this payment clause:

"The tendered rate shall cover all fixed costs (plant, equipment, material, labour, transport, etc.) for procuring, manufacturing, transporting, providing to Site and erecting 2 No. project name boards, in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*. Reference is made to clause PSA-5.11. The rate shall also cover the removal of the name boards upon completion of the *works.*"

PSA-8.3.3: Other Fixed-charge Obligations

Replace the wording under this payment item with the following:

"The tendered sum shall include full compensation for the fixed cost of providing the services as listed above in clause PSA-5.10 and as further described in the Works Information."

PSA-8.4: SCHEDULED TIME-RELATED ITEMS

PSA-8.4.2: Operation and maintenance of facilities on Site, for duration of construction, except where otherwise stated

Change payment item 8.4.2.1 to read as follows:

"PSA-8.4.2.1: Facilities for *Employer*"

PSA-8.4.2.1.c): Name boards (2 No.)……Unit: Sum

Add the following to this payment clause:

"The tendered rate shall cover all time-related costs (plant, equipment, material, labour, transport, etc.) for maintaining the project name boards, in accordance with this specification."

PSA-8.4.5: Other Time-related Obligations

Replace the wording under this payment item with the following:

"The tendered sum shall include full compensation for the time-related cost of providing the services as listed above in clause PSA-5.10 and as further described in the Works Information."

PSA-8.5: SUMS STATED PROVISIONALLY BY ENGINEER

Change the heading to read "SUMS STATED PROVISIONALLY BY *EMPLOYER*".

Replace this payment item with the following:

"PSA-8.5.a): Additional Information, Tests and Certificates:

i) Additional test certificates, etc. and information and/or tests ordered by the *Employer*, over and above the Contract requirements, carried out by approved commercial laboratories and institutions ……Unit: Provisional Sum

The provisional sum shall cover the cost of all additional tests ordered by the *Employer.* Such costs will only be payable if such tests are beyond the scope of the *Contractor's* responsibilities in terms of the contract, or if tests and results previously submitted by the *Contractor* are found to provide a true, adequate and accurate reflection of the quality of the *works* performed by the *Contractor*.

PSA-8.5.b): Additional Equipment:

i) Provision, installation, commissioning, testing etc. of any *Employer* specified new equipment or changes, including installations or any other requirements/*works*, as instructed by the *Employer* - all costs included…..……Unit: Provisional Sum

The provisional sum shall cover all costs (plant, equipment, material, labour, transport, etc.) the *Contractor* require to attend to above listed item(s).

PSA-8.5.c): Checking of As-built Information

i) Checking by independent surveyor……Unit: Provisional Sum

The provisional sum is provided for checking of as-built information by an independent surveyor, if so ordered by the *Employer*.

The *Contractor* must note that this provisional sum is not for the use of the *Contractor* to carry out the required as-built survey as stipulated in clause PSA-5.1.3."

PSA-8.8: TEMPORARY *WORKS*

PSA-8.8.2: Dealing with Traffic……Unit: Sum

Add the following:

"The tendered rate shall cover all costs for the provision, erection, moving, re-erection and maintenance of all barriers, road signs, lights and flagmen necessary for the protection of the *works*, for compliance with traffic regulations, liaison with road authorities and affected third parties, the temporary filling of trenches overnight at road and driveway crossings and all other costs necessary in respect of the accommodation of traffic and in accordance with clause PSA-5.2: WATCHING, BARRICADING, LIGHTING AND TRAFFIC CROSSINGS."

PSA-8.8.3: Protection of the *Works* and Surrounding Structures Until Construction in Vicinity is Complete..……Unit: Sum

Add the following:

"From the start of the contract (date of Site hand-over to *Contractor*) until the completion of the contract and hand-over to the *Employer*, the *Contractor* shall be responsible for protecting the *works* (in progress and completed) from any damage caused by the construction *works*, weather, theft and/or interference from the public. The *works* include any structures, civil services infrastructure, layerworks and any other items described in the drawings, specifications and the bill of quantities. Any repairs of damages to the *works* during this period as a result of the above shall be for the *Contractor*'s account."

Add the following new payment clauses:

"PSA-8.8.7: Temporary non-adjustable construction stays

i) Supply……Unit: No.

ii) Install……Unit: No.

The tendered rate shall cover all costs for the complete supply and installation of temporary non - adjustable construction stays (Eskom specification 115kN MV type), with galvanised steel stranded wires, fixed stayrod, guy grips, thimbles, base plate, bolts/nuts, neoprene protection material for poles and all other accessories as required.

The tendered rate shall further cover the costs for all required excavations, planting and backfilling of the stays (to the required Eskom requirements) as well as the removal of the complete stay assemblies from Site and making good excavated areas by filling it with the same excavated material stockpiled from original excavation.

PSA-8.8.8: Pull testing of stays…..……Unit: Sum

The tendered rate shall cover all costs for the supply, delivering to Site, establishment, de-establishment and removal from Site of the approved stay test rig, moving the rig from stay to stay and performing pull testing of each temporary stay in accordance with the Eskom requirements.

PSA-8.8.9: Temporary wooden structures

i) Supply……Unit: No.

ii) Install……Unit: No.

The tendered rate shall cover all costs for the complete design, manufacture, supply and installation of temporary wooden structures, to correctly and safely string conductors over existing roads, overhead line infrastructure and the like, strictly in accordance with the Eskom requirements.

The tendered rate shall further cover the costs for all required excavations, planting and backfilling of the wooden structures (to the required Eskom requirements) as well as the removal of the complete wooden structure assembly from Site and making good excavated areas by filling it with the same excavated material stockpiled from original excavation."

8.2 PSC: SITE CLEARANCE

8.2.1 PSC-1: SCOPE

PSC-1.1: Insert the phrase "rubbish, rubble" before "vegetation" in the first line.

Add the following:

“This specification furthermore covers:

a) Location, protection, relocation and removal of existing services.
b) Road crossings of services.
c) The stockpiling, re-use and/or removal of excavated materials at road crossings and road excavations.
d) Search and rescue of vegetation identified to be relocated.
e) Clearing of vegetated areas and treatment by grinding and mulching, for re-use during restoration of disturbed areas.

8.2.2 PSC-3: MATERIALS

Delete Clause 3.1 and replace as follows:

“PSC-3.1: DISPOSAL OF MATERIAL

a) The *Contractor* shall be responsible for the proper disposal of waste (rubble, non-composite rubbish, contaminated soil, surplus material and the like) in accordance with the Environmental Conservation Act of 1982. This shall include the disposal of high risk substances as defined in the Occupational Health and Safety Act (Act No. 85 of 1993) under GAR Annexure 4, and in particular the disposal of asbestos in accordance with AR R17 of that Act. The burning of combustible material is prohibited.
b) The *Contractor* shall dispose of clean, granular materials, including hard rock excavations and unsuitable, oversized materials (cobbles and/or boulders) at the designated stockpile area as indicated in Part C.4: Site Information. Payment for overhaul of these materials shall be made as described in these specifications.
c) All other spoil materials, including materials from Site clearance operations (unless indicated otherwise in clause PSC-5.3) and sections of existing road surfacing that are to be removed as part of road crossings, shall be taken to a registered waste disposal Site, to be approved by the *Employer.* The *Contractor* shall present a valid certificate to the *Employer* for the disposal of all materials spoiled at the registered waste disposal Site.
d) All hazardous waste shall be disposed of at a registered hazardous waste landfill Site.”

8.2.3 PSC-4: PLANT

Add the following to clause 4.1:

“The *Contractor* shall further familiarise himself with the Site conditions and type of Site clearance *works* that need to be performed and allow in the rates for the correct plant and equipment, with sufficient capacity to carry out the *works*.”

8.2.4 PSC-5: CONSTRUCTION

PSC-5.1: AREAS TO BE CLEARED AND GRUBBED

Add the following:

“No clearing and grubbing shall be done other than on the written instructions of the *Employer*, who shall designate in detail the exact areas to be cleared and grubbed and the time when it shall be done.

The *Contractor* shall note that, in order to avoid re-clearing, the clearing and grubbing may have to be done at the last practicable stage of construction.”

PSC-5.3: CLEARING

Under section PSC-5.3.c) replace the flywheel power of 130kW with “145kW”.

Add the following:

“PSC-5.3.1: Search and Rescue

The *Contractor* shall take note that prior to the commencement of any clearing and grubbing, a comprehensive search and rescue survey shall be performed strictly in accordance with section PSS: SOIL AND VEGETATION REHABILITATION of the Civil Works Technical Specification document number 1924701-2-300-C-SP-0001.

PSC-5.3.2: Clearing and Treatment of Vegetated Areas

Refer to clause PSC-5.3.2: Clearing and Treatment of Vegetated Areas of the Civil Works Technical Specification document number 1924701-2-300-C-SP-0001.

Add the following new clauses:

“PSC-5.9: ROAD CROSSINGS AND EXCAVATION OF ROAD SECTIONS

In the case of rehabilitation of layerworks, surfacing and ancillary *works* associated to it being required as a result of the *works*, reference is made to clause PSC-5.9: ROAD CROSSINGS AND EXCAVATION OF ROAD SECTIONS of the Civil Works Technical Specification document number 1924701-2-300-C-SP-0001.

PSC-5.10: PROTECTION, RELOCATION AND REMOVAL OF EXISTING SERVICES

PSC-5.10.1: Protection of Overhead and Underground Services

Prior to commencement of Site clearance, the *Contractor* shall carry out comprehensive surveys of the Site to identify and establish the location of all existing underground services.

These investigations shall include a review of all available as-built services drawings and a full sweep of the Site using suitably calibrated and fit for purpose ground-penetrating radar systems and cable locators, operated by qualified and experienced personnel.

If the existence of a service can be reasonably expected, or such services have been identified as part of the surveys as outlined above, the *Contractor* shall, in conjunction with all relevant authorities and landowners, determine the exact depth and location of such services before the commencement of construction.

This shall include excavation of trial pits and proving trenches by hand to expose such services.

After locating the exact position of services, such services shall be deemed to be known services and the *Contractor* shall be liable for all costs arising from the damage thereof as a result of the *Contractor*’s activities.

These services must also be indicated on the “As Built” drawings submitted by the *Contractor*.

The *Contractor* shall provide all temporary protection of underground services, which shall include, but is not limited to, the following:

a) Demarcation and fencing off (barricading) of services.
b) Split sleeving and concrete encasing of underground services.
c) Providing protective earth filled raised platforms over shallow underground services.

The table below details the *works* to be undertaken for the protection of underground services.

Table 16 : Protection of Existing Known Services

Task	Known Underground Service		
	Pipes (Assume 160Ø)	Cables	Ducts with Cables Inside
Excavate/expose existing service and stockpile excavated material adjacent to trench	Yes	Yes	No
Place split sleeve around applicable service	Yes 250mm Ø split sleeve	Yes 160mm Ø split sleeves	No
Wrap split sleeve in geotextile (Kaytech A2 bidim or equivalent approved) with 500mm minimum overlap	Yes	Yes	No
Encase split sleeve in 30MPa concrete at least 250mm all around the split sleeve	Yes	Yes	No
After sufficient curing of concrete (minimum 7 days), backfill trench with stockpiled material (adjacent to trench) in 150mm layers and compact to at least 93% of MOD AASHTO density (100% for sand)	Yes	Yes	No
Dispose of excess material at designated stockpile area	Yes	Yes	No
Excavate to maximum 500mm above existing service and stockpile excavated material adjacent to excavation	No	No	Yes
Cast 30MPa slab (3m wide x 0.15m thick x length of protection L) above ducts	No	No	Yes
After sufficient curing of concrete (minimum 7 days), backfill trench with stockpiled material (adjacent to trench) in 150mm layers and compact to at least 93% of MOD AASHTO density (100% for sand)	No	No	Yes

The *Contractor* shall further take note of the existence of overhead telecommunication lines within the footprint of the *works* and that these lines will be crossed by new electrical overhead lines. The *Contractor* shall adhere to all legislation and working protocols relating to clearances and working in the vicinity of life cables/lines, i.e. the Occupational Health and Safety Act 85 of 1993, the relevant codes and standards of Eskom as well as the codes and standards of the specific telecommunications service provider.

The *Contractor* shall ensure that all existing services that are to be abandoned are decommissioned and/or safe before any Site clearing or excavations commences. Reference shall be made to the Works Information and associated documentation/drawings for known services.

PSC-5.10.2: Relocation/Removal of Services

Where required, the following procedures shall be implemented by the *Contractor* for the relocation of existing underground services:

a) Compile a detailed method statement on how the required *works* will be carried out and submit to the *Employer* for comments and approvals.
b) Verify the proposed route for the relocated service in conjunction with the *Employer* and service owner, including the junction points between the existing and relocated portions of the service.
c) Install the new service along the new route, in accordance with the specifications applicable to the specific service, to include testing, witnessing by the *Employer* and backfilling.
d) Arrange with the *Employer* and service owners for date and time for cross-over and reconnection between the existing and relocated services.
e) Undertake checks as required to confirm that existing service is isolated. Lock-out procedures shall be strictly enforced for all electrical cables. For wet services, all upstream and downstream isolation valves shall be closed off and the affected pipelines shall be drained, where possible. For communication cables, switch-overs to alternate lines shall be in place.
f) Cut the existing services at the junction points and make tie-ins, in accordance with applicable specifications and method statements.

g) Re-commission service, including tests and integrity checks as required.
h) Redundant sections of existing service shall be removed, if so instructed by the *Employer*.
i) Dispose of excess excavated material to the designated stockpile area (as indicated in Part C.4: Site Information)."

8.2.5 PSC-8: MEASUREMENT AND PAYMENT

Delete pay items 8.2.2 to 8.2.10 and replace as follows:

"PSC-8.2.2: Clearing of vegetated areas and treatment by grinding and mulching

Payment will be covered under payment clause PSC-8.2.2 of the Civil Works Technical Specification document number 1924701-2-300-C-SP-0001.

PSC-8.2.3: Location of Existing Services

PSC-8.2.3.a): Site survey by ground-penetrating radar and cable detector ..... Unit: Sum

The tendered sum shall cover all costs (plant, equipment, material, labour, transport and the like, to carry out comprehensive surveys of the Site, prior to the commencement of any *works,* by ground-penetrating radar and cable detectors to identify and establish the location of all existing underground services.

The tendered sum shall also include the pegging out of the various services on Site and marking the pegs with different colours in accordance with the type of service identified. The cost for adding the services onto As-built drawings shall not form part of this tendered sum, but shall form part of the Preliminary and General costs, as explained in clause PSA-5.1.3.

PSC-8.2.3.b): Excavation by hand in soft and intermediate materials
to expose existing services ..... Unit: m^3

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) to locate and expose existing services by hand which may affect the *works*, as required under this contract and as agreed beforehand with the *Employer*.

Excavation by hand in soft and intermediate material to expose existing services shall only be measured and paid for if so ordered in writing by the *Employer*.

Extra-over payments for hand excavations will not be made where the height difference between the bottom of the trench and the top of the service exceeds 300mm.

PSC-8.2.4: Temporary protection of known underground services:

a) Water or sewer lines (assume 160Ø) ..... Unit: m
b) Cables (electrical and/or communication)..... Unit: m
c) Ducts with cables inside ..... Unit: m

The tendered rates shall cover all costs (plant, equipment, material, labour, transport, etc.) for the temporary protection of the above listed services, in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSC-8.2.5: Temporary protection of known above-ground services:

a) 66kV Overhead electrical lines ..... Unit: Sum
b) Telecommunications overhead lines ..... Unit: Sum

The tendered rates shall cover all costs (plant, equipment, material, labour, transport, etc.) for the temporary protection of the above listed services and the structures these services are connected to or suspended from, in strict accordance with this specification, as shown on drawings or as instructed on Site by the *Employer*.

PSC-8.2.6: Remove existing cable - and pipe markers for later re-use ..... Unit: No.

The tendered rate shall cover all costs (plant, equipment, material, labour, transport, etc.) for the careful removal and storing of cable and pipe markers on Site, as shown on drawings or as instructed on Site by the *Employer*.

PSC-8.2.7: Remove all redundant underground services from Site

a) 160mm Ø Water line.....Unit: Sum
b) 160mm Ø Foul sewer line.....Unit: Sum
c) HV electrical cables.....Unit: Sum
d) Communication cables.....Unit: Sum
e) Electrical lighting cables.....Unit: Sum

The tendered rate shall cover all costs (plant, equipment, material, labour, transport and the like) for removing of all redundant services from excavated trenches and disposing of it at a registered waste disposal Site, as described also under Clause PSC-3.1 and Clause PSC-5.10.2 of this specification, as shown on the drawings or as instructed on Site by the *Employer*.

PSC-8.2.8: Temporary protection and relocation of unknown existing services..... Unit: Provisional Sum

The provisional sum shall cover all costs (plant, equipment, material, labour, transport and the like) required by the *Contractor* for the temporary protection and relocation of any unknown underground services, defined as services that are not listed in these specifications or shown on the drawings.

Payment under this item shall only be made upon a written instruction and approval of a compensation event by the *Employer*, in accordance with the conditions of contract.

PSC-8.2.9: Demolish and remove existing mast concrete foundations.....Unit: Sum

The tendered rate shall cover all cost (plant, equipment, material, labour, transport and the like) required by the *Contractor* to expose (i.e. excavate) and demolish the reinforced concrete foundations of existing masts with numbers 1 BLW/ISC 30 and 2 BLW/ISC 30 and to dispose of the concrete and reinforcing rubble at a registered waste disposal Site, as described under Clause PSC-3.1.

The tendered rate shall further cover the costs for backfilling the excavated areas (where foundations used to be) by filling it with 150mm layers of G7 quality material, wetting it and compacting it to at least 93% of MOD AASHTO.

8.3 PSD: EARTHWORKS

8.3.1 PSD-1: SCOPE

Add the following:

“This specification covers the earthworks (cut-to-fill, cut-to-spoil, borrow-to-fill and import-to-fill) for the new monopole masts 1 BLW/ISC 32/1, 2 BLW/ISC 32/1, 1 & 2 BLW/ISC 32/2, 1 BLW/ISC 32/3 and 2 BLW/ISC 32/3 foundation structures.

8.3.2 PSD-3: MATERIALS

Delete Clause 3.1 and replace as follows:

“PSD-3.1: CLASSIFICATION FOR EXCAVATION PURPOSES

a) Soft and intermediate excavations

Soft and intermediate excavations shall include all materials, except materials that can only be loosened by blasting. No distinction will be made between soft and intermediate excavations. All calcrete, regardless of the hardness of such materials, shall be classified as soft and intermediate excavations and shall be measured and paid as such.

b) Hard excavation

Hard excavation shall be materials that can only be loosened by means of blasting.”

Delete and replace Clause 3.2. as follows:

"PSD-3.2: CLASSIFICATION FOR PLACING PURPOSES

PSD-3.2.1: Classification for Placement Purposes

In-situ excavated soft and intermediate materials shall either be used as fill material for the new mast foundation platforms and road repairs, or be disposed of at the designated stockpile area, as detailed in Part C.4: Site Information.

The fill materials used shall comprise of free-draining, granular material, conforming to at least TRH 14: G7 standard of material. Such material shall preferably be obtained from selected soft and intermediate excavations within the Site.

PSD-3.2.2: Processing of Excavated Materials

Excavated materials for fills shall be spread in layers with a loose thickness not exceeding 150mm, thoroughly mixed, watered, processed and compacted.

All oversized materials larger than 75mm shall be removed by hand, and shall be separately stockpiled for disposal to the designated stockpile area."

Delete Clause 3.3 and replace as follows:

"PSD-3.3: SELECTION

If suitable fill materials cannot be obtained from Site, and only if so instructed by the *Employer*, such materials shall be obtained from one of the following sources for imported fill material:

a) Stockpiled soft and intermediate excavations at the Tippler 3 construction area.
b) Designated stockpile area as indicated in Part C.4: Site Information.

The *Contractor* shall be responsible for identifying and selecting materials from the above areas that meet the specified requirements for fill materials. The *Contractor* shall deal with all cut materials so that usable material is not contaminated with unsuitable material. If usable material is contaminated, such contaminated material shall be removed and replaced with suitable material at the *Contractor*'s expense.

All hard rock excavation material shall be deemed unsuitable material and discarded at the designated stockpile area, as indicated in Part C.4: Site Information."

8.3.3 PSD-5: CONSTRUCTION

PSD-5.1: PRECAUTIONS

PSD-5.1.1: Safety

PSD-5.1.1.2: Safeguarding of Excavations

Add the following sub-paragraphs:

"g) The *Contractor* shall not require or allow any person to work under unsupported overhanging material or in an excavation which is more than 1.5m deep (unless specified otherwise in the contract's health and safety documentation), unless the excavation has been adequately supported, shored or braced and there is no danger of the overhanging material or the sides of the excavation collapsing. The support, shoring or bracing to be designed and constructed by the *Contractor* shall be strong and sturdy enough to support the sides of the excavation in question. Such support, shoring and/or bracing shall be allowed for in the *Contractor's* tendered excavation rates."

PSD-5.1.4.1: Dust Nuisance

Add the following:

"The *Contractor* shall be responsible for dust control and is liable for all claims that may result from dust nuisance on all parts of the Site at all times, from the date of handing over of the Site to the completion date. Separate payment for these measures will not be made and all such costs are deemed to be covered by the tendered rates."

PSD-5.2: METHODS AND PROCEDURES

PSD-5.2.1: Site Preparation

Delete Clause 5.2.1.2 and replace as follows:

"PSD-5.2.1.2: Conservation of Topsoil

The conservation of topsoil shall be undertaken as described under section PSD-5.2.1.2 of the Civil Works Technical Specification document number 1924701-2-300-C-SP-0001.

The replacement of topsoil shall be undertaken as described under section PSS: SOIL AND VEGETATION REHABILITATION of the Civil Works Technical Specification document number 1924701-2-300-C-SP-0001."

Add the following new sub-clauses:

"PSD-5.2.1.4: Survey of Mast Foundation Footprint

Immediately upon completion of the search and rescue, Site clearance and topsoil stripping operations, and prior to commencement of any further earthworks, the *Contractor* shall carry out a detailed topographical survey of the areas where new monopole mast foundations are to be constructed.

The survey shall include spot shots (X-Y-Z) at a grid of no more than 2.5m, as well as any break lines, where sudden changes in the slope of the Site occur. The survey shall be submitted to the *Employer* in an electronic format that is compatible with digital terrain model software (Modelmaker, AutoCAD Civil 3D or similar). This survey, in conjunction with the lines and levels of the earthworks as shown on the drawings, or as instructed by the *Employer*, shall form the basis for the measurement and payment for the earthworks, including hard rock excavations and overhaul for such materials.

Should any hard rock be encountered during the bulk earthworks, the full extent of such areas shall be exposed and a further survey, to determine the surface level of the hard rock formations, shall be undertaken prior to any drilling and/or blasting. This survey, in conjunction with the lines and levels of the earthworks as shown on the drawings, or as instructed by the *Employer*, shall be used for the measurement and payment of hard rock excavations, including overhaul of such materials.

The surveys shall be undertaken by a SAGC registered surveyor, to be appointed by the *Contractor* and to be approved by the *Employer*. The surveys shall be submitted to the *Employer* within one week of the completion of the field surveys.

PSD-5.2.1.5: Geotechnical Investigations (including extracts from Eskom Document 240-47172620)

It shall be the *Contractor*'s responsibility to perform adequate soil/rock investigations to the satisfaction of the *Employer* and Eskom to determine the soil/rock suitability at each mast position. The soil/rock investigation shall be conducted to recognised standards and codes of practice to ensure that all encountered soil and/or rock strata are identified and delineated by area along the line route. The *Contractor* is referred to various Geotechnical Investigative Reports (carried out in the vicinity of the *works*), listed in the Site Information document, which is available upon request.

The *Contractor* shall therefore appoint an experienced registered professional (approved by the *Employer*), to carry out geotechnical investigations, in the form of a desk-level study of the area and intrusive excavation specific inspections during the construction phase, at all locations where new masts that require reinforced concrete foundations, are to be installed. The intrusive investigation shall include soil profiling (in the presence of the *Employer* and the Eskom Site Representative), final soil nominations and submission of a report with recommendations to the *Employer* and Eskom for approval. The report shall include all findings, test results, photographic evidence and the like.

Final foundation type(s) selection shall be based on the location of installation of the masts and the findings of the geotechnical investigation by the *Contractor*. Additional supplementary geotechnical investigations already conducted on-Site shall be made available to the *Contractor*, as documented in the reports referenced in the Site Information.

Soil profiling standards shall be in accordance with SANS 10161, Eskom document TRMSCAAC5.3 and the South African Institute of Engineering Geology (SAIEG) Code of Practice for Site Investigation (i.e. each stratum/layer must be described in terms of MCCSSO). The test pits shall be excavated outside the zone of influence of the appropriate foundation, and shall be taken down to a depth equal to the lesser of the depth of the foundation system to be constructed or 3m, unless instructed otherwise by the *Employer*.

In addition, the following soils tests shall be carried out per mast location:

1) Standard Dynamic Cone Penetrometer (DCP) tests.
2) Visual classification of soils.
3) Determination of present and probable water table level.
4) Laboratory tests to determine soil friction angles and cohesion values.
5) Laboratory tests to determine stress-strain modules of soils and rock.
6) Laboratory tests to determine soil unit weights.
7) Laboratory tests to determine particle grading analysis.
8) Continuous rock cores with recovery values and drilling times (where applicable).

The *Contractor* shall allow in his tendered rates for dewatering of these investigative holes, if and when required.

Note: Within drilled boreholes, the standard penetration tests and recovery of soil samples shall be obtained in each soil strata encountered or at 1.5m intervals, whichever is less. Where applicable, rock cores shall extend a minimum of 3.0m into fresh rock.

The soil/rock foundation type nominations based on the aforementioned procedures shall take place well in advance of actual foundation installation, so as not to disrupt construction activities, and to allow for the possibility of having to conduct laboratory tests on border case or mix layer type soils and/or rocks.

The test pit shall be suitably backfilled and levelled immediately after the relevant inspections and tests have been completed.

Where specialised grout injected anchor foundation systems (i.e. Micro Piles) are envisaged to be used, a more applicable geotechnical investigation for this type of anchor must be done with the following minimum requirements:

i. An investigative borehole must be drilled next to the foundation to be installed and flushed with water only, in order to establish the geotechnical conditions. From the changes of drilling rates the depths and consistency of layers, can be determined.
ii. The rate of drilling and continuous grout pressure must be recorded for each hole drilled, including all installation information that is: anchor type, size, diameter, depth, etc.
iii. From the pumped out suspension, some characteristics of the soil/rock can be determined and recorded for the layers as encountered. That is as follows:

    For soil:

    1. a fine grained or granular soil,
    2. soft/loose or dense/stiff soil
    3. the colour etc.,

    For rock:

    4. hard or soft rock and degree of weathering,
    5. shape and condition of flushed out material,
    6. the colour, etc.

iv. All this information must be logged for every drilled hole of the foundation by a qualified geotechnical specialist. If there are differences between the investigation hole and the actual anchor holes of the foundation, a further investigation hole on the opposite side of the foundation can be drilled to determine more accurate information of the geotechnical conditions.

v. Soil frictional /shear values and or strengths and other geotechnical conditions influencing the anchor performance shall be confirmed by a minimum of 10% anchor tests as per specification before foundation installation commence."

PSD-5.2.2: Excavation

Change the heading of sub-clause 5.2.2.1 to read as follows:

"PSD-5.2.2.1: Excavations for General Earthworks and for Mast Foundation Structures

Add the following (including extracts from Eskom Document 240-47172620):

"f) At each mast position, the *Contractor* shall excavate, construct the appropriate foundation and backfill the excavation as required. Excavation in this instance shall be the removal of soil/rock by any accepted means for the purpose of constructing a particular foundation system, including conventional pad and pier type foundations, spread footings, piles, etc.

g) No excavation work, other than for soil investigation, shall commence until the following conditions have been met:

1) The *Contractor* has submitted the proposed soil/rock type nomination schedules to the *Employer,* carried out in accordance with sub-clause PSD-5.2.1.5: Geotechnical Investigations.
2) The excavated topsoil shall be kept separate from the subsoil.

h) Excavations shall be made to the full foundation dimensions required, and shall be finished to the prescribed lines and levels. The bottom or sides of excavations upon or against which concrete is to be poured shall be undisturbed. If, at any point in excavation, the natural material is disturbed or loosened or over excavated, the over-excavations shall be backfilled with 10MPa concrete, including the application of a blinding layer at the base of foundations where these eventualities are likely to occur during the construction process. Soil backfilling will not be accepted.

i) When the material at foundation depth is found to be partly rock or incompressible material, and partly a soil or material that is compressible, all compressible material shall be removed for an additional depth of 200mm and backfilled with 15MPa concrete "reimbursable as per to the bill of quantities".

j) The excavations shall be protected so as to maintain a clean subgrade until the foundation is placed. Any water, sand, mud, silt or other objectionable material which may accumulate in the excavation, including the bottom of pile or anchor holes, shall be removed prior to concrete placement.

k) Excavations for cast-in-situ concrete, including pile caps cast against earth, shall be concreted within seventy-two hours after beginning the excavations. In addition to this general requirement, pile and/or anchor holes that are not adequately protected against the elements, must be corrected and be acceptable to the *Employer*. Soil excavations that remain un-concreted for longer than seventy two hours shall be required to be enlarged by 150mm in all sides/directions.

l) The excavations shall be kept covered or barricaded in a manner accepted by the *Employer* to prevent injury to people or livestock. Failure to maintain proper protection of excavations may result in the suspension of excavation work until proper protection measures have been restored.

m) The *Contractor* shall notify the *Employer* upon completion of the excavation for each foundation. No concrete shall be placed until the excavation and its associated shuttering and reinforcing steel have been inspected and accepted in writing by the *Employer*.

n) All temporary earthworks embankments shall not be steeper than 1:1 (45°), unless otherwise specified by the *Employer* or otherwise indicated on the drawings.

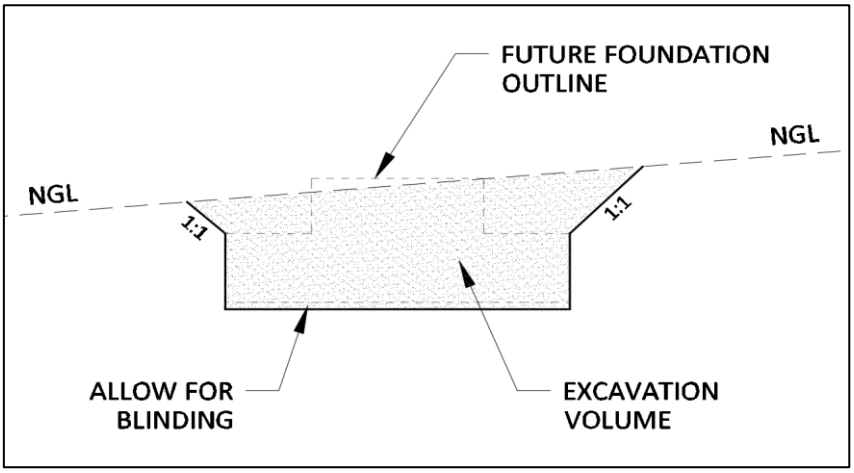
o) The *Contractor* shall allow in his tendered rates for shoring where excavation gradients becomes steeper than 1:1, or when the excavation depths are more than 3m deep (unless specified otherwise in associated contract documentation or drawings). The support, shoring or bracing shall be designed and constructed by the *Contractor* and shall be strong and sturdy enough to support the sides of the excavation in question for the duration of the excavation, foundation construction and backfilling period.

p) All permanent earthworks embankments shall not be steeper than 1:2 (~26° from the horizontal), unless otherwise specified by the *Employer* or otherwise indicated on the drawings.

q) The *Contractor* shall ensure that all excavations are done according to the relevant safety and environmental requirements.

r) All oversized excavated materials that cannot be broken down on Site and all hard rock excavations shall be spoiled at the designated stockpile area as indicated in Part C.4: Site Information.

s) The *Contractor* shall only be paid for the volume of material excavated per mast foundation as per the lines, gradients and levels indicated below or as instructed on Site by the *Employer*. Any over excavation due to collapsing sides or calcrete being encountered, shall be deemed to be included in the *Contractor*'s tendered rates for excavations."



PSD-5.2.2.3: Disposal

Add the following:

"All waste products generated through the demolition of existing structures or through excavation and compaction activities shall be removed and shall be disposed of at the spoil sites, as described under PSC-3.1. Waste material that is temporarily stockpiled on Site shall be removed within a period of no more than 60 days of excavation and/or demolition, and prior to completion of the *works*. Separate payment for disposing of waste materials will not be made and all costs are deemed to be covered by the tendered rates."

PSD-5.2.3: Placing and Compaction

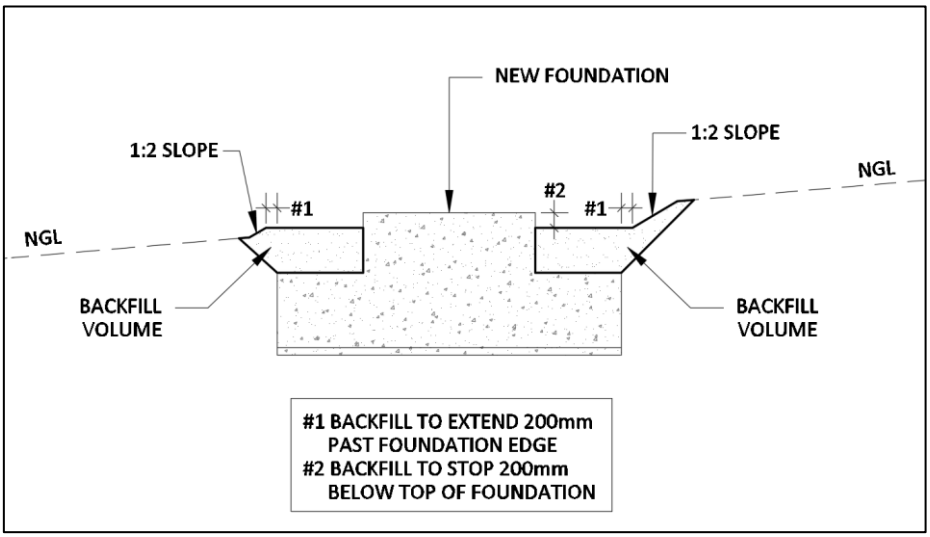
Add the following new sub-clause:

"PSD-5.2.3.3: Backfilling of General Structures and New Mast Foundations (including extracts from Eskom Document 240-47172620):

a) After the completion of the foundation construction, the *Contractor* shall backfill each mast excavation with suitable material.
b) The material to be utilised for compacted backfill shall be moistened to optimum moisture content (which is to be determined by the laboratory testing) and deposited in horizontal layers, having a final thickness of not more than 150mm after being compacted. The pad of the foundation shall be covered, first with a 200mm layer of well-graded material containing no particles larger than 20mm in diameter, before any coarse material is deposited.
c) The backfill material to be compacted shall contain no material of size more than 75mm in diameter, and be free from organic material such as trees, brush, scraps, etc.
d) The distribution of material shall be such that the compacted material will be homogenous to secure the best practicable degree of compaction, impermeability and stability.
e) Prior to and during compaction operations, the backfill material shall have the optimum moisture content (±2%) required for the purpose of compaction, impermeability and stability.
f) The material shall be mechanically compacted to a minimum of 93% of the Mod-AASTHO Maximum Dry Density of the undisturbed material (as determined from laboratory testing) (100% compaction is required for clean sand).
g) The surface of the backfill around the foundation shall be carried to such an elevation and shape that water will not accumulate on top of the backfilled area.
h) Material removed from the excavation, which is either not suitable or not required for backfill, shall be disposed of at the designated stockpile area as indicated in Part C.4: Site Information. Spreading of subsoil in adjacent undisturbed areas will not be allowed. Excavated soil suitable for backfill will be returned to the excavation by backfilling with the subsoil first and the topsoil last.
i) Where the excavated material is considered to be unsuitable for backfill, such as a material with high clay content or a sandy material with little variation in particle size, the *Contractor* shall propose a suitable method of soil improvement for consideration and acceptance by the *Employer* prior to being implemented.

This material shall be properly mixed with the agreed upon soil improvement additive, moistened, placed and compacted in the same manner as other excavated material.

j) The *Contractor* shall only be paid for the volume of material backfilled per mast foundation as per the lines, gradients and levels indicated below or as instructed on Site by the *Employer*. Any over backfilling due to collapsing sides or calcrete being encountered (resulting in larger excavations), shall be deemed to be included in the *Contractor*'s tendered rates for backfilling.



PSD 5.2.4: Finishing

PSD 5.2.4.1: Final Grading

Add the following:

"Finished levels for earthworks shall be as follows:

a) Within areas that are to be landscaped or revegetated: 150mm below the final levels, to allow for re-spreading of topsoil."

Delete and replace clause 5.2.5 as follows:

"PSD-5.2.5: Transport for Earthworks

PSD-5.2.5.1: Freehaul

The freehaul distance for all materials disposed from Site shall be 1.0km.

PSD-5.2.5.2: Overhaul

Haul distances shall be measured from the existing Iscor Substation.

Overhaul shall only be payable for conveyance of the following materials:

i. Overhaul Measured to Line and Level

Overhaul for the following materials, to be taken to the designated stockpile area as described in Section C.4: Site Information shall be measured to line and level, as described below:

a) Cut to spoil of excess soft and intermediate materials.
b) Hard rock excavations (blasting).

The quantities to be used for the calculation of overhaul for the above items shall be based on the in-situ or nett, compacted volumes as determined from the surveys, as described under PSD-5.2.1.4 and the final lines and levels of the excavations, as indicated on the drawings or as instructed by the *Employer*. Haul distances shall be via the shortest feasible route to the designated stockpile area.

ii. Overhaul Measured per Truckload

Overhaul for the following materials shall be measured per truckload, as described below:

a) Disposal of oversized material.
b) Disposal of excess topsoil, as described under Clause PSD-5.2.1.2.
c) Fill materials imported from the Tippler 3 construction area or designated stockpile area, as described in Clause PSD-3.3. Payment for the importation and overhaul of such materials shall only be made if a written instruction to this effect has been issued by the *Employer.*
d) Removal of excess or unsuitable clean, granular trench excavations, where so instructed by the *Employer.*

The volume of materials for which overhaul is payable by truckload shall be based on the loose volume in the truck, adjusted as follows for bulking:

a) Nett volume for calculation of overhaul = 0.75 x loose volume in truck

For materials where overhaul is measured loose, per truckload, the following shall apply:

a) The type and nett, full volumes per truck shall be submitted to the *Employer* for record purposes, prior to the commencement of overhaul.
b) Part payments shall be made in cases where trucks are not fully laden.
c) Tallies for overhaul shall be handed to the *Employer* on a daily basis, to include the following:

- Type of materials conveyed.
- Registration number and name of truck driver.
- Make of truck.
- Nett, full or part volume transported.

Payment for overhaul of loose materials will not be made if complete records have not been received or approved by the *Employer*. Haul distances shall be via the shortest feasible route to the designated stockpile area. The table below provides a further summary of payments for overhaul.

Table 17 : Overhaul

Earthworks Item	Area of Application	Pay Items	Basis
Cut to Fill	Earthworks for monopole mast foundations	Not payable	n/a
Temporary stockpiling on Site as part of the *works*	During earthworks for the creation of monopole mast platforms	Not payable	n/a
Borrow to Fill	Import materials from Tippler 3 or designated stockpile area	PSD-8.3.6	Loose, per truckload
Cut to Spoil	Rock excavations	PSD-8.3.6	Survey, design line and level
	Oversized materials	PSD-8.3.6	Loose, per truckload
	Excess granular material from soft and intermediate excavations	PSD-8.3.6	Survey, design line and level
	Unsuitable materials from trench excavations	PSD-8.3.6	Loose, per truckload
Removal of Topsoil	Excess topsoil not to be used for rehabilitation of embankments, etc.	PSD-8.3.6	Loose, per truckload

Overhaul will not be payable for any materials obtained from commercial sources or waste materials disposed of at a registered waste disposal Site, other than the designated stockpile area, as described under Clause PSC-3.1 above, including, but not limited to, the following:

a) Disposal of building rubble resulting from the demolition of existing structures and the like, where applicable.
b) Disposal of any other waste materials generated as a result of construction activities.

The above materials shall be disposed of at an approved, registered waste disposal Site. The costs of disposing of these materials shall be included in other scheduled rates."

Add the following new sub-clauses:

"PSD-5.2.6: Keeping Excavations Dry

The *Contractor* shall be responsible for the control of all ground - and surface water entering any part of the excavated areas. This control shall be carried out by means of proper water catchment and channel systems, dewatering systems and the like, which shall be subject to the approval by the *Employer*. The *Contractor* shall ensure that all excavations are completely dry prior to the placing of concrete.

The design, installation, operation and maintenance of the approved method of dealing with water on Site shall be the responsibility of the *Contractor* and the cost of these measures shall be provided for under pay items PSA-8.3.2.2 and PSA-8.4.2.2 of PSA: GENERAL.

Reference is also made to Clause PSA-5.5: DEALING WITH WATER ON *WORKS*.

PSD-5.2.7: Improvement of Bearing Capacity of In-situ Soil

When the excavation for a mast foundation reaches the proposed foundation level, the *Contractor* shall (in the presence of the *Employer*) carry out a 2m deep standard Dynamic Cone Penetrometer (DCP) test from this foundation level to test the bearing capacity of the in-situ soil.

The allowable penetration depth (for the in-situ soil bearing capacity to be deemed satisfactory) shall be between 15mm/blow to a maximum of 20mm/blow. Where the penetration depth per blow is more than 20mm, the in-situ soil shall be re-engineered/improved as follows:

a) Excavate the in-situ soil up to the bottom of the "failed" layer(s) and stockpiled for re-use. The size of the excavation shall be such that it shall include the width of the effective bulb pressure in relation to the depth of the excavation. The size of the excavation shall be agreed on-Site between the *Contractor* and the *Employer*.
b) When the bottom of the "failed" layer is reached, scarify and re-compacted the in-situ soil to at least 93% of MOD AASHTO to a depth of at least 150mm.
c) Backfill the excavation with the stockpiled material in layers not exceeding a final thickness of 150mm, with each layer compacted to at least 93% of MOD AASHTO.
d) Upon completion of the backfilling up to the proposed foundation level, the 2m deep standard Dynamic Cone Penetrometer test shall be repeated.
e) If the re-engineered/improved soil still fails the minimum bearing capacity requirements, the same process described in items a) to e) shall be repeated with the addition of a 2% cement stabilisation in each 150mm layer of material backfilled.

Note: Where the excavated material stockpiled (item c) above) is unsuitable to be re-used as backfilling, and only if so instructed by the *Employer*, such materials shall be obtained from one of the sources described in clause PSD-3.3: SELECTION."

8.3.4 PSD-6: TOLERANCES

PSD-6.1: POSITION, DIMENSIONS, LEVELS, ETC.

Add the following:

"Cut and fill operations shall comply with the tolerances set out for terraces and embankments in Clause 6.1.b) of SANS 1200D (Degree of Accuracy I) except for the final 150mm layer of fill material placed, which shall comply with the tolerances for a selected layer as set out in clause 6.3 of SANS 1200DM (Degree of Accuracy II) and clause 6.2 of SANS 1200M."

8.3.5 PSD-7: TESTING

Delete Clause 7.2 and replace as follows:

"PSD-7.2: TAKING AND TESTING OF SAMPLES

The minimum testing frequency for process control for the construction of the earthworks shall not be less than the frequency set out in the table below:

Table 18 : Test Frequencies: Earthworks

Test	Testing Frequency
Density (Relative Compaction at OMC)	1 test per 150mm of fill layer per monopole mast
Indicator Tests, Grading and CBR	1 test per 10m³ of fill material placed
2m deep DCP test	1 test per mast foundation

The *Contractor* shall conduct the appropriate tests as given in TMH1 to check that the materials and workmanship comply with the applicable requirements given in this specification. Should the average and minimum density of a test(s) carried out in accordance with the above, be equal to or exceed the applicable values given in the table below, the compaction shall be deemed to comply with the requirements for density.

Table 19 : Compaction Densities: Earthworks

Layer	Density Specified (% of MOD AASHTO max density)	Average Density (%) of At Least 3 Positions Tested	Minimum Density for Any Single Test (%)
General backfill materials (other than cohesionless sand)	93.0	93.7	89.4
General backfill materials (cohesionless sand)	100.0	101.0	98.0

The cost for all process control tests shall be included in the rates for supplying, processing, placing, watering and compacting of the various layers."

8.3.6 PSD-8: MEASUREMENT AND PAYMENT

Replace Clause 8.2 as follows:

"PSD-8.2: COMPUTATION OF QUANTITIES

Delete this clause and replace with the following:

"PSD-8.2.1: Scope

Construction of the bulk earthworks for the monopole mast platforms and road crossings includes the re-use or disposal of existing soft and intermediate excavations and importation of fill materials from the Tippler 3 construction area or designated spoil Site as indicated in clause PSD-3.3 and the importation of material from commercial sources. The following sections cover the measurement and payment for these *works*, as well as further requirements.

PSD-8.2.2: Disposal or Re-use of Existing Soft and Intermediate Excavations

In-situ excavated soft and intermediate materials may either be disposed of at the designated spoil Site or may be re-used as backfill material for the new high and low mast platforms and road crossings. Existing excavated materials shall not be used for the construction of any new layerworks.

The quantity of materials to be disposed of or re-used shall, for the purposes of payments, be the calculated in-situ volumes taken from the lines and levels of the excavations in soft/intermediate soils, as determined from the drawings or as instructed by the *Employer*. Payments shall be made as follows:

a) Disposal of Existing In-situ Soft and Intermediate Excavations (Excavate and Dispose)

The scheduled rate for the disposal of existing in-situ materials to the designated spoil Site shall include scarifying, loosening, excavation, loading and unloading of the materials.

Overhaul will be payable for the conveyance of the material to the spoil Site. The volume of materials to be used for payment purposes of overhaul shall be the same quantity used to calculate the volume of soft and intermediate excavations, as described above.

b) Re-use of Existing In-situ Soft and Intermediate Excavations (Cut to Fill)

Payment for the re-use of the excavated soft and intermediate materials for the construction of the new high and low mast platforms and road crossings shall be made under the designated cut-to-fill pay item. The rate shall include scarifying, loosening and moving of the existing soft and intermediate excavated materials within the footprint of the Site, as well as the watering, compaction and testing of the layer after placement, as part of the new fill formation or embankment.

Separate payment shall not be made for the temporary stockpiling of these materials and shall be deemed to be included in the tendered cut-to-fill rate of the *Contractor*.

PSD-8.2.3: Imported General Fill Materials (Borrow to Fill) for the New Monopole Mast Platforms

Preference shall be given to the re-use of existing excavated soft and intermediate materials for the construction of the new monopole mast platforms and road crossings. Where, due to logistical reasons, scheduling constraints or insufficient material quality, it is not possible to re-use these materials, the *Contractor* shall import fill material from the Tippler 3 construction area or designated spoil Site.

Importation of fill materials shall be subject to an instruction to this effect being issued by the *Employer.* The *Contractor* shall carefully select suitable materials from the spoil Site that meet the specified requirements for use as backfilling.

Payment for importing of fill materials shall include the loading of materials at the Tippler 3 construction area or designated spoil Site as well as the off-loading, spreading, watering, compaction and testing of the materials in the final position.

Overhaul will be payable for the conveyance of the material from the spoil sites. The volume of materials to be used for payment purposes of overhaul shall be the same quantity used to calculate the volume of imported materials, as described above.

PSD-8.2.4: Extra-over for Hard Rock Excavations

The rate shall cover the additional cost of the operations enumerated above in sub-clause PSD-8.2.2 for any portion of the excavation that is classified as hard rock excavations.

PSD-8.2.5: Quantities for Payment Purposes

The calculated volume for measurement and payment purposes for soft and intermediate materials (cut to fill, cut to spoil and importing) and hard rock materials (cut to spoil) shall be the calculated placed and compacted volume, based on the following information:

a) The topographical surveys to be conducted upon removal of topsoil, as described under sub-clause PSD-5.2.1.4.
b) The lines and levels of the excavations in soft/intermediate and hard rock soils, as determined from the sketches in PSD-5.2.2 and PSD-5.2.3 or as instructed by the *Employer.*

Overhaul quantities shall be measured as described in Clause PSD-5.2.5."

PSD-8.3: SCHEDULED ITEMS

PSD-8.3.1: Site Preparation

Add the following new payment item:

"PSD-8.3.1.3: Carry out topographic survey of the Site:

a) After search and rescue, Site clearance and removal of topsoil ..... Unit: m^2
b) After exposure of rock surface ..... Unit: m^2

The tendered rates shall cover all costs (plant, equipment, material, labour, transport and the like) to conduct the surveys as detailed under PSD-5.2.1.4, including compilation and handing over of all hard copy and electronic data to the *Employer*."

PSD-8.3.2: Bulk Excavation

Delete Item 8.3.2 and replace with the following:

"PSD-8.3.2.a): Excavate in soft and intermediate materials and dispose, as ordered, for:

i) New monopole mast foundations..... Unit: m^3

PSD-8.3.2.b): Cut to fill (existing in-situ soft and intermediate materials), for:

i) New monopole mast foundations..... Unit: m^3

PSD-8.3.2.c): Borrow to fill, for:

i) New monopole mast foundations..... Unit: m^3

PSD-8.3.2.d): Extra-over for hard rock excavations, for:

i) New monopole mast foundations..... Unit: m^3

The tendered rates above shall include all plant, labour, materials and equipment as required for the procuring, disposal and processing of materials, described under Clause PSD-8.2 as follows:

For Item a) : Refer to Clause 8.2.2.a)
For Item b) : Refer to Clause 8.2.2.b)
For Item c) : Refer to Clause 8.2.3
For Item d) : Refer to Clause 8.2.4"

Delete payment item 8.3.6 and replace as follows:

"PSD-8.3.6: Overhaul ..... Unit: m^3.km

The tendered rate shall cover all costs for loading, transporting and off-loading materials for which overhaul is payable, as described under Clause PSD-5.2.5. The overhaul quantities shall be calculated as described under Clause PSD-5.2.5.2."

Add the following new payment items:

"PSD-8.3.14: Carry out geotechnical investigations, for:

a) Conventional foundations (pad footings, etc.) ..... Unit: Sum
b) Piled foundations (micro piles, etc.) ..... Unit: Sum

The tendered rates for a) and b) above shall cover all costs for the *Contractor* to appoint an experienced registered professional to carry out geotechnical investigations at each monopole mast position, as described under Clause PSD-5.2.1.5: Geotechnical Investigations. The tendered rate shall further include for test pit excavations, soil profiling, laboratory testing, backfilling of test pits and compiling of final on-Site geotechnical reports for the scrutiny and approval of the *Employer*.

PSD-8.3.15: Improvement of Bearing Capacity of In-situ Soil, by:

a) Conventional means (excavate and backfill in layers) ..... Unit: m^3
b) Soil stabilisation ..... Unit: m^3

The tendered rates for a) above shall cover all costs for the *Contractor* to excavate and stockpile, scarify and re-compact in-situ bottom layer, backfill and compact in layers of 150mm and carrying out a 2m DCP test to verify soil stabilisation, as described under clause PSD-5.2.7: Improvement of Bearing Capacity of In-situ Soil items a) to d).

The tendered rates for b) above shall cover all costs for the *Contractor* to excavate and stockpile, scarify and re-compact in-situ bottom layer, mix 2% cement stabiliser with backfill material, backfill and compact in layers of 150mm and carrying out a 2m DCP test to verify soil stabilisation, as described under clause PSD-5.2.7: Improvement of Bearing Capacity of In-situ Soil item e).

If and when applicable, the sourcing of suitable backfill material (i.e. when stockpiled soil is found not to be suitable for backfilling), the hauling thereof, as well as the disposal of excess material, shall be measured elsewhere.

PSD-8.3.16: Removal of oversize materials ..... Unit: m^3

The unit of measurement shall be the cubic metre of oversized materials that cannot be broken down as specified and is removed. The volume shall be determined as the loose volume of oversized materials, measured in stockpiles or per loose, full truckload.

The tendered rate shall include full compensation for blading oversize materials to windrow, loading and transporting the material within the freehaul distance to temporary stockpile or onto trucks."

8.4 PSF: PILING

8.4.1 PSF-1: SCOPE

Add the following:

"This specification covers the construction in sub-soil of reinforced monopole mast foundation piles only when conventional pad foundations cannot be constructed due to soil conditions and space constraints on Site."

8.4.2 PSF-3: MATERIALS

Add the following:

"Following approval of the method statements by the *Employer*, the sources of materials shall not be changed unless the *Contractor* has demonstrated that the materials from the new source can meet all the requirements of the specification. Materials failing to comply with the specification shall be removed promptly from the Site.

The materials used for concrete and reinforcement shall comply with the requirements of SANS 1200 G, including amendments as covered under section PSG: Concrete (Structural) in this technical specification. The characteristic concrete strength shall be at least 40MPa.

The *Contractor* shall ensure that all materials and equipment required for the piles are available on Site well ahead of the commencement of installation.

The *Employer* shall be provided with unencumbered access to inspect all materials and equipment delivered to Site, including inspections at the premises of manufacturers, subcontractors and suppliers.

Only new piles shall be used for permanent *works*. Precast piles, if used, shall be carefully examined at the time of delivery and damaged piles shall be repaired or replaced. Records of tests performed on the steel to be used for the piles shall be submitted to the *Employer* prior to commencement of the *works*."

Add the following new clause:

"PSF-3.5: TEMPORARY CASINGS

Temporary casings for cast-in-situ piles shall have sufficient strength and rigidity to ensure that they can be installed without distortion and will remain undamaged during placing of concrete. The cast-in-situ piles shall be designed by the *Contractor* to meet the working load applications indicated on drawings."

8.4.3 PSF-4: PLANT

PSF-4.1: PLANT AND EQUIPMENT FOR CONSTRUCTION

PSF-4.1.1: General

Add the following

"The selection of plant for the installation of the percussive foundation piles (Rotapiles) shall be at the *Contractor's* discretion, but shall take account of the ground conditions and pile type. The lined Rotapiles shall be drilled to the specified level as shown on the drawings using 'Down the Hole Hammer' (DTH) percussion drilling techniques. This percussive technique requires significant quantities of compressed air to operate the hammer and ensure adequate flushing of spoil from the hole.

Temporary casing shall be provided to ensure stability of the drilled hole during installation of the steel reinforcement and pouring of concrete. The pile reinforcement is placed in the drilled hole once the hole has been flushed clean by air."

8.4.4 PSF-5: CONSTRUCTION

PSF-5.1: GENERAL

Add the following new sub-clauses:

"PSF-5.1.8: The *Contractor* shall appoint a suitably experienced and qualified person and/or subcontractor to complete the detail designs and manage the installation of the foundation piling, based upon the provisions of this specification. Particulars of the person and/or subcontractor appointed by the *Contractor* shall be submitted to the *Employer* for his review and approval.

PSF-5.1.9: The *Contractor* shall supply in writing a guarantee specifying the load capacity of the piles as well as details of concrete, reinforcing used and earthing requirements thereof in accordance with the electrical specifications, drawings and other associated contract documentation. The *Contractor* shall provide a final completion certificate.

PSF-5.1.10: The *Contractor* shall compile detailed method statements, describing the plant, materials and construction methods to be used for the installation of the foundation piles, including particulars of the monitoring equipment and quality control procedures that the *Contractor* plans to use and implement.

PSF-5.1.11: The *Contractor* shall also submit a detailed programme for all piling activities prior to commencement of the *works,* showing his planned sequence and timing for installing pile elements and taking particular account of the avoidance of damage to adjacent piles, structures or services. The programme shall be updated at fortnightly intervals, or at such intervals as agreed to with the *Employer*.

PSF-5.1.12: The foundation piles shall comprise of Rotapiles (or percussive piles) of varying diameters, to be founded in the underlying hard granite rock.

PSF-5.1.13: Alternative methods to those stated above may be used, provided that the *Contractor* demonstrates that such alternatives satisfy all requirements of the specification and that these methods are approved by the *Employer.*

PSF-5.1.14: The *Contractor* shall, as a matter of course, inform the *Employer* each day of the intended *works* to be undertaken within the next 24 hours. The *Contractor* shall also give 24 hours' notice of his intention to work outside normal hours and at weekends.

PSF-5.1.15: The *Contractor* shall submit to the *Employer* on the first day of each week a progress report showing the current rate of progress and progress during the previous period on all important items of each section of the *works.*

PSF-5.1.16: Where applicable, the vertical, horizontal and moment working (unfactored) pile loads are indicated on drawings. All loads indicated are per pile, in kN or kNm unless otherwise indicated on drawings. Horizontal loads can act in any direction. All piles must be able to withstand a minimum vertical uplift load and bending moment in accordance with the calculated maximum loads and bending moments of each mast.

The *Contractor* shall ensure to meet the required working load applications, indicated in the drawings (where applicable), in his design.

PSF-5.1.17: The *Contractor* is responsible to program and monitor the piling operation in such a way that it does not delay any of the other *works*.

PSF-5.1.18: The depth of rock shall be determined on-Site.

PSF-5.1.19: Should expansive ground conditions be present, all piles are to be anchored to the underlying rock by means of socketing to resist heave.

PSF-5.1.20: The *Contractor* shall immediately report to the *Employer* any circumstance which indicates that, in the *Contractor*'s opinion, the ground conditions differ materially from the ground conditions that can reasonably be inferred from the geotechnical investigation reports.

PSF-5.1.21: Should the *Contractor* wish to perform additional subsoil investigations during the course of the *works*, to verify the subsoil conditions or to prove that a different method of construction is required, the *Employer* may permit him to do so, provided that the *Employer* shall be notified and be provided with the opportunity to witness such additional tests.

PSF-5.1.22: The *Contractor* shall ensure that, during the course of the *works*, displacements or damages, which may impair either the performance or durability of the *works,* do not occur. The *Contractor* shall, at his own cost, submit plans for undertaking surveys and monitoring movements or vibration before the commencement of the *works.*

PSF-5.1.23: The *Contractor* shall carry out the work in such a manner and at such times as to minimize noise, vibration and other disturbance in order to comply with all environmental requirements, in accordance with the relevant details included in the Works Information.

PSF-5.1.24: If, in the opinion of the *Contractor,* damage may be caused to other structures or services through the execution of the *works* or surrounding property, he shall immediately notify the *Employer*.

PSF-5.1.25: The *Contractor* shall determine the positions of all known services and structures before commencing work on-Site.

PSF-5.1.26: The *Contractor* shall provide a competent, suitably qualified and experienced full-time supervisor on-Site to manage the piling operations as described in these specifications. Particulars for the full-time supervisor shall be submitted to the *Employer* for review and approval.

PSF-5.1.27: Driven or displacement piles shall not be used unless the *Contractor* can demonstrate that they can meet all the required loading conditions and can satisfactorily penetrate the ground conditions.

PSF-5.1.28: The diameter of the rock sockets, if required, shall be fixed as part of the final selection and design of the piling system. The *Contractor* shall provide the necessary details for review and approval by the *Employer*. Rock sockets shall penetrate to a minimum depth of 3,000mm into the granite rock. The specified rock hardness for sockets shall be at least 50MPa compressive strength (i.e. class R4)."

PSF-5.5: CAST-IN-SITU CONCRETE PILES

PSF-5.5.1: Placing of Reinforcement

Replace sub-clause 5.5.1.6 with the following:

"The longitudinal bars shall project above the cut-off level by a minimum of 50 times the bar diameter."

PSF-5.9: PILING RECORDS

Add the following:

"The *Contractor* shall keep complete piling records for inspection by the *Employer* at any time. The *Contractor* shall update the *Employer* frequently regarding rock levels, cast levels, etc."

PSF-5.10: PILE HEADS AND CAPS

PSF-5.10.1: Stripping of Pile Heads

Replace sub-clause 5.10.1.2 with the following:

"PSF-5.10.1.2: Cast-in-situ piles shall be concreted to a minimum of 150mm above cut-off level and a maximum of 500mm above cut-off level, unless agreed otherwise in writing."

Replace sub-clause 5.10.1.6 with the following:

"PSF-5.10.1.6: The main reinforcement of a concrete pile shall extend a minimum of 50 times its diameter beyond the cut-off level into the pile cap. This reinforcement shall be left straight unless otherwise shown in the drawings or as directed by the *Employer* on-Site."

8.4.5 PSF-6: TOLERANCES

PSF-6.1: GENERAL

Add the following:

"All piles (driven or cast in-situ) shall be positioned to degree of accuracy II according to SANS 1200F Clause 6.2. A land surveyor shall certify final pile positions before further construction may continue.

Marker pins for all foundation pile positions shall be set out and installed by the *Contractor*. Prior to installation of the foundation piles, the positions shall be checked by the *Contractor* and confirmed by the *Employer*."

8.4.6 PSF-7: TESTS

Replace this clause with the following:

"PSF-7.1: GENERAL

Testing of piles to be executed in such a way that it does not interfere with the construction sequence.

PSF-7.2: LOAD TESTS ON PILES

The *Employer* requires one or more pile load tests to be carried out as part of this contract. The test piles, which will be nominated by the *Employer*, may include piles that form part of the permanent *works*, or may be piles installed for the sole purpose of undertaking the tests. In the latter case, additional piles may have to be installed to fix load-bearing members that are required for the test.

The results of the pile test will be used to determine the short-term settlement, i.e. during construction up until the working load is applied, as well as the long- term settlement after the working load is applied. The method of testing shall be as stated in below clause PSF-7.3: PILE TEST ASSEMBLY AND TEST PROCEDURE.

Static loading of the test pile shall be undertaken with a test load of at least 2.0 times the design load.

PSF-7.3: PILE TEST ASSEMBLY AND TEST PROCEDURE

PSF-7.3.1: Pile Test Assembly

PSF-7.3.1.1: Capacity of Test Assembly

The test assembly shall be capable of the safe application of the test load, which is taken to be 2.0 times the Design Load.

PSF-7.3.1.2: Test Assembly

The test assembly shall be constructed and supported such that safe access to all parts of the assembly may be made at all times during a test.

The force to load the pile shall be provided by jacking against the reaction of either tension piles or kentledge, or ground anchors, or any combination of these as accepted by the *Employer*.

If in the opinion of the *Employer* the Site is such that pile uplift or heave may be caused by driving adjacent piles, then the reaction for Trial Pile tests shall be provided by tension piles which shall be installed in a sequence to be agreed with the *Employer*.

Driven piles shall not be used as tension piles for working pile tests.

The *Contractor* shall submit complete details of the test assembly he proposes to adopt for approval. These details shall include a complete list of all equipment to be used in the test including manufacturer's name and catalogue number and any other identification marks.

PSF-7.3.1.3: Tension Piles

Under-reamed piles shall not be used as tension piles.

Working piles shall not be used as tension piles.

PSF-7.3.1.4: Ground Anchors

Ground anchors shall be pre-loaded to provide a reaction greater than the specified capacity of the test assembly so that sufficient contact stress is maintained throughout the pile test between the loading beam and loading beam support to prevent unrestrained lateral movement. The ground anchor pre-load shall be agreed.

Each ground anchor shall be loaded to 1.2 times the approved pre-load and the load held for 5 minutes while measurements of tendon extension are recorded at 1 minute Intervals. If these measurements indicated that the ground anchor is satisfactory it may be locked off at an accepted load in excess of the pre-load to allow for loss of load due to creep.

PSF-7.3.1.5: Method or Applying Load to the Test Piles

The test force shall be applied concentrically to the test pile by means of a single hydraulic jack. The permissible extension of the jack shall be such that for each test pile the pile can be moved continuously and without repacking.

PSF-7.3.1.6: Measurement of Load

The test load shall be applied to the head of the pile by means of a hydraulic jack. Where more than one jack is used to apply the load, all the jacks shall be activated in a common circuit by the same pumping unit. The jack(s) shall be so positioned as to ensure that the load is applied axially.

The load applied shall be calculated from the hydraulic pressure which shall be monitored by means of two pressure gauges in the circuit. The pressure gauges shall be calibrated in divisions not exceeding 2% of the maximum pressure to be applied and the range of the gauges shall be not greater than 150% of the said maximum pressure. The jack(s) and gauges shall have been calibrated by an approved test laboratory not more than 4 weeks before the start of the test.

A calibration certificate shall be submitted by the *Contractor* for approval. All increments of the applied load shall not be allowed to fall below 1% of the specified load.

PSF-7.3.1.7: Measurement of Pile Movement by Dial Gauges

Vertical movement shall be measured by four dial gauge extensometers having 50mm travel and graduated in 0.01mm divisions. Dial gauge readings shall take precedence over precise level measurements on the test pile for the purposes of this Specification.

The extensometers shall be positioned mutually at right angles and at equal distance from the centre of the test pile. The plungers of the extensometers shall bear on plane glass or machined metal plates set level. To extend the range of the extensometers 25mm thick metal or glass blocks with parallel surfaces machined to a tolerance of 0,02mm shall be provided in sufficient number to allow continuous measurements of deflection up to 20% of the test pile diameter.

PSF-7.3.1.8: Precise Level

A benchmark that has its level independent of Site conditions shall be used.

The level instrument and staff shall be suitable for giving direct readings to an accuracy of 0.1mm (e.g. a precise level with optical micrometer, and an invar staff. Venire sheets or millimetre rules can be used on the pile cap and reaction assembly).

At least one levelling point shall be established on the pile cap. Precise level readings of the test pile and reaction assembly shall be taken as directed by the *Employer*.

The precise level shall be located such that all levelling points can be seen from one location. (The preferred system is to concrete the legs of the precise level into the bottom of a pit located in the line with the datum beams).

PSF-7.3.1.9: Reference Beams
Datum beams shall be free to move longitudinally at one end and fixed at the other end. Supports for the datum beams shall consist of steel members cast into concrete foundations at least 0.5m deep.

PSF-7.3.1.10: Protection of the Test Assembly

The entire measuring assembly shall be protected throughout testing against rain, direct sunlight and any other disturbance that could affect the reliability of readings.

A maximum / minimum thermometer (degrees C) shall be provided and temperature readings shall be taken at regular intervals throughout the test period.

PSF-7.3.2: Test Procedure

PSF-7.3.2.1: Concrete Strength

Piles selected for testing shall not be loaded until the concrete strength is shown by cube tests to be at least twice the pile stress at the greatest test load (ignoring any reinforcement) or the pile concrete is at least seven days old whichever gives the longer period of time.

PSF-7.3.2.2: Supervision of Tests

The *Contractor* shall keep the tests under continuous and competent supervision to the satisfaction of the *Employer*.

PSF-7.3.2.3: Facilities for the *Employer*

All necessary facilities shall be provided to enable the *Employer* to take and check readings during the progress of the tests.

PSF-7.3.2.4: Dial Gauge Readings

Dial gauge readings of pile movement shall be made at frequent intervals during each pile loading cycle as agreed with the *Employer*.

PSF-7.3.2.5: Rate of Vertical Movement Defining Settlement

Each increment of load shall be maintained until the rate of settlement does not exceed 0,05mm in half an hour measured over a half hour interval and the amount of settlement shall be that recorded when this rate is reached.

PSF-7.3.2.6: Test Load Cycles

For Trial Piles, Test Load Cycles 1 to 6 shall be carried out. Working piles shall be subjected to Test Load Cycles 1 to 3. Loading and unloading and the taking of level readings shall be made in the following sequence for each Test Load Cycle:

a) Take level readings of the supports of the reference beams and test pile datum.
b) Apply load for stage 1 (see table below).
c) Apply load for stage 2 (see table below).
d) Apply load for stage 3 (see table below).
e) Apply load for stage 4 (see table below).

f) Take level readings of the supports of the reference beams and test pile datum.
g) Unload in three approximately equal steps.
h) At zero load allow pile to recover until the rate of rebound does not exceed 0.05mm in half an hour.
i) Take level readings of the supports of the reference beams and test pile datum.

Table 20 : Test Load Cycles

Stage	TEST LOAD CYCLE					
	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6
1	0.25 DL	DL	1.5 DL	1.5 DL	1.75 DL	2 DL
2	0.5 DL	1.25 DL	1.5 DL	1.75 DL	2 DL	2.25 DL
3	0.75 DL	-	-	-	-	2.5 DL
4	DL	-	-	-	-	-

PSF-7.3.2.7: Test Reports

At the conclusion of work each day the *Contractor* shall send to the *Employer* a copy of his daily record sheet. The *Contractor* shall send to the *Employer* within one week of the completion of each test four copies of all records, graphs and results of laboratory and in situ tests related to the installation and testing of each pile tested. This information shall include load against settlement diagrams plotted to scales where the length of one kN of load is equal to the length of 0.025mm settlement.

PSF-7.4: IMPACT FREQUENCY RESPONSE TEST

PSF-7.4.1: General Description

Pile integrity testing shall include impulse or impact frequency response (IFR) testing, to be undertaken in conjunction with base integrity tests, as described under Clause PSF-7.7 below. Should these tests reveal that the pile does not have the required integrity, the cost of these tests shall be borne by the *Contractor*.

The IFR tests shall be undertaken and assessed by a suitably qualified and experienced independent, specialist subcontractor, to be appointed by the *Contractor* and approved by the *Employer*. The specialist subcontractor shall have at least 3 years' experience in IFR testing.

The tests shall demonstrate the homogeneity and integrity of the hardened concrete. Further details for the proposed procedures for the IFR tests shall be submitted by the *Contractor* to the *Employer* for approval at least 14 days before the tests are to be conducted.

IFR testing and base integrity tests shall be undertaken on every fourth pile, or as instructed by the *Employer*. Should additional piles be incorporated into the piled foundation design, then this new foundation pile will also be subject to integrity testing.

PSF-7.4.2: IFR Test Method

The pile head is struck with a hand held hammer, which sends low strain stress waves down the pile shaft. The pile concrete shall have attained an age of at least 3 days prior testing.

The induced stress wave is reflected off the pile toe, as well as off any other discontinuities along the pile shaft. This reflected wave is recorded by a hand held accelerometer pressed against the top of the pile, and converted into a velocity-time trace, presented on-screen as velocity versus pile depth.

Interpretation of the resulting graph shall include the following:

a) Significant inclusions (5-10 % of pile shaft area).
b) Horizontal cracks (or joints).
c) Pile necking.
d) Changes in surrounding soil layers.

PSF-7.4.3: Pile Head Preparation

Piles shall be tested from the cut-off level in sound concrete (about 50mm above pile cap soffit level). Helical shear links shall be removed to allow ample swing area for the hammer. A level hammer area of about 100mm diameter shall be prepared in the pile centre by using scabblers, scutch hammer or hammer and chisel. For the geophone, an area of about 80mm diameter shall be similarly prepared close to the pile perimeter.

PSF-7.4.4: Results

A written report in an easy to read and understandable format shall be submitted within five (5) working days of completion of the testing. The report shall include all IFR logs, as well as interpretation of the data.

PSF-7.5: BASE INTEGRITY TEST

In order to establish the quality of the pile/base rock contact, a base integrity test shall be performed, as described below.

a) A 75mm diameter tube shall be installed (attached to the reinforcement cage) to within 300mm of the base of the pile. The base of the tube shall be sealed square with a water tight seal.
b) NX (55mm) diameter cores shall be drilled within the 75mm diameter tubes, through the remaining 300mm of pile concrete and for a distance of 1,200mm into the rock at the toe of the pile. The core shall be carefully retrieved, with drill string lengths and datums noted.
c) The cores shall be marked and carefully placed inside a plastic sheath so that the interface between pile and rock is not disturbed.
d) The core shall be stored in a core box for inspection by the *Employer*.
e) The recovered core shall be inspected by the *Employer*.
f) The *Contractor* shall provide appropriate test equipment and undertake a hardness test, to be witnessed by the *Employer.* The rock hardness shall be at least class R4.

Following completion of the test and acceptance of the pile by the *Employer*, the 75mm diameter hole shall be filled from the bottom up to the top of the pile with a non-shrink grout of at least 30MPa strength.

PSF-7.6: ACCEPTANCE CRITERIA

Acceptance Criteria Should the settlement of any test pile loaded to the required test capacity exceed the short term settlement criteria, or if the pile fails to achieve the required working load as specified in this specification, then that pile shall be deemed to have failed.

The maximum allowable total settlement for any test pile at service load is three (3) mm and six (6) mm at 1.5 x service loads. The British test procedure shall be used – see SANS 1200F clause 7.4.

The costs of any failed pile tests shall be to the *Contractor*'s account.

PSF-7.7: FURTHER TESTS

For each working pile that fails in terms of the above acceptance criteria, the *Contractor* shall carry out tests on a further 2 working piles. The *Employer* will select the 2 piles to be tested and the tests shall be carried out at the expense of the *Contractor*."

8.4.7 PSF-8: MEASUREMENT AND PAYMENT

PSF-8.2: SCHEDULED ITEMS

PSF-8.2.1: Establishment on-Site for Piling.....Unit: Sum

Add the following:

"The tendered rate shall include the once-off establishment of all machinery and equipment on-Site for the installation of piles. This payment item shall also include the removal of all equipment and materials upon completion of all foundation piling operations on-Site."

PSF-8.2.2: Move Equipment to and Set Up at Each Pile Position.....Unit: No.

Add the following:

"The tendered rate shall include the cost of all plant, labour, equipment and ancillaries for levelling of piling Site, moving of the equipment into the correct position, provision and installation of all ancillary plant prior to the installation of piles."

Replace payment clause 8.2.4 with the following:

"PSF-8.2.4: Auger or Bore Holes for Piles of the following Pile Sizes through Material Situated in the Following Successive Depth Ranges:

a) 410mm Ø piles

i) 0m to 10m depth ..... Unit: m
ii) Exceeding 10m and up to 15m depth ..... Unit: m
iii) Exceeding 15m and up to 20m depth ..... Unit: m

b) 510mm Ø piles

i) 0m to 10m depth ..... Unit: m
ii) Exceeding 10m and up to 15m depth ..... Unit: m
iii) Exceeding 15m and up to 20m depth ..... Unit: m

c) 610mm Ø piles

i) 0m to 10m depth ..... Unit: m
ii) Exceeding 10m and up to 15m depth ..... Unit: m
iii) Exceeding 15m and up to 20m depth ..... Unit: m

The tendered rate shall include all plant, labour, equipment and ancillary costs for forming boring for the Rotapiles, supplying, installing and extracting the temporary casing or forming the rock socket, as well as for disposing of surplus material resulting from the hole having been formed.

The unit of measurement shall be the vertical length of the percussion holes, as shown on the drawings or as instructed by the *Employer*, within the depth ranges as indicated above.

The limits for the successive depth ranges will be measured from the working level to the agreed founding level. The depth measured will be that of the accepted hole.

Irrespective of the total depth of hole, the quantity within each depth range will be measured and paid for separately."

Replace payment clause 8.2.16 with the following:

"PSF-8.2.16: Steel Reinforcement in Cast-in-situ Piles

a) High-tensile Steel ..... Unit: ton

The mass measured will be that of reinforcement placed in the pile, and for the projection into the pile cap (refer to clause PSF-5.10.1.6 above). Clips, ties, separators, and other steel used for positioning reinforcement will not be included in the mass measured for payment.

The tendered rate shall cover the cost of supplying, cutting, bending, welding, placing in position, and fixing of the reinforcing and supporting steel scheduled, including the cost of binding wire, clips, ties, separators, spacer devices, other steel used for positioning reinforcement, and waste.

The unit of measurement shall be the nett ton of steel, as shown on the drawings or as instructed by the *Employer."*

Replace payment clause 8.2.17 with the following:

"PSF-8.2.17: Concrete for Cast-in-situ Piles, Under-reams, Bulbous Bases and Sockets (40MPa)

a) 410mm Ø piles ..... Unit: m³
b) 510mm Ø piles ..... Unit: m³
c) 610mm Ø piles ..... Unit: m³

The tendered rates shall include the cost of all plant, labour, materials and all ancillary costs for of the design of the mix, the provision of concrete, mixing, testing, placing, compacting, the forming of stop-ends, striking-off or levelling as applicable, curing and repairing where necessary.

The provisions of SANS 1200 G, including amendments as given under clause PSG: CONCRETE (STRUCTURAL) in this specification shall apply.

The measured quantity for payment purposes shall be measured net to the dimensions shown on the drawings, or as instructed by the *Employer.* The volume will be calculated from the pile diameter and length of the pile from the founding level to 75mm into the pile cap.

The measured quantity shall further include additional concrete in under-reams, bulbous bases and rock sockets, where applicable."

Replace payment clauses 8.2.21 to 8.2.23 with the following:

"PSF-8.2.21: Pile Load Test

a) Establishment of Test Equipment on-Site ..... Unit: Sum
b) Undertake Test ..... Unit: No.

The tendered rate for item a) shall include the once-off costs for establishing all equipment as required for the pile load test on-Site and the removal of all equipment upon completion of all tests. The provision of anchor piles and anchors shall be deemed to form part of the testing equipment under this item.

The tendered rate for item b) shall include the cost of all plant, labour, equipment and all ancillary costs for undertaking the pile load test, as detailed under clause PSF-7.3: PILE TEST ASSEMBLY AND TEST PROCEDURE. The rate shall include installation of the anchor piles and anchors where necessary, supervision and conducting the load test, processing and submitting the results.

PSF-8.2.22: Impact Frequency Response (IFR) Test ..... Unit: No.

The unit of measurement shall be the number of IFR integrity tests conducted on the instruction of the *Employer*, as described under clause PSF-7.4: IMPACT FREQUENCY RESPONSE TEST.

The tendered rate shall include for all establishment of equipment necessary to perform the tests, supervision and conducting the integrity tests, processing and submitting the results. Payment will not be made in the event that the test indicates that the integrity of the pile is defective and unsuitable for use.

PSF-8.2.23: Base Integrity Test

a) Establishment of Test Equipment on-Site ..... Unit: Sum
b) Undertake Test ..... Unit: No.

The tendered rate for item a) shall include the once-off costs for establishing all equipment as required for the base integrity test on-Site and the removal of all equipment upon completion of all tests.

The tendered rate for item b) shall include the cost of all plant, labour, equipment and all ancillary costs for undertaking the base integrity test, as described under clause PSF-7.5: BASE INTEGRITY TEST and shall include the supervision and conducting the integrity tests, processing and submitting the results including the following:

i. Establishment on-Site for core drilling.
ii. Moving equipment and assembling it at each location/pile position where cores are to be drilled as instructed by the Engineer.
iii. Drilling of core of approximately 55 mm diameter in concrete.
iv. Drilling of core of approximately 55 mm diameter in hard granite rock.
v. Log of core, processing of data.
vi. Grouting up 75mm tube after successful.

The unit of measurement shall be the number of base integrity tests conducted on the instruction of the *Employer*."

8.5 PSG: CONCRETE (STRUCTURAL)

8.5.1 PSG-1: SCOPE

Add the following:

"This specification covers the following concrete *works*:

a) New monopole mast reinforced concrete foundations.
b) Concrete encasing of services (if required)."

8.5.2 PSG-2: INTERPRETATIONS

PSG-2.1: SUPPORTING SPECIFICATIONS

Add the following:

"Plain and reinforced concrete shall comply with SANS 1200 G, with supplementary requirements as contained herein. In addition, the following specifications shall apply where relevant or referenced:

SANS 1083	:	Aggregates from natural sources - Aggregates for concrete
SANS 1200 D	:	Earthworks
SANS 1200 H	:	Structural Steelwork
SANS 121 (ISO 1461)	:	Hot dip galvanized coatings on fabricated iron and steel articles Specifications and test methods
Colto	:	Standard Specifications for Road and Bridge Works for State Road Authorities (1998 Edition)
SANS 2001-CC1	:	Construction Works Part CC1: Concrete Works (Structural)
SANS 2001-CC2	:	Construction Works Part CC2: Concrete Works (Minor Works)"

8.5.3 PSG-3: MATERIALS

PSG-3.1: APPROVAL OF MATERIALS

Add the following:

"The *Contractor* shall submit for approval by the *Employer* samples and test results for aggregates. For aggregates sourced from commercial sources, the *Contractor* shall provide historical records of grading and other test results, covering the preceding 6 months. A statistical analysis of the means and variations per sieve size and test property shall also be provided.

The *Contractor* shall also furnish a sample of the water intended for use in the concrete mixes. Reference is made to the requirements of PSG-3.3 and PSG-3.4 below.

The samples shall be submitted at least eight weeks prior to commencement of concrete *works*, to enable testing and checking by independent laboratories."

PSG-3.2: CEMENT

Add the following:

"The minimum cement class used in concrete shall be Class 42.5N.

100% OPC (CEM I or II/A) Classes 42,5 and 52.5, and accelerating admixtures shall not be utilised for structural concrete batching, unless approved in writing by the *Employer*.

The cement utilised for grout mixes shall be of a "non-shrink" type. Any shrinkage compensating admixture shall only be used with the *Employer*'s acceptance."

PSG-3.2.1: Applicable Specifications

Add the following at the end of this clause:

"The standard cement and extenders specifications applicable to the contract are as follows:

SANS 50197-1	:	Cement Part 1: Composition, specifications and conformity criteria for common cements
SANS 50197-2	:	Cement Part 2: Conformity evaluation
SANS 50450-1	:	Fly ash for concrete Part 1: Definition, specifications and conformity criteria
SANS 50450-2	:	Fly ash for concrete Part 2: Conformity evaluation
SANS 53263-1	:	Silica fume for concrete Part 1: Definition, specifications and conformity criteria
SANS 53263-2	:	Silica fume for concrete Part 2: Conformity evaluation
SANS 55167-1	:	Ground granulated blast furnace slag for use in concrete, mortar and grout Part 1: Definitions, specifications and conformity criteria
SANS 55167-2	:	Ground granulated blast furnace slag for use in concrete, mortar and grout Part 2: Conformity evaluation
SANS 50413-1	:	Masonry cement Part 1: Composition, specifications and conformity criteria
SANS 50413-2	:	Masonry cement Part 2: Test methods"

PSG-3.2.2: Alternative Types of Cement

Add the following new sub-clauses:

"PSG-3.2.2.1: Blended Cement Binders

Where required, watertight concrete with blended cement binders may be produced on Site by:

a) Blending 70% CEM II A-L 52,5N (PPC Western Cape (De Hoek clinker) OPC "old spec") and 30% Classified, siliceous Fly ash (FA),
b) Blending 80% CEM II A-S 52,5N (PPC Western Cape (De Hoek clinker) OPC "new spec") and 20% Classified, siliceous Fly ash (FA),
c) Blending 50% CEM II A-L 52,5N (PPC Western Cape (De Hoek clinker) OPC "old spec") and 50% Ground Granulated Corex Slag (GGCS),
d) Blending 59% CEM II A-S 52,5N (PPC Western Cape (De Hoek clinker) OPC "new spec") and 41% Ground Granulated Corex Slag (GGCS).

If aggregates to be used in this contract are alkali-reactive, the total alkali content of the concrete shall not exceed 2.1kg/m³ for aggregates falling in the rapidly expanding group (e.g. Malmesbury Group metasediments) or 3.8kg/m³ for Cape Granite. The *Contractor* shall submit the necessary SANS 6245 test results to prove the above.

Concrete mixes must be determined by means of a proper mix design by an accredited laboratory and must be approved by the *Employer*. Over and above the proportions of the mix, the following information shall also be provided in the mix design report:

i. The type, description and source of fine and coarse aggregate.
ii. Grading analysis and grading graphs of fine and coarse aggregates.
iii. Water demand of fine aggregate, determined in accordance with Colto Clause 8105 (e).
iv. Water absorption values of fine and coarse aggregates.
v. Average crushing values and flakiness index of coarse aggregate.
vi. Minimum Coarse aggregate by volume (refer PSG-3.4.4)
vii. Petrographic analysis of fine aggregate (refer to PSG-3.4.1).
viii. Manufacturer's design composition of the cementitious material in case of a pre-blended cement (Design percentage of extender & type).
ix. Exact brand name, manufacturer and dosage in mℓ of admixture per 100kg of cementitious material, accompanied by a data sheet from the manufacturer containing in particular the percentage of Na_2O equivalent total alkalis in the admixture.
x. Workability retention tests (refer to PSG-3.4.1), if applicable.
xi. At least the 3, 7 and 28 day cube test results for all structural concrete mixes.
xii. Drying Shrinkage tests for all structural concrete mixes.

PSG-3.2.2.2: Crystalline Waterproofing Additive (for Single Circuit Terminal Masts no. 1 BLW/ISC 32/3 and 2 BLW/ISC 32/3)

The concrete foundations for the two single circuit terminal masts (no. 1 BLW/ISC 32/3 and no. 2 BLW/ISC 32/3 shall incorporate a cementitious crystalline waterproofing additive, such as “Xypex Admix C500NF” or equal approved, which shall be added to the concrete mix at the time of batching at a dosage rate of 1.5% by weight of the total cementitious content (binder) (minimum dosage of 4.5kg/m³ concrete).

Only one product manufacturer/supplier shall be permitted to supply all the products for the crystalline waterproofing system.

The *Contractor* shall supply the *Employer* with documented evidence, published by an independent laboratory meeting the requirements of ASTM E329, that the crystallizing capability of the waterproofing technology is evidenced by independent Scanning Electron Microscope photographs verifying crystalline formations within the concrete matrix to a minimum depth of 50mm.

The *Contractor* shall supply to the *Employer* documented evidence, in the form of compliance with SANS 50934 or suitable independent test report and internationally-recognized (British, etc.) Board of Agrément certification that the integral waterproofing technology has been tested in accordance with US Army Corps of Engineers CRD-C48-73 “Permeability of concrete” and treated samples shall exhibit as a minimum no measurable leakage after pressure testing to 1,05 MPa (equivalent to 106m head of water), measured relative to the surface of product application.

The documented evidence shall include statement that the integral waterproofing technology shall also have demonstrable benefits proving improved chemical resistance to sulphuric acid exposure, improved compressive strength, and certified approval for use on structures holding potable water.

The product manufacturer/supplier shall have immediate local access to the full product range, including Crystalline Waterproofing additive (Xypex Admix C-500NF or equal), Crystalline Coating (Xypex Concentrate or equal), Crystalline Reinforced Coating (Xypex Modified or equal), Fast-setting, non-shrink Crystalline Patching and Resurfacing compound (Xypex Patch ‘n Plug or equal) and Crystalline-based Thick Repair Mortar (Xypex Megamix 2 or equal).

The *Contractor* shall consult the relevant local technical services representative (for Xypex or equal approved product) for assistance in using this product.

The directions for use, storage, concrete placement and compaction, curing of concrete, etc. shall be in strict accordance with the manufacturer’s specifications.”

PSG-3.2.3: Storage of Cement

Add the following:

“It is of prime importance that the cement to be used shall always be stored in a cool environment. Cement silos shall therefore be painted white to reduce temperature rises in the stored cement.

The sides and tops of silos shall be insulated with 4.0mm Alucushion double sided aluminium foil insulation, which shall be wrapped around silos and kept in position with galvanized steel hoop straps. Alucushion shall overlap by at least 100mm at joints.”

PSG-3.3: WATER

Replace this clause with the following:

“All mixing water for concrete *works* shall fully comply with SANS 51008 and shall be of a potable quality, clean and free from all earthy, vegetable or organic matter, acids or alkaline substances in solution or suspension that may impair the strength or durability of concrete.

To limit heat gain in watertight concrete, the temperature of mixing water must be below 20℃ when added to the concrete mix.

The sides and tops of water tanks for mixing water, including pipework leading to and from tanks, shall be insulated with 4.0mm Alucushion double sided aluminium foil insulation, which shall be wrapped around silos and kept in position with galvanized steel hoop straps. Alucushion shall overlap by at least 100mm at joints.”

PSG-3.4: AGGREGATES

Add the following:

"Fine and coarse aggregate shall be obtained from sources accepted by the *Employer* and shall be assessed in accordance with SANS 1083. Fine aggregate shall be natural sand or other accepted inert material with similar characteristics, composed of clean, hard, strong, durable, uncoated particles.

Fine aggregates shall be free from deleterious amounts of soft, flaky or porous particles, loam, soft shale, clay lumps or organic material. Fine aggregates shall be selected from local sources to provide a reasonably uniform grading of the various size fractions.

The sand equivalent, in accordance with SANS 3001-AG5, shall be tested for all fine aggregates and shall be minimum 65 percent. Fine aggregates having a large deficiency or excess of any size fraction, shall be avoided to the extent practicable.

Coarse aggregate shall consist of crushed stone, gravel or other accepted inert material of similar characteristics having hard, strong, durable, uncoated pieces free from deleterious substances. Coarse aggregates up to 26.5mm nominal size may be single-sized stone.

Coarse aggregates up to 40mm nominal size shall be blended consisting of two parts by volume of single-sized 40mm stone to one part by volume of single-sized 20mm stone. The content of fine material (less than 4.75mm) in coarse aggregate shall be less than 10% by mass.

The bulk void content of fine or coarse aggregate shall not exceed 48%. Aggregate shall not contain any materials that are reactive with any alkali in the aggregate itself or in the cement, the mixing water or in water in contact with the finished concrete or grout in amounts sufficient to cause excessive localised or general expansion of the concrete or grout.

The maximum nominal aggregate size for concrete batching shall be as follows:

- For unreinforced concrete: 37.5mm, 28mm, or 20mm
- For reinforced concrete excluding piles: 20mm
- For piles: 20mm, or 14mm
- For grout: 10mm"

PSG-3.4.1: Applicable Specifications

Add the following:

"The aggregates shall comply with the requirements of SANS 1083. The maximum water absorption of both the fine and coarse aggregate shall not exceed 0.5% each and the combined water absorption of fine and course aggregate shall not exceed 0.75% total.

The flakiness index of coarse aggregate shall not exceed 30. The fineness modulus (FM) of combined fine aggregate in the concrete mix shall be 2.3 to 2.8.

Coarse aggregate shall comply with the 10% FACT values specified for aggregate used in concrete subject to abrasion and minimum 150kN (dry). The 10% FACT wet to dry ratio shall be 0.70 minimum. In addition to SANS 1083, the grading of fine aggregate shall comply with the requirements in the table below.

If the *Contractor* proposes to use sand which complies with the prescribed grading of Table 1 of SANS 1083, he shall prove to the satisfaction of the *Employer* that the concrete produced will comply with the specifications."

Table 21 : Grading Requirements for Fine Aggregate

Sieve Size (mm)	Cumulative % Passing	
4.75	90-100	
2.36	75-100	
1.18	60-90	
0.60	40-60	
0.30	20-40	
0.15	10-20	
0.075	Natural sand 5-10	Crusher sand 5-20

Workability retention tests on the proposed mix design(s) shall be conducted by an accredited laboratory by measuring the slump of the mix at 15 minute intervals, starting immediately after mixing and extending over a period of 2 hours after mixing.

Petrographic analysis shall be conducted on natural sands to determine the presence of deleterious minerals (smectite, etc.), which may have a negative impact on workability of the fresh concrete or may be detrimental to the hardened concrete.

Fine aggregate shall contain more than 20% quartz by mass. The acid insolubility of fine aggregate, determined in accordance with Colto Clause 8105 (b) shall not exceed 40%.

Aggregates to be used in this contract shall be tested in accordance with SANS 6245 to determine whether they are potentially alkali-reactive. If they are alkali-reactive they shall either be replaced with aggregates that are non-reactive or the requirements of PSG-3.2.2.1 in respect of alkali-reactiveness shall apply.

The content of chloride ion in the aggregates shall be determined and shall be within the limits specified in SANS 1083. Test results shall be submitted to the *Employer*.

At tender stage the *Contractor* shall assure himself by means of tests and test mixes by an accredited laboratory that the fine and coarse aggregates that he intends to use comply with the specification.

The *Contractor* shall be responsible for locating the sources of all aggregates. Coarse aggregates from the Table Mountain Group orthoquartzite shall not be used for this contract.

The tendered rates shall be deemed to allow for the importation of aggregates, if necessary to comply with the specification."

PSG-3.4.3: Storage of Aggregates

Add the following new sub-clause:

"PSG-3.4.3.c): the aggregate to be used shall at all times be stored in a cool environment and, if at time of mixing, the ambient temperature exceeds 30°C, only the coarse aggregate shall be sprayed with water to assist cooling by evaporation.

All coarse - and fine - aggregate stockpiles shall be shaded from the sun by means of 80% shade netting.

The *Contractor* shall ensure adequate drainage of the coarse aggregate stockpile.

Aggregates exposed to a marine environment shall be covered to protect them from salt contamination."

Add the following new sub-clause:

"PSG-3.4.4: Minimum volume of coarse aggregates in the concrete mix

The following minimum volume of coarse aggregates shall be included in all structural concrete mixes:

a) For concrete placed and compacted by conventional means, the minimum volume of coarse aggregate shall be 385 litre per cubic metre of concrete; or
b) For concrete delivered by pump and placed by conventional means, the minimum volume of coarse aggregate shall be 360 litre per cubic metre of concrete;
c) For self-compacting concrete, the minimum volume of coarse aggregate shall be 325 litres per cubic metre."

PSG-3.5: ADMIXTURES

PSG-3.5.1: Approval of Admixtures Required

Add the following new sub-clause:

"PSG-3.5.1.1: All proposed concrete admixtures shall fully comply with the latest revisions of ASTM C309 or SANS 50934."

PSG-3.5.2: Air-Entraining Agents

Replace the contents of this sub-clause with the following:

"Air-entraining agents shall not be used."

PSG-3.6: REINFORCEMENT

Add the following:

"Reinforcing bars shall comply with the requirements of SANS 920 and satisfy the following:

a) Y-bars to have a minimum characteristic strength of fy = 450 MPa.
b) R-bars to have a minimum characteristic strength of fy = 250 MPa.

Reinforcing shall be fabricated and bent in strict accordance with the drawings, bending schedules and SANS 282."

8.5.4 PSG-4: PLANT

PSG-4.3: MIXING PLANT

PSG-4.3.1: General Requirements for Mixing Plant

Add the following:

"On-Site mixing plants may be approved by the *Employer* only if the plant capacity exceeds 400m³ of concrete per day. The *Contractor* shall provide standby plant capacity and all necessary equipment to ensure that the maximum required daily production can be placed without interruption or delay."

Add the following new sub-clauses:

"PSG-4.3.3: Ready Mix Concrete (Should the *Contractor* Choose to Use Ready Mix Concrete)

The *Contractor* may choose to use ready-mixed concrete, subject to the prior approval by the *Employer*. Ready-mix concrete shall be mixed in accordance with the requirements of SANS 878.

The ready mix plant supplier shall be either:

a) South African Ready Mix Association (SARMA) member in good standing and have passed the latest round of SARMA audits, or
b) The plant, measuring, mixing, transport and associated processes are audited by a recognized independent body in accordance with all the following requirements: ISO 9002 (standardisation), ISO 14001 (environmental); ISO 39001 (road transport safety management); OHSAS 18001 (legal compliance); and SANS 50206/SANS 878/ISO 9001(quality management system for concrete production).

Ready-mixed concrete shall not be delivered to Site before the *Contractor* has furnished the *Employer* with a copy of his order to Supplier, in which he has included the following:

a) The target compressive strength of concrete at 28 days.
b) The nominal maximum sizes of aggregate.
c) Aggregate Gradings, Fineness modulus and all aggregate tests required by PSG-3.4
d) The type of cement & extenders.
e) The required slump at the point of delivery, being the Site.
f) An instruction to the supplier to provide details of the admixture he proposes to use, if applicable.
g) The details/information provided shall be in accordance with the requirements of SANS 1200 G:3.5.1 - Concrete (Structural).

The *Contractor* shall have delivered with each truck load of ready-mixed concrete, a delivery note from the supplier on which the following information is noted:

i. The compressive strength of the mix.
ii. The slump.
iii. The date and time at which the mixing of the batch was commenced.
iv. The time of delivery.
v. The quantity of concrete supplied.
vi. Identify part of structure for which the concrete mix was used.

These delivery notes are to be kept on Site and shall be available for inspection at any time. Reference is made also to Clause PSG-5.5.3.2.

PSG-4.3.4: Batching Plant (Should the *Contractor* Choose to Site Batch Concrete)

Batching on-Site will be considered only if the plant is exclusively dedicated to the Site. The plant capacity shall be designed to meet all requirements of the *Contractor*'s construction programme.

Use of additional external commercial sources for concrete supply will only be considered in extreme, critical and exceptional cases, provided that the mix design and all constituents are in accordance with the approved Site batched concrete.

Weigh batch plants shall be fully computerised and incorporate automated systems. The batching system shall provide computer-generated records, traceable to a load, materials used, quantity batched and placement location.

Cement and extender silo fill lines shall incorporate dedicated adapters, to prevent direct connection to standard tanker couplings. Each extender type shall incorporate differential couplings to their respective silos. All silo fill lines shall be locked and labelled. All silos shall be painted white with solar reflective paint to reduce temperature of the contained cementitious material.

Water storage tanks shall be painted white and shall, as far as possible, be shaded on all sides from direct radiation from the sun or covered with 4.0mm Alucushion double sided aluminium foil insulation.

Aggregate stockpiles shall, as far as this is possible, be shaded on all sides from direct radiation from the sun.

Adequate drainage shall be provided in and around the plant to accommodate and control all water from washing, run-off and rain."

PSG-4.5: FORMWORK

Add the following:

"The formwork shall be mortar-tight and shall be designed, constructed, braced and maintained such that the finished concrete will be true to the line and elevation, and will conform to the required dimensions and contours. It shall be designed to withstand the pressure of concrete, the effect of vibration as the concrete is being placed and all loads incidental to the construction operations without distortion or displacement.

Where the bottom of the formwork is inaccessible, provision shall be made for cleaning out extraneous material immediately before placing the concrete.

All exposed corners of the concrete shall be chamfered approximately 20mm. A suitable nosing tool may be used for horizontal chamfers only if approved by the *Employer.* All formwork dimensions shall be checked, and if necessary, corrected before any concrete is placed."

PSG-4.5.1: Design

Add the following:

"The *Contractor* shall appoint a suitably qualified and experienced person, registered as a Professional Engineer or Professional Technologist with the Engineering Council of South Africa, to design all formwork and support *works*.

The *Employer* is to be contacted if any loading requirements are unclear. Formwork layout drawings prepared by the competent person are to be kept on-Site for inspection at any time."
PSG-4.5.2: Finish

Add the following:

"The quality of the formwork shall be in accordance with PSG-5.2.1."

PSG-4.5.3: Ties

Add the following:

"Formwork ties in all structures shall be Form-scaff (or approved equivalent) continuous 12mm extended coil tie type. No ferrules or ferrule pipes may be used in structural elements of watertight structures. The *Contractor* shall allow in his rates for the specified formwork ties and ensure that his formwork is compatible with these ties. The minimum cover to all ties shall be 25mm. Plastic ferrule spacing cones shall have minimum 20mm depth for use with the extended coil ties.

After removal of the plastic spacing cones of the extended coil ties from the concrete, the openings in the concrete shall be roughened with a mechanical wire brush. Thereafter the openings shall be painted with Xypex Concentrate slurry coat and filled with Xypex Megamix 2 (dry) / Patch 'n Plug (wet), or approved equivalent.

Alternatively only dry openings shall be painted with Xypex Concentrate slurry coat or compatible Epoxy-cement bonding agent (Sika Armatec 110 Epocem or equal approved) and filled with a non-shrink grout such as "Sikagrout 212" by Sika or equal approved. The grout filling shall be applied in such a way as to protect the ties against corrosion and ensure watertightness of the element.

The application of Xypex materials and proprietary grout, or approved equivalent, shall be applied in accordance with the manufacturer's specifications and method statements."

8.5.5 PSG-5: CONSTRUCTION

PSG-5.1: REINFORCEMENT

Add the following:

"All main reinforcing steel shall conform to SANS 920 Type C, Class 2, Grade II hot rolled deformed bars with a minimum yield stress of 450MPa. The minimum bar size utilised shall be 10mm.

All secondary reinforcing for stirrups, hoops and spirals, shall as a minimum conform to SANS 920 Type "A" hot rolled bars of plain cross-section of mild steel with a minimum yield stress of 250MPa.

Reinforcing steel, before being positioned, shall be thoroughly cleaned of mill scale and any coatings that will destroy or reduce bond.

Reinforcing steel shall be accurately positioned and secured against displacement during placing and vibrating of concrete.

Reinforcing steel shall be provided and placed as detailed on the foundation drawings. Use of suitable accepted spacers or supports shall be made, to ensure that the minimum concrete cover to the reinforcement is maintained during the placement of concrete.

The *Contractor* shall ensure that all reinforcing is electrically continuous, including with the holding down bolts. This should be achieved by at least double-tying all rebar.

Refer to the electrical specifications and drawings pertaining to the earthing of all reinforcing."

PSG-5.1.1: Bending

Replace sub-clause PSG-5.1.1.1 with the following:

"PSG-5.1.1.1: Bending of reinforcement shall be in accordance with SANS 282."

Replace sub-clause PSG-5.1.1.4 with the following:

"PSG-5.1.1.4: No heat treatment, welding or cutting of steel without the written approval of the *Employer* shall be allowed."

Add the following new sub-clause:

"PSG-5.1.1.5: Should starter bars move during a preceding cast, they may not be bent back into position. The *Employer* is to be informed in writing and the supporting correspondence shall include sufficient photographs to identify the problem. Remedial measures shall be proposed by the *Contractor*, to be approved by the *Employer*."

PSG-5.1.2: Fixing

Add the following new sub-clauses:

"PSG-5.1.2.1: No reinforcing may be cut without written approval from the *Employer*.

PSG-5.1.2.2: The *Contractor* shall inspect and approve the fixed reinforcement before the *Employer* is notified of a required inspection. The *Employer* is to be notified in writing at least 24-hours in advance for the required inspection. All reinforcement shall be inspected and approved by the *Employer* before casting of concrete may commence.

PSG-5.1.2.3: No slab will be inspected unless the reinforcing and cables (if present) have been fully fixed, all other services have been installed and the *works* area has been cleaned properly.

PSG-5.1.2.4: Bend-out bars at construction joints shall be bent out with a suitable pipe so that no kink is formed in the bar."

PSG-5.1.3: Cover

Replace PSG-5.1.3 with the following:

"PSG-5.1.3: Minimum allowable concrete cover to reinforcing shall be as indicated in the table below:

Table 22 : Concrete Cover to Reinforcement

Concrete Structure	Cover
Foundations for monopole masts	75mm (to reinforcing and holding down bolts)
General foundations cast against soil	75mm
General foundations cast against blinding	50mm
Plinths/foundation columns	50mm

No tie-wire shall encroach on the specified minimum cover by more than a strand thickness. No plastic cover-blocks or spacers shall be permitted.

Pre-manufactured, high strength fibre-cement micro-concrete spacers, as supplied by Joluka or equivalent, require approval by the *Employer* and shall be only be permitted if galvanized tie wires (Class A in accordance with SANS 675) are used in all instances.

Concrete cover blocks shall be manufactured in accordance with the requirements of SANS 10100 Part 2 (8.4.1.2). Fixing wire shall be fully galvanised Class A in accordance with SANS 675. Blocks shall be fully cured in water for 14 days before use. Refer to SANS 0400 for minimum spacing of cover blocks."

PSG-5.1.4: Splicing

Add the following:

"Splice lengths in the case of all structures shall not be less than 50 x diameters. Where applicable, splices shall be staggered so that they are evenly spread throughout the structure."

PSG-5.2: FORMWORK

PSG-5.2.1: Classification of Finishes

Add the following:

"Formwork for all classes of finish shall be made of steel panels. High density polystyrene backing is required when 'Plain steel formwork' is used in cold weather (i.e. < 5ºC). The panels shall be free from rust, ridges, fins, bulges, imperfections, irregularities, chips and holes.

Small, approved laminated wooden board inserts to steel framed panels may only be used in confined places and the use thereof will be subject to approval by the *Employer*. New timber formwork may only be used, following the *Employer's* approval.

The new timber formwork not coated with epoxy or similar finishing material is to be treated with cement slurry before the first use and to be cleaned and sprayed/painted with release agent at least twice.

Grout checks shall be used at all construction joints and chamfers at all corners.

Joints between panels shall be sealed tightly to prevent local honeycombing, grout loss or leaching of concrete. Joints between panels shall form straight, horizontal and vertical lines which shall be spaced evenly on the formed concrete surface, and shall be even and smooth, requiring minimal or no finishing. The layout of all formwork panels and construction joints shall be discussed with the *Employer* before application and shall be approved in writing prior to erection of formwork.

Concrete surfaces shall be smooth and completely rubbed or treated to form a finish of uniform texture, appearance and colour. The concrete surface shall be free of irregularities, bulges, ridges, imperfections, air bubbles, honeycomb or surface discolorations.

Only proven release agents that leave no spots on the concrete may be used. All release agents shall be used strictly as specified by the relevant manufacturer. Chemical compatibility of the release agent with concrete admixtures shall be verified before the commencement of construction *works*. Reinforcement may not be soiled by the release agents. Timber formwork shall be treated with release agent in such good time, so that it has fully penetrated into the timber before the reinforcement is fixed.

The top surface of the foundation shall be at least a wood float finish, and shall be contoured to shed water.

All concrete placed against shuttering shall be free from irregularities, fins, rock pockets or other imperfections. Any rock/aggregate pockets, porous or defective concrete shall be removed to the extent instructed by the *Employer* and repaired by filling these voids with specialized concrete, cement mortar of a higher strength, as accepted by the *Employer.*

All exposed concrete sections shall be shuttered to a minimum of 250 mm below ground level.

Replace sub-clauses PSG-5.2.1.a), PSG-5.2.1.b) and PSG-5.2.1.c) with the following:

"PSG-5.2.1.a) Rough: All unexposed concrete surfaces. Permissible deviation: Degree of Accuracy II for formwork as per SANS 1200 G clause 6.2.

PSG-5.2.1.b) Smooth: All exposed/visible concrete surfaces shall be as per PSG-5.2.1.c).

PSG-5.2.1.c) Special: All exposed/visible concrete surfaces shall be smooth-special formwork as per Table 1 - Surface Finishes of Formed Surfaces: SANS 2001-CC1: 2012. A surface using steel forms shall have a Degree of Accuracy II with permissible deviation for formwork as per SANS 1200 G Clause 6.2."

PSG-5.2.5: Removal of Formwork

Replace sub-clause PSG-5.2.5.2 with the following:

"PSG-5.2.5.2: Stripping times of shuttering and propping shall be in accordance with Clauses 4.3.8 and Table 2: SANS 2001-CC1. If formwork is retained as a curing measure, it shall remain in place for a minimum of 5 days in summer, 8 days in windy conditions and 10 days in winter, or as specified by the *Employer*.

No brick or block walls are to be built on floor slabs before the slabs have reached their 14-day strengths. Propping underneath slabs and beams shall be completely removed before brickwork is built. All bricks required for brick walls on a specific slab panel shall be stacked evenly onto the slab panel before walls are being built."

Add the following new sub-clauses:

"PSG-5.2.5.6: The following elements or parts of the structure are to remain fully propped until the required 28 day characteristic (design) concrete strength has been reached:

a) Beams.
b) Cantilevers.
c) Slabs supporting hanging structures (Note that the portions being suspended cannot support the floor directly above).

Formwork/propping designs shall account for any loads imposed on the propped structure.

When full-height concrete walls are cast on slabs or beams, they are to be fully propped until the wall and slab have reached their 28 day characteristic (design) strengths.

PSG-5.2.5.7: Designs and method statements for back-propping shall be submitted to the *Employer* for approval."

PSG-5.4: PIPES AND CONDIUTS

Add the following:

"The *Contractor* shall install all required embedded items shown on the drawings, prior to placing (pouring) of concrete. Structural steelwork or holding down bolts shall be accurately positioned and securely held in place during the placement (pouring) of concrete. The minimum cover to all embedded items shall be 100mm.

Structural steelwork or anchor bolts shall be embedded such that the top of the concrete of the foundation correctly coincides with the designed level."

PSG-5.5: CONCRETE

PSG-5.5.1: Quality

PSG-5.5.1.1: General

Add the following:

"All casting procedures, construction methods and positions of construction joints (where applicable) shall be submitted to the *Employer* eight weeks prior to the commencement of any concrete placement.

The *Contractor* shall take note that earthing material shall be embedded in the concrete foundations in accordance with Eskom requirements.

No chasing into concrete elements is allowed."

PSG-5.5.1.3: Workability

Add the following:

"The consistency of concrete in the fresh state shall be determined using the slump test in accordance with SANS 3001-CO1-3 (previously SANS 5862-1).

The workability range (slump) for all (except pumped) concrete shall be between minimum 75mm and maximum 125mm. The workability range (slump) for all pumped concrete shall be minimum 125mm and maximum 175mm.

Adjusting of the slump on Site shall only be done by adding the mix design admixture amount strictly to manufacturer's instructions and mix proportions. Any admixtures to the concrete proposed by the *Contractor* shall be subject to the *Employer*'s acceptance.

The consistency of grout mixtures shall be proportioned so that the mixture is pourable. The fine aggregate to cement ratio shall not exceed 3:1 irrespective of workability."

PSG-5.5.1.5: Durability

Replace PSG-5.5.1.5 with the following:

"All concrete mixes are to be designed by a specialist SANAS-accredited laboratory or ready-mix supplier and forwarded to the *Employer* for approval. The maximum water/binder ratio and minimum cement content shall be as indicated in the table below.

Table 23 : Maximum water/binder ratio and minimum cement content

Item	Maximum Water to Binder Ratio	Minimum Binder Content (kg/m^3)
Monopole mast foundations (30MPa) - ***with*** total binder consisting of replacement of 30% Fly Ash.	0.54	350
Monopole mast foundations (30MPa) - ***with*** total binder consisting of replacement of 50% GGCS.	0.67	290
Monopole mast foundations (35MPa) - ***with*** 1,5% crystalline waterproofing additive - ***with*** total binder consisting of replacement of 30% Fly Ash.	0.47	395
Monopole mast foundations (35MPa) - ***with*** 1,5% crystalline waterproofing additive - ***with*** binder consisting of replacement of 50% GGCS.	0.60	315
Mass concrete	0.67	280
Blinding	not applicable	not applicable

The binder, except for the 15MPa blinding mix, shall comply with the requirement of PSG-3.2.2.1: Blended Cement. The 15MPa blinding mix may contain binders consisting of 100% CEM I (42,5 or greater), 100% CEM II A-L 52.5 (PPC Western Cape OPC) or 100% CEM III A-S 42,5 (PPC Western Cape Surebuild).

The maximum water content of the mix shall be 190ℓ/m³. All structural concrete mixes shall be tested for drying shrinkage in accordance with SANS 3001-CO2-7 (previously SANS 6085), and the drying shrinkage shall not exceed 0,040% for prestressed concrete or 0,045% for reinforced and mass concrete."

PSG-5.5.1.6: Prescribed Mix Concrete

Add the following:

"The concrete mix supplied by the *Contractor* shall consist of cement, fine aggregate, coarse aggregate and water proportioned in accordance with the mix design. Adjustments in these proportions may be directed at any time by the *Employer* when found necessary as a result of field tests of the concrete. No change in mix proportions shall be made unless instructed by the *Employer*.

No change in the source, character or gradation of materials shall be made without written notice to the *Employer* and without a revised mix design being prepared and accepted by the *Employer* prior to use of these materials."

PSG-5.5.1.7: Strength Concrete

Add the following:

"The minimum cube strengths shall be as shown in the table below.

Table 24 : Concrete Strength

Item	Characteristic Cube Strength (28-day, MPa) (Min)	Target average strength (28-day, MPa)	Aggregate size & type
Monopole mast foundations (without crystalline waterproofing additive)	30	36.5	19mm Granite or 19mm Greywacke
Monopole mast foundations (with crystalline waterproofing additive)	35	42.5	19mm Granite or 19mm Greywacke
Mass Concrete	25	30	19mm Granite or 19mm Greywacke
Blinding	15	18	19mm Granite or 19mm Greywacke

Add the following new sub-clause:

"PSG-5.5.1.8: Blinding

A 50mm thick blinding layer, unless otherwise required, of 15MPa/19mm shall be cast under all reinforced foundations, as approved by the *Employer*. No blinding layer needs to be cast for unreinforced brickwork and mass concrete foundations, but these excavation surfaces require approval by the *Employer*.

No foundation or ground beam shall be cast on non-engineered fill.

Portions that are over-excavated beyond the depth required by the *Employer* or as indicated on the drawings are to be filled with mass concrete at the *Contractor's* expense."

PSG-5.5.3: Mixing

Add the following:

Concrete shall be mixed sufficiently to ensure that the various sizes of aggregate are uniformly distributed throughout the mass, and each aggregate particle is adequately coated with cement paste of uniform consistency. Concrete delivered to Site that lacks homogeneity should be mixed for a longer time or discarded, as directed by the *Employer*.

Concrete delivered to the Site shall be mixed en-route. Mixing shall be rigorously controlled for agitating time, mixing time and overall time upon arrival at the foundation construction Site. Concrete discharge shall be completed within one and one-half hours after introduction of the water to the cement and aggregate.

In exceptional cases only with the approval of the *Employer*, may the *Contractor* at his own risk add water to a concrete mix at the point of delivery. The maximum amount of water that may be added on Site is three litres per cubic metre of concrete. At no time shall the cement/water ratio be less than 1.8.

Non-shrink grout shall be mixed in a suitable mechanical grout mixer/pump accepted by the *Employer*.

PSG-5.5.3.2: Ready-mixed Concrete

Replace PSG-5.5.3.2 with the following:

"The use of ready-mixed concrete for this contract shall be permitted, provided that it complies with the requirements of this specification. Test results obtained by such a production facility shall not be regarded as part of the quality control system, and the *Contractor* shall take his own samples of concrete on-Site and have them tested in accordance with Clause 7 of SANS 1200 G and Clause PSG-7.1.2.

Reference is made also to PSG-4.3.3."

PSG-5.5.5: Placing

Add the following to sub-clause 5.5.5.1:

"PSG-5.5.5.1: The *Contractor* shall give the *Employer* at least 48 hours' notice of his intention to cast concrete."

Replace sub-clause 5.5.5.5 with the following:

"PSG-5.5.5.5: Freshly mixed concrete shall be handled, transported and deposited in such a manner as to prevent segregation or loss of material.

Concrete in all structures shall not be allowed to fall freely through a height of more than 2.0m. The use of tremie or similar concrete handling equipment shall be used to ensure that the risk of wet concrete segregating is minimised at all times. When chutes are utilized to cast concrete, the slope of the chute shall be uniform throughout its length and shall not be flatter than 1 in 3 or steeper than 1 in 2 and they shall incorporate baffles and spouts to minimize segregation."

Add the following new sub-clauses:

"PSG-5.5.5.10: During summer months, when maximum ambient temperatures exceed 25℃, concreting shall start as early as possible in the mornings, but not later than 07h00. Pouring shall, as far as possible, be confined to the cooler parts of the day.

During hot weather concreting operations, the *Contractor* shall take and record of the air temperature of each batch casting. The temperature of the air immediately before placement (pouring) shall not exceed 32°C.

Where the air temperature exceeds 32°C but is still below 42°C the following measures shall be executed over and above normal curing:

a. For pads insulating sheeting (such as DPC plastic) must be overlain on the freshly casted concrete and applied curing compound with a 50mm layer of sand on top of it.
b. For columns the formwork must be kept on for 3 days and wetted at least 3 times during the first two days.

Where the air temperature exceeds 42°C but is still below 50°C the following measures shall be executed over and above normal curing:

c. For pads insulating sheeting (such as DPC plastic) must be overlain on the freshly casted concrete and applied curing compound with a 50mm layer of sand on top of it.
d. For columns the formwork must be kept on for 4 days and wetted at least 5 times during the first three days.

Where the temperature exceeds 50°C the concrete shall be discarded.

All steel-lined concrete mixer and transport vehicles (ready mix trucks) shall be cooled by the application of sufficient running water to the outside of the steel mixing drum surfaces for a continuous period of 5 minutes during the mixing process at the batch plant (including ready-mix operations) and again at the point of concrete discharge, if more than 20 minutes has elapsed since the initial treatment.

The *Contractor* shall provide appropriate hard standing areas with appropriate drainage and stormwater management facilities near all concrete discharge points, to facilitate the cooling of steel lined mixing drums of all concrete mixer and transport vehicles.

All concrete shall only be discharged if the temperature of the mixture is below 30℃. In all instances where concrete mixtures exceed 30℃, liquid nitrogen shall be directly injected into the mixer or transport vehicle until the concrete mixture reaches 20℃, provided not more than 2 hours have elapsed since the addition of mixing water into the concrete mixer.

Concrete mixtures delivered in excess of 30℃ or exceeding two hours after the addition of mixing water to the concrete shall be rejected. During winter months, when minimum ambient temperatures are below 5℃, concreting shall start towards mid-morning and only when a raising trend in ambient temperature is projected. The tendered rates shall be deemed to make adequate provisions for these requirements.

PSG-5.5.5.11: All foundations shall be placed symmetrically below columns/plinths unless otherwise shown.

PSG-5.5.5.12: Kickers shall have a minimum height of 150mm. Kickers shall be properly compacted, set, and cured as watertight concrete members. Raking of fresh concrete to form a rough surface shall not be permitted.

The surface of the kickers shall have a profile depth of between 6mm to 10mm, to be achieved by using a combination of wire brushing, water jetting within 24 hours of casting and light sandblasting techniques, to clearly expose the points of the coarse aggregates embedded in sound concrete, and partially exposed fine aggregates. The prepared surfaces shall be entirely free of cracks, spalling, damage, laitance, loose debris, concrete slush and any other form of contamination.

Scabbling, using light chipping hammers or similar mechanical techniques, as well as acid etching, shall not be permitted, as this may damage the bond line and compromise water tightness of the structure.

After the satisfactory preparation of the kicker surface, and following approval by the *Employer*, the surface shall be saturated with fresh, clean water for a period of at least 4 hours.

PSG-5.5.5.13: During the concrete operations, the concrete mixture shall be tested for each batch by the *Contractor* to determine the slump of the fresh concrete in accordance with SANS 3001-CO1-3 (Method 5862). Records of slump tests shall be supplied to the *Employer* on a daily basis."

PSG-5.5.5.14: The amount of moisture in the aggregates shall be determined on a daily basis by a method accepted by the *Employer*, and the water requirements as per the mix design altered accordingly.

PSG-5.5.5.15: No concrete for foundations shall be placed (poured) until each foundation has been inspected and accepted by the *Employer.* The foundation at the time of this inspection shall be ready for concrete placement (pouring) including reinforcing steel, embedded items and any necessary formwork.

PSG-5.5.5.16: All surfaces of the foundation upon or against which concrete is to be placed shall be free from mud and/or loose or disturbed material. The surfaces of dry absorptive materials, against which concrete is to be placed, shall be moistened prior to the placing of concrete to prevent excessive moisture being withdrawn from the fresh concrete.

PSG-5.5.5.17: At least two suitable concrete poker vibrators shall be ready for operation at the Site prior to placement of concrete.

PSG-5.5.5.18: No concrete shall be placed which has taken its initial set, regardless of whether the specified one and one-half hour period has elapsed or not. If a setting retarder, accepted by the *Employer*, has been used, the one and one-half hour period may be exceeded provided the concrete has not taken its initial set. The *Contractor* shall dispose of waste concrete in a place acceptable to the *Employer*.

PSG-5.5.5.19: Concrete shall be thoroughly settled and compacted into a dense homogeneous mass throughout the whole depth of each layer being consolidated, using internal vibrators. Excessive vibration, causing segregation, is to be avoided. Concrete vibrator penetrations shall be at ± 400mm spacing and shall not be used to move concrete.

PSG-5.5.5.20: The concrete in cast-in-situ piles shall be vibrated from the bottom upwards.

PSG-5.5.5.21: Concrete in all drilled foundations utilising piles shall be inspected immediately prior to concrete placement using a suitable high powered torch and measuring tape. The inspection is required to determine:

a) That no soil has fallen into the drilled hole such that either the design length or the design diameter of the pile has been affected, and
b) That no material from the hole sides has become dislodged and has fallen against reinforcing. No concrete will be allowed to fall directly against the hole sides during placement. A poker vibrator shall be placed in the bottom of the pile hole prior to any concrete placement and gradually lifted with the concrete pour. With inclined piles the concrete is to be placed by means of a tremie pipe which extends down the full length of the pile. The tremie pipe, together with the poker vibrator can then be gradually lifted together with the pour.

PSG-5.5.7: Construction Joints

Add the following to sub-clause 5.5.7.1:

"PSG-5.5.7.1: Before construction *works* commence the *Contractor* shall indicate on the drawings his proposal for positioning construction joints and submit these to the *Employer* for his comment and approval.

In general, foundations shall be constructed monolithically. Construction joints are to be avoided as far as possible. If construction joints cannot be avoided and are accepted by the *Employer*, the *Contractor* may be permitted to make a construction joint if the following criteria are met:

a) The concrete is reinforced and the reinforcing steel will develop full bond strength both sides of the construction joint. No construction joints will be allowed in unreinforced concrete.
b) In multiple cast-in-situ piles, the construction joint is to be 75mm, and in rock anchors 100mm, above either the base of the pile cap excavation or the top of blinding level. If the piles are constructed after the excavation for the pile cap has taken place, suitable ring shutters of the same diameter of the piles shall be used to construct the above mentioned pile/anchor projections.

No construction joints will be allowed in piles, pile caps, deadman anchors and pad slabs of pad and pier foundations.

At all construction joints, the surfaces of the previously placed and hardened concrete shall be thoroughly cleaned of all foreign matter, and primed with a 15mm thick layer of a wet mix of cement and sand in equal proportions, in the presence of the *Employer* before new concrete is placed.

The grout coating shall be brushed over the concrete surface to ensure thorough coverage, particularly between the reinforcing bars. The new concrete shall be placed before the grout coating has taken its initial set."

Replace clause 5.5.7.3 with the following:

"PSG-5.5.7.3: Construction Joints in All Structures

Depending on the weather conditions and as instructed by the *Employer*, all construction joints surfaces of the concrete shall be roughened to have a profile of between 6mm to 10mm, using a combination of wire brushing, water jetting (water jetting only if deemed necessary by the *Employer*) within 24 hours of casting and light sandblasting techniques to clearly expose the points of coarse aggregate embedded within sound concrete and to partially expose fine aggregate particles. Subsequent concrete operations shall be completed before the first cast reaches the age of 24 hours.

Scabbling, using light chipping hammers or similar mechanical techniques, as well as acid etching, shall not be permitted, as this may damage the bond line.

PSG-5.5.8: Curing and Protection

Replace sub-clause PSG-5.5.8 with the following:

"PSG-5.5.8.a): General

In adverse weather conditions (refer PSG-5.5.9), in windy conditions (with intermittent wind gusts exceeding 35km/h) and during periods of low ambient relative humidity (relative humidity is below 75%) or in every instance where the evaporation rate (according to Table 4.2 of ASTM C305R-10) exceeds 1 kg/m^2/hour, the *Contractor* shall be required to protect the area to receive concrete. These protection measures shall be in place during the final pre-concreting inspections and shall continue until all curing measures have been fully implemented.

Protection measures shall include, but are not limited to, the following, to be applied individually or in combination with each other:

i. Use of high pressure water jetting machines sprayed into the air or irrigation mist-type sprayers to locally modify the ambient relative humidity.
ii. Erect sturdy screens to deflect and limit wind passing through the concreting area.
iii. Erection of solar screening to provide shade on the formwork and general concreting area.
iv. Other Site-developed acceptable methods to limit wind speed, limit direct solar exposure and increase the relative humidity of the immediate ambient environment.

The *Contractor* shall ensure that concrete in the fresh state is not exposed to excessive thermal, humidity or wind fluctuations during the first 5 days after casting. Precautionary measures shall be taken by the *Contractor* during extreme hot, cold, dry or windy weather. One or more curing and protection measures may be applied to effectively counter the prevailing environmental risk(s), until the evaporation rate is maintained less than 1 kg/m^2/hour.

Curing shall effectively promote and maintain the adequate hydration of the cementitious binder system to ensure the adequate development of the desired mechanical and durability properties of concrete in place. Curing shall be executed in such a manner as not to cause staining, contamination or marring of the surface of the concrete.

The *Contractor* shall take all necessary precautions to prevent water used for curing from penetrating adjacent structures, adjacent work areas and the soil beneath the structure.

Drainage shall be provided to prevent water ponding and to prevent curing water affecting other parts of the *works*. The required method of curing shall be by water, unless the temperature falls below 5°C. For temperatures below 5°C, a combination of curing compound, thermal insulating blankets and heavy-duty DPM shall be used, as approved by the *Employer*.

All costs for curing and protection shall be allowed for in the tendered rates and prices.

PSG-5.5.8.b): Curing Period

The curing period, based on prevailing ambient temperatures, is indicated in the table below.

Table 25 : Curing Periods

Strength class of cement	Minimum Curing period, days		
	Ambient temperature		
	Higher than 20°C	20°C to 5°C	5°C and lower
CEM II, CEM III, CEM IV, CEMV and blends of CEM I with more than 20% slag or fly ash.	7	10	15

In windy conditions (gusts exceeding 35km/h) or periods of low ambient humidity (RH < 75%), the curing period shall be extended by 3 days.

PSG-5.5.8.c): Columns/Plinths

Sides of walls and columns shall be kept moist by means of an irrigation-type mist spraying system, as specified in clause PSG-5.5.8.f) below, together with mats of moisture-retaining materials. Sprayers shall be spaced at such intervals to ensure that the whole concrete face is wetted. The maps of moisture-retaining materials shall be fastened at the top and secured to prevent it from flapping in windy conditions.

Curing shall commence the day after concrete has been cast and shall continue for the number of days as specified above. If formwork is to remain in position (e.g. to support subsequent lifts), it shall be loosened as soon as the concrete has gained sufficient strength (usually within a day) to allow curing water to thoroughly wet the surfaces of the concrete.

PSG-5.5.8.d): Irrigation Type Mist Spraying System

Irrigation-type mist spraying systems shall be controlled by an automatic, programmable timer, which can activate the system for any chosen time periods and intervals, such that curing will be continuous over week-ends, public holidays and builder's holidays. Sprayers shall be spaced at such intervals as to ensure that the whole area of concrete is wetted. The design of the system shall be submitted to the *Employer* for approval. Should the existing water pressure on-Site be insufficient, a pump shall be installed to operate the mist spraying system.

The duration of water application and the intervals of application shall be such as to prevent the concrete from drying out. Allowances shall be made for adverse conditions, such as high temperatures and/or dry, windy conditions, subject to approval and further instructions by the *Employer*.

PSG-5.5.8.e): Plastic Sheets and Tubes

Plastic sheets and tubes used for curing shall be waterproof and shall cover every portion of concrete to be cured. Sheeting shall be white or light-coloured. Black or other dark coloured plastic sheets are not permitted. Sheets and tubes shall be held down or fixed securely to the elements being cured. Joints in sheets shall be firmly taped to prevent loss of moisture from the concrete. Care shall be exercised to prevent staining of any exposed concrete.

Plastic sheets shall be puncture-free tarpaulin or heavy-duty DPM - 500micron puncture-free, providing an impervious covering for the minimum number of days specified in paragraph (b) above. This curing method shall be used in conjunction with the irrigation-type mist spraying system, wherever possible."

PSG-5.5.10: Concrete Surfaces

Replace sub-clause PSG-5.5.10.2 with the following:

"PSG-5.5.10.2: When a wood-floated finish is specified, the surface shall first be treated as follows:

a) Immediately after placing and compaction, the concrete shall be screeded with true straight edged equipment, working between forms or other guides set accurately to line and level.
b) No mortar shall be added to depressions and proud aggregate shall be tamped level.
c) After the concrete has hardened sufficiently, it shall be floated to a uniform surface free from trowel marks with a wooden float.
d) Within 2 hours of final set curing of the concrete shall commence.

When a steel-floated finish is specified, the surface shall be treated as specified for a wood-floated finish above. In addition the following is to be done:

i. When the bleed water has disappeared and the concrete has hardened sufficiently to prevent the migration of laitance foam to the surface, the levelled surface shall be floated with a steel trowel.
ii. Firm, uniform pressure shall be applied to provide a dense, smooth, uniform surface free from any irregularities.

When a power-floated finish is specified, the surface shall be treated as specified for a wood-floated finish above. In addition the following is to be done:

1) The levelled concrete surface shall be power-floated to provide a dense surface.
2) After the bleed water has disappeared and the concrete has hardened sufficiently, the float-blades shall be replaced with trowel-blades.
3) The surface will be power-trowelled with a single pass to provide a dense, smooth, uniform surface free from irregularities.

When a power-trowelled finish is specified, the surface shall be treated as specified for power-floated finish above. In addition the following is to be done:

- After fitting the trowel-blades the surface shall be continually burnished to provide a dense, smooth, high quality polished surface free from any irregularities."

PSG-5.5.13: Grouting

Add the following to sub-clause PSG-5.5.13:

"The following grouts, or approved equivalents, holding approvals as per ETAG 001 may be used for dowel bars (where required). Grouts shall be used strictly in accordance with the manufacturers' specifications:

- Y10 up to Y16 bars (u.n.o.) — Fischer FIS-V or Hilti HIT-HY 250
- Y20 up to Y40 bars (u.n.o.) — Fischer FIS-EM or HILTI HIT-RE 500
- Moist substrate (u.n.o.) plus cored holes — Fischer FIS-EM or Hilti HIT-RE 500

Should the *Contractor* wish to use an alternative product, full details shall be provided to the *Employer* for review and approval. The information to be provided shall include valid European Technical Approval (ETA) certification in accordance with ETAG 001 for installing reinforcement in cracked concrete for the intended use of the anchor."

PSG-5.5.14: Defects

Delete Clause PSG-5.5.14.1 and replace with the following:

"PSG-5.5.14.1: The concrete shall be homogeneous and free of honeycombing, interstices and planes of weakness. If, after the removal of forms, the concrete has any defects, the *Contractor* shall immediately report such defects to the *Employer*. The *Contractor* shall not carry out any patching or remedial *works* until authorized by the *Employer*."

Delete Clause PSG-5.5.14.2 and replace with the following:

"PSG-5.5.14.2: After thorough inspection and investigation of quality and strength of the defective *works*, and after due consideration of the possible consequences of such defect, the *Employer* will either specify the extent and method of repair or order the demolition and reconstruction of the whole of the defective *works* to the extent that he considers necessary.

The cost of all such investigation, repair and remedial *works* and any demolition and reconstruction of the defective *works* shall be borne by the *Contractor* and all repair, remedial and reconstruction *works* shall be executed to the satisfaction of the *Employer*.

The method of repair of defects in dry concrete shall be by first applying an approved cement-based, epoxy-modified anti-corrosion and bonding agent like SikaTop-Armatec110 EpoCem, or approved equivalent, to the prepared surface, followed by an approved repair mortar (SikaMonoTop 612 or approved equivalent), a one component polymer modified repair mortar containing silica fume and synthetic reinforcement fibres supplied by Sika (or approved equivalent).

Where defects present wet or damp surfaces, a combination of Xypex Patch 'n Plug to arrest surface water flow, Xypex Concentrate as a slurry primer and Xypex Megamix 2 repair mortar shall be used. Alternative, equivalent products will be considered, subject to approval by the *Employer*.

Products shall be applied strictly in accordance with the manufacturer's specification or such other methods as may be approved to the *Employer*.

All repair materials shall be equivalent to the surrounding concrete in respect of thermal and structural properties. Such repairs will only be allowed after the defects were inspected by the *Employer* and approval of the method of repair has been given."

Add the following new sub-clause:

"PSG-5.5.16: Monitoring of Temperatures

The *Contractor* shall monitor and record the following for each batch of concrete on a form to be provided by the *Employer*, to ensure compliance with the specifications:

- Date and time of casting.
- Structural element and description of pour.
- Daily maximum and minimum temperatures.
- Ambient temperature at time of casting.
- Relative humidity at point of concreting.
- Wind speed at point of concreting.
- Temperature of mixing water.
- Temperature of concrete on arrival at the point of casting.
- Slump at concrete discharge.

The *Contractor* shall install a Major Tech (011-822 1551) MTD16 digital maximum/minimum thermometer, or similar approved, within a shaded area on-Site. The *Contractor* shall furthermore provide and use a Major Tech MT605, or similar approved, digital pen type thermometer to record mixing water and concrete temperatures. The *Contractor* shall also supply a Major Tech MT947 pocket anemometer to measure wind speed on-Site and a Major Tech Mt667 humidity meter to measure humidity on-Site."

8.5.6 PSG-6: TOLERANCES

PSG-6.1: BASIS OF MEASUREMENT

Add the following sub-clauses:

"PSG-6.1.3: Holding Down (H.D.) Bolts

"PSG-6.1.3.1: All H.D. bolts shall be hot-dipped galvanized to SANS 121 (ISO 1461).

"PSG-6.1.3.2: Tolerances as per SANS 2001-CS1: Structural Steel Works Item 3, Table 7:

Horizontal Level	:	+5mm or -3mm
Vertical Alignment	:	3mm

PSG-6.2: PERMISSIBLE DEVIATIONS

Replace sub-clause PSG-6.2.1 with the following:

"PSG-6.2.1: General

PSG-6.2.1.1: All Types of Concrete except Concrete for Monopole Mast Foundations

General Degree of Accuracy II shall apply for all *works* as set out in SANS 1200-G Clause 6.2.3, unless indicated otherwise."

PSG-6.2.1.2: Concrete for Monopole Mast Foundations

The concrete cast for monopole mast foundations shall be subject to the following permissible deviations:

a) Variation in structure location

- Transverse to centre-line: less than 50mm
- Longitudinal displacement: less than 300mm

b) Rotation - maximum deviation of transverse axis of structure from bisector of interior line angle

- Less than 0º30"

c) Elevation - variation of tower base from centre-line peg

- Minus 150mm
- Plus 350mm

d) Height of concrete foundations above ground level

- Minimum: 200mm (±10mm)
- Maximum: as per design

e) Variation in relative placement of foundation components from those indicated on drawings, including piles, shuttering, and structural steelwork

- Less than 50mm

f) Tolerances for placing reinforcing steel

- Variation of protective cover: –5mm +15mm
- Variation from indicated spacing: ±10mm

h) Tolerances for Mast Foundations

- Mast foundations shall be constructed such that the mast, and the associated foundation *works* are within 50mm of the correct calculated position."

PSG-6.2.3: Specified Permissible Deviation (PD)

Replace sub-clause PSG-6.2.3.a.1) with the following:

"Spacing between adjacent bars shall be -10mm +10mm, irrespective of the Degree of Accuracy (additional bars have to be added at the *Contractor's* expense if the number of detailed bars is insufficient due to incorrect bar placement by the *Contractor*)"
Replace sub-clause PSG-6.2.3.a.3) with the following:

"Cover to reinforcement: - 5mm +15mm irrespective of the Degree of Accuracy"

Replace sub-clause PSG-6.2.3.d.7.ii) with the following:

"Abrupt changes in a continuous surface: Between different concrete pours at construction joints in floors: ±5mm irrespective of the Degree of Accuracy."

8.5.7 PSG-7: TESTS

PSG-7.1: FACILITIES AND FREQUENCY OF SAMPLING

PSG-7.1.2: Frequency of Sampling

Add the following new sub-clause:

PSG-7.1.2.5: The minimum number of 150mm cubes to be sampled on-Site for all structural concrete shall be as per the table below:

Table 26 : Minimum Cubes to be Sampled

Volume of Individual Element/Concrete Pour/Lot (m^3)	Minimum Number of 150mm Cubes
0 – 49	6
50 – 70	9
71 – 100	12
101 – 150	15
>150	18

Test cubes shall be prepared, in accordance with SANS Method 5863.

Test cubes shall only be made out of a concrete batch at the point of discharge in actual use.

PSG-7.2: TESTING

PSG-7.2.1: General

Add the following:

"The *Contractor* shall allow in his tendered rates for all costs for quality and process control testing. Slump tests, concrete temperature, humidity, wind speed and compression strength tests shall be required for all concrete operations."

PSG-7.2.4: Early-Strength Testing

Add the following:

"Of each sample of six 150mm cubes, three cubes shall be tested at 7 days and the remaining three cubes at 28 days."

PSG-7.3: ACCEPTANCE CRITERIA FOR STRENGTH CONCRETE

Add the following subclause:

"PSG-7.3.6: Reporting

Defective concrete *works* shall be reported to the *Employer* without delay. The *Contractor* may not proceed with any remedial *works* or patching unless approved by the *Employer*."

8.5.8 PSG-8: MEASUREMENT AND PAYMENT

PSG-8.1: MEASUREMENT AND RATES

PSG-8.1.1: Formwork

Replace the first sentence of sub-clause PSG-8.1.1.2 with the following:

"PSG-8.1.1.2: No narrow widths will be measured."

PSG-8.1.2: Reinforcement

Replace sub-clause PSG-8.1.2.2.a) with the following:

"PSG-8.1.2.2.a): The mass of steel bars will be measured as the total mass of the steel, irrespective of diameters."

PSG-8.1.2.3.a): Delete the words "of nominal size 25 mm" in the first line of this sub-clause."

PSG-8.1.2.3.b): Delete sub-clause PSG-8.1.2.3.b).

PSG-8.1.3: Concrete

Add the following to sub-clause PSG-8.1.3.3.a):

"The tendered rate for concrete to be used shall also include all measures necessary to store cement, water and aggregates in a cool environment to ensure that the ingredients of the concrete are cool at the time of mixing."

Add the following new sub-clause:

"PSG-8.1.4: Casting In of Pipes and Specials

No separate items will be scheduled for building in items supplied under this contract except for those specially measured in the bill of quantities.

The relevant rates for supply and installation shall cover the cost for casting in the items supplied under this contract, whether the items are positioned prior to construction or subsequently placed in blocked-out holes."

Add the following new payment items:

"PSG-8.9: Reinforced Concrete Mast Foundations (30MPa/19mm Stone), for:

a) Monopole mast no. 1 BLW/ISC 32/1 .....Unit: No.
b) Monopole mast no. 2 BLW/ISC 32/1 .....Unit: No.
c) Monopole mast no. 1 & 2 BLW/ISC 32/2 .....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for the casting of 30MPa reinforced concrete foundations for the above-listed monopole masts, as indicated on the relevant drawings and typical drawings, including (but not limited to) the following:

- all surface preparation
- casting of blinding
- designing, ordering and installation of formwork
- ordering and placement of reinforcing (in accordance with the drawings and bending schedules)
- placement of holding down bolts (in accordance with the drawings)
- ordering and casting of concrete
- vibrating the concrete
- finishing (wood float with broom finish)
- jointing (where required)
- curing
- testing of concrete strength
- removal of formwork
- making neat

all in accordance with this specification.

PSG-8.10: Reinforced Waterproofed Concrete Mast Foundations (35Mpa/19mm Stone), for:

a) Monopole mast no. 1 BLW/ISC 32/3 .....Unit: No.
b) Monopole mast no. 2 BLW/ISC 32/3 .....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, water, transport, etc.) for the casting of 35MPa reinforced waterproofed concrete foundations for the above-listed monopole masts, as indicated on the relevant drawings and typical drawings, including (but not limited to) the following:

- all surface preparation
- casting of blinding
- designing, ordering and installation of formwork
- ordering and placement of reinforcing (in accordance with the drawings and bending schedules)
- placement of holding down bolts (in accordance with the drawings)
- ordering and casting of concrete (including crystalline waterproofing additive as per clause PSG-3.2.2.2)
- vibrating the concrete
- finishing (wood float with broom finish)
- jointing (where required)
- curing
- testing of concrete strength
- removal of formwork
- making neat

all in accordance with this specification.

8.6 PSH: STRUCTURAL STEELWORK

8.6.1 PSH-1: SCOPE

Add the following:

"This specification covers the structural steelwork for all new monopole structural steel masts.

The table below provides a summary of the type and number of the monopole masts that will be required to be manufactured, supplied and erected.

Table 27 : Type and Number of Structural Steel Masts

Type of Mast	Number of Masts
28.5m high T-off structure mast (mast no. 1 BLW/ISC 32/1)	1
18.5m high T-off structure mast (mast no. 2 BLW/ISC 32/1)	1
26.5m high strain structure mast (mast no. 1 & 2 BLW/ISC 32/2)	1
18.4m high terminal structure mast (mast no. 1 BLW/ISC 32/3)	1
20.4m high terminal structure mast (mast no. 2 BLW/ISC 32/3)	1

The *Contractor* shall be responsible for the detailed design, fabrication, assembly, transport, erection and fixing of the above-listed masts, strictly in accordance with this specification, associated contract documentation and within the required tolerances. The *Contractor* shall further produce the required detailed shop drawings, with all applicable calculations, and submit it to the *Employer* for scrutiny and approval.

The masts shall be designed, manufactured and erected in accordance with this specification, all the relevant listed codes and standards and drawings listed in the Works Information.

Furthermore the masts shall also comply fully with the provisions of ASCE Standard 48-11 as well as SANS 10280-1, IEC 60826, Eskom Standard 240-75883378 and associated others.

The holding down bolts shall be hot dip galvanised throughout in accordance with SANS 121 (ISO 1461). Each bolt shall be supplied with 3 x galvanised nuts, 2 x washers and 1 x spring washer, unless otherwise required. The holding down bolts shall form part of a 'bolt cage' type system, unless otherwise specified or instructed. Earthing of the masts, bolt cages and foundation rebar shall be in accordance with the requirements of Eskom.

All parts of the mast shall be hot dip galvanised throughout in accordance with SANS 121 (ISO 1461) and test certificates shall be provided. No drilling, machining or welding shall be performed on the masts after galvanising.

Further reference shall be made to table 15 in this specification.

8.6.2 PSH-3: MATERIALS

Add the following (including extracts from Eskom Document 240-47172620):

"Structural steel for all mast members shall be Grade S355JR steel conforming to SANS 50025-1 to SANS 50025-6, and shall be hot dip galvanised after fabrication and marking.

Proof must be supplied by the *Contractor* that the mast manufacturer is ISO 9001:2008 and Eskom accredited.

Certified mill test reports of the chemical and mechanical properties of the steel for the full quantity required for fabrication shall be obtained from the steel supplier. Copies of these mill test reports shall be retained on-Site for review by the *Employer*.

The *Contractor* shall, if so instructed, cut samples from deliveries of Grade S355JR steel and conduct mechanical tests upon the samples to ensure that the steel is Grade S355JR. The frequency of testing shall be subject to acceptance by the *Employer*.

Only structural shapes included in the latest edition of the "South African Steel Construction Handbook", published by the South African Institute of Steel Construction, shall be used, unless otherwise specified or required by Eskom. Ensuring the availability of member shapes selected is the sole responsibility of the *Contractor*. To facilitate the transport of masts, these shall be limited to a maximum section length of 12.5m.

The steel selected for manufacturing purposes of masts shall be suitable for hot dip galvanizing. In general two steel types are acceptable namely "Aluminium Killed Steel" and "Silicon Killed Steel", unless differently required by Eskom.

The chemical content of the steel should be within the following limits:

a) For Aluminium Killed Steel: Silicon (Si) = 0.01 to 0.04% and Phosphorous (P) = 0.015% maximum.
b) For Silicon Killed Steel: Silicon (Si) = 0.15 to 0.25% and Phosphorous (P) < 0.02% maximum.

All structural steelwork shall be fabricated and erected in accordance with SANS 2001-CS1.

A certificate from the steel manufacturer in which the grade of the structural steel is verified shall be handed to the *Employer* for approval.

The *Contractor* shall, at the commencement of the project, acquaint himself with the availability and delivery time of the products and steel profiles specified in this specification and on the drawings, so that such material can be ordered ahead of time. Note: Manufacture may only commence upon approval of the detailed shop drawings and calculations.

All components exposed to the environment must be non-corrosive or be treated for corrosion in accordance with clause PSHC: CORROSION PROTECTION TO STRUCTURAL STEELWORK in this specification, and those of Eskom.

PSH-3.6: BOLTS, NUTS AND WASHERS

Change the title of clause 3.6.1 to the following:

“PSH-3.6.1: Bolts, Nuts and Washers”

Add the following (extracts from Eskom Document 240-47172620):

a) Bolts and nuts shall be at least Grade 6.8 and manufactured in accordance with DIN EN ISO 898-1, and shall be hot dip galvanised to SANS 121/ISO 1461.
b) After hot dip galvanizing, bolt holes shall be not less than 1.2mm larger in diameter than the corresponding bolt diameter.
c) Bolts of different diameters can be used on the same mast (if so required by the approved mast drawing), provided that bolt sizes are not mixed in any one connection or plate. The minimum diameter size of bolt shall be 16mm.
d) The threaded portions of all bolts shall project through the corresponding nuts by an amount not exceeding 15mm and not less than 3mm after tightening.
e) No threaded portion of any bolt shall occur within the thickness of the parts bolted together. To ensure this a single washer of suitable thickness shall be placed under the nut so that in all cases the required clamping force can be achieved.
f) The minimum thickness of washers shall be 3mm and the maximum thickness shall be 6mm.
g) No lock nuts or spring washers shall be used on the masts (unless noted otherwise).
h) As a general rule when hot dip galvanizing a threaded component or ISO metric fastener, the galvanizing of one thread either internal or external requires an extra clearance of four times the coating thickness. In practice it is normal for standard bolts from stock to be fully galvanized, but for nuts to be galvanized as blanks and then tapped up to 0.38mm-0.42mm oversize with the threads lightly oiled. When assembled the nut thread is protected by contact with the coating on the bolt.
i) Further to the requirements as stated above, if protection of bolts, nuts and washers by means of a specialised thermal diffusion zinc coating is specified in the relevant line specification, then additional clearances on the nut may be required as both bolt and nut threads will remain zinc coated to the required zinc coating thickness and easy fitment of nut and bolt must still be retained.
j) All mast bolts shall be manufactured with standard thread sizes so that they can be inspected with a go/no-go gauge prior to hot dip galvanizing. Bolts should be threaded according to SANS 1556-1: ISO Metric screw threads.
k) Hot dip galvanizing should be done according to SANS 121/ISO 1461 by which the suggested mean coating thickness for centrifuged articles with a diameter of more than 20mm will be 55µm and for articles with a diameter less than 20mm will be 45µm.
l) When use is made of a thermal diffusion zinc coating process the minimum coating thickness will be 70µm and the thread cut should accommodate this.
m) Undersize cutting of the male thread (i.e. Bolt) before hot dip galvanizing will not be allowed as the quality inspection before hot dip galvanizing cannot be done with a standard go/no-go gauge.

8.6.3 PSH-5: CONSTRUCTION

Add the following:

“All mast drawings shall be read in conjunction with this specification, the Bill of Quantities and all other associated documentation and any discrepancy to be brought to the attention of the *Employer* in writing.

PSH-5.1: DRAWINGS AND SHOP DETAILS

Replace the above heading with the following:

"PSH-5.1: DESIGN, DRAWINGS AND SHOP DETAILS"

PSH-5.1.1: Design Drawings

Replace the above sub-clause heading with the following:

"PSH-5.1.1: Design and Design Drawings"

Replace the content of the sub-clause with the following:

"The *Contractor* shall be responsible for the detailed design of all the structural steel monopole masts. The drawings of the *Employer* are indicative only and provide the minimum requirements that the *Contractor* shall include in his design. The *Employer* reserves the right to request any additional information, including on the drawings, and in the format stipulated. The *Contractor* shall allow for the aforementioned in his BoQ rates. No additional claims will be entertained pertaining to the aforementioned.

Every reasonable precaution and provision shall be incorporated in the design of the masts for the safety and security of the system and of those concerned with its operation and maintenance – all in accordance with these specifications, associated contract documentation, Eskom requirements and all other statutory regulations and standards.

The masts shall be designed for mounting on a reinforced concrete foundation by means of a base flange secured to a bolt cage cast into the foundation.
The base flange shall be free from laminations and the welded connection to the mast, shall fully develop the strength of the section. Means shall be provided to enable masts to be adjusted from deviations from the vertical.

The head frame shall be designed to effectively seal the top of the mast against the ingress of water.

All masts shall be mounted on foundations. No mast shall have its base cover below or at ground level.

Refer to clause PSH-1: SCOPE for more detailed design requirements for each of the specific masts."

PSH-5.1.2: *Contractor* Provides Shop Details

Add the following:

"All dimensions and levels shall be checked on-Site before shop drawings commence. Any discrepancies shall be brought to the attention of the *Employer*.

A complete set of detailed shop drawings, and associated calculations, shall be submitted to the *Employer* for approval before fabrication commences. Shop drawings will only be checked by the *Employer* for compliance with design intent. No dimensional checks will be done by the *Employer*. Dimensional checks and check for fit shall remain the responsibility of the *Contractor*.

All shop splices shall be indicated on drawings. All drawings and calculations submitted by the *Contractor* for approval shall only be in metric units.

PSH-5.2: FABRICATION

PSH-5.2.1: General

Add the following (including certain extracts from Eskom Document 240-47172620):

"The fabricator shall ensure that centres of gravity of members intersect at node points, except where eccentricities are specified on the drawings provided by the *Employer*.

Where temporary bracing or propping is required, the *Contractor* shall be responsible for the design, erection, maintenance and removal (where necessary) of such supports. If splices in trusses are required due to transport, proposals of this shall be submitted to the *Employer* at an early stage for written approval. The cross-section and wall thickness of each mast shall be determined by the *Contractor*.

All parts of structures shall be fabricated in accordance with the accepted shop drawings, and generally carried out in accordance with SANS 2001-CS1. Workmanship and finish shall be equal to the best modern practice for steel monopole work. Pieces having the same markings shall be interchangeable.

All parts of the structure shall be neatly finished and free from kinks or twists. All holes, blocks and clips shall be made with sharp tools and shall be clean-cut without torn or ragged edges."

PSH-5.2.3: Cutting

Add the following (extracts from Eskom Document 240-47172620):

"Shearing and cutting shall be neatly and accurately done. Cuts shall be clean without torn or ragged edges. Particular care shall be taken in the edge finish of plates subjected to large bending moments or large bends in fabrication."

PSH-5.2.4: Holes for Fasteners

Add the following new sub-clauses (extracts from Eskom Document 240-47172620):

"PSH-5.2.4.14: Where necessary, to avoid distortion of the holes, holes close to the points of bends shall be made after bending of member. The use of a blow torch for cutting holes to size shall not be permitted. Plasma cutting machines can be used in combination with drilling or reaming to achieve final hole dimensions.

For material less than 10mm in thickness - punching holes to full size, the diameter of the punch shall be 1.5mm less than the diameter of the die.
For material greater than 10mm but smaller than 18mm in thickness - punching holes to full size, the diameter of the punch shall be 2.0mm less than the diameter of the die.

Sub punching for reamed work shall be such that after reaming, no punched surface shall appear in the periphery of the hole.

PSH-5.2.4.15: All holes shall be spaced accurately in accordance with the drawings and shall be located on the gauge or back mark lines. The maximum allowable variation in hole spacing for a bolt group, from that indicated on the drawings for all bolt-holes, shall be 1.0mm. Miss drilled or miss punched holes may not be refilled by welding.

PSH-5.2.4.16: The *Contractor* may submit alternative manufacturing processes to the *Employer* for approval before manufacturing commences other than those listed above."

Add the following new sub-clause:

"PSH-5.2.7: Steel Bending (extracts from Eskom Document 240-47172620):

a) All forming or bending during fabrication, shall be only done according to methods accepted by the *Employer*, such that it will prevent any embrittlement, cracking or loss of strength in the material being worked. The technical requirements for hot and cold forming are as follows:

1) The bending radius will be at least equal to 1.5 times the material thickness to be used.
2) When hot bending of steel needs to be performed, an accurately controllable form of heating must be employed for both temperature and time.
3) The length of the section to be heated shall be clearly marked on the section, and heating equipment set accordingly.
4) The required bending tool shall be ready on the bending press with checking jigs available at all times. Checking jigs must be of high quality so that they do not deteriorate over time. Steel jigs should be used.
5) A dry run shall be made first to check that all systems are operational and that the proper tools are used.
6) Material shall be uniformly heated over the required length, to a temperature of between 750°C to 900°C. Oxidation of the material shall be minimised. An acceptable consistent means of temperature measurement of the steel temperature must be used.
7) Heated material shall be inserted into the bending press and formed while the temperature is still within the specified range. The bending process of a single bend must be done using a single action.
8) Formed material shall be checked immediately to ensure that they have been formed correctly.

9) Formed/bent material shall be left to cool naturally in open air. The use of any liquids or forced air to cool formed material is not acceptable.
10) Re-checks shall be made with the appropriate jigs when the material is cold.

b) If more than one bend is required on a section, the operation shall be repeated for each bend. Repeated heating of a bend position shall not be allowed.

c) New bends shall not deform the bend previously made.

d) For bending limitations on the flaring of flanges on angle sections, refer to the *Employer*. Any other bending of angle sections shall be done hot.

e) For cold bending process, designs must take into account that the neutral axis distance shall be 0.33 of the plate thickness for plates thicker than 2mm."

PSH-5.3: ASSEMBLY

Add the following:

"The correct installation of the nuts at the base of the mast must be done as per manufacturer instruction to prevent damage to bolt screw threads, foundations and insulation materials."

PSH-5.3.4: Welding

Add the following:

"Welds shall conform to SANS 10167, SANS 10044 and AWS D 1.1 specifications.

Site welding will not be allowed without the written approval of the *Employer*.

Where no weld sizes are shown, the minimum weld size shall be that of the thickest plate of the connecting plates/elements. Unless otherwise shown the intention of connections are to transfer the full force that can be developed in connecting members through the connection.

When using electric arc welding, all electrodes shall be E7018. For any other welding process to be used, the *Contractor* shall apply, in writing, for the approval from the *Employer* for the electrodes to be used.

All butt welds shall develop the full strength of the elements joined.

All splices shall develop the full strength of the elements joined.

Welding shall only be performed by professional coded welders.

Suitably qualified and experienced welders using proper equipment in a good condition shall do all Site welding.

The *Contractor* shall design all welds and, where necessary, gussets of sufficient strength shall be provided to obtain the required weld length to ensure the full strength of the connection.

Minimum quality control on welding shall be as follows:

a) All welds shall be inspected using visual aids.
b) All butt welds: 100% ultrasonic NDT.
c) All fillet welds: 20% MPI.
d) Crane/crawl beams: 100% ultrasonic NT.

Welding procedures and welders' performance qualifications shall conform to the requirements of AWS D 1.1. The supporting documentation is to be submitted to the *Employer* and approved prior to the start of welding."

PSH-5.5: ERECTION

PSH-5.5.1: Procedure

Add the following:

"The *Contractor* shall compile a safe erection method statement that is to be submitted to the *Employer* for comment and/or acceptance.

PSH-5.5.2: Storage and Handling

Add the following:

"Steel in storage shall be supported off the ground with a sufficient number of blocks to prevent bending or warping of individual members.

Mast steel shall be handled with the use of nylon or fabric slings. The use of unprotected wire rope slings is not permitted.

Steel material shall not be dumped or dropped from trucks, but shall be carefully unloaded and stacked.

Steel material shall not be dragged on the ground."

PSH-5.5.3: Safety during Erection

Add the following:

"The *Contractor* shall adhere to all safety requirements in accordance with requirements from Eskom, the *Employer's* requirements as well as all statutory standards and regulations.

Add the following new sub-clause:

"PSH-5.5.6: Assembly and Erections of Masts

a) The applicable type of mast shall be erected on the completed foundation. Masts shall not be erected until the foundation concrete had at least 14 days to cure and the concrete 7 day cube strength tested above 30MPa, the minimum 7 day cube strength requirement.
b) All masts shall be vertical within 2mm in 1m in both the transverse and longitudinal directions when erection is completed, unless a different tolerance is specified.
c) Steel masts shall be assembled and erected so as not to overstress structural members, bolts or foundations. The structural assemblies shall be erected with the members supported in their proper relative position. Structural assemblies that are not sufficiently rigid to be raised in one piece shall be stiffened by means of temporary bracing during erection.
d) All masts shall be assembled in strict accordance with the drawings. The size and length of all bolts, washers, nuts, ring fills and plate fills shall be as specified on the erection or manufacturing drawings.
e) A reasonable amount of drifting will be allowed in the assembly of members, but driving of bolts to correct mismatched holes will not be allowed.
f) Where drilling, punching or clipping is done in the field, all exposed steel surfaces shall be coated with materials endorsed by the Hot Dip Galvanizing Association or other material approved by the *Employer*.
g) After final tightening of all nuts, they shall be fixed in position by punching three indentations at approximately 120 degree intervals around the threads with a round pointed centre punch. The nuts and exposed bolt thread shall be painted with a single pack waterborne anti corrosive primer with a life expectancy of 20 years.
h) After erection, all masts shall be cleaned of all foreign matter.
i) The *Contractor* shall provide a detailed method statement of the assembly and erection of masts for approval."

8.6.4 PSH-7: TESTING

Add the following:

"Tensile strength testing results shall be provided for each batch of steel from which cold-formed sections are sourced.

The *Employer* reserves the right to inspect the *works*, and witness tests at any stage during the manufacture process.

Witnessed tests to SANS 50025 1 to 6 / EN10025 1 to 6 may require samples of steel from the *Contractor*'s stockpile.

The *Employer* may take tests, to ensure satisfactory quality of the hot dip galvanizing.

Certificates shall be provided by the *Contractor* proving compliance with all aspects of material quality, manufacture and hot dip galvanizing."

8.6.5 PSH-8: MEASUREMENT AND PAYMENT

PSH-8.3: SCHEDULED ITEMS

Add the following new payment item:

"PSH-8.3.14: Design, Supply and Install the following steel monopoles:

a) Monopole mast no. 1 BLW/ISC 32/1 .....Unit: No.
b) Monopole mast no. 2 BLW/ISC 32/1 .....Unit: No.
c) Monopole mast no. 1 &2 BLW/ISC 32/2 .....Unit: No.
d) Monopole mast no. 1 BLW/ISC 32/3 .....Unit: No.
e) Monopole mast no. 2 BLW/ISC 32/3 .....Unit: No.

The tendered rates shall cover all costs (plant, equipment, material, labour, transport, etc.) for the complete design, supply and installation of the above-listed monopole masts, as indicated on the relevant drawings, including (but not limited to) the following:

- the complete structural and functional design of all aspects of the monopole masts and submitting design calculations to the *Employer* for approval,
- the preparation of detail shop drawings and submitting these drawings for the *Employer* for approval relating to the structural and functional items of the masts,
- the sourcing, supplying and fabrication/manufacturing of all structural steel material for the masts (including holding down bolts), including all welding, drilling, punching, stamping, cutting and bending of parts required for the complete product,
- hot dip galvanising (HDG) of complete mast units as well as holding down bolts, nuts, washers and other steel items,
- safe and careful loading, transporting and off-loading of all hot dip galvanised masts and associated accessories, fixtures and fittings to Site,
- safe and careful storage of above-mentioned material on Site for the duration of the Contract,
- safe and careful erection/planting of the masts in accordance with the drawings and other related specifications, guidelines and manufacturer's requirements,
- fixing of masts onto cured foundation plinths via hot dip galvanised holding down bolts,
- carrying out tests as required,

all in accordance with this specification."

8.7 PSHC: CORROSION PROTECTION OF STRUCTURAL STEELWORK

8.7.1 PSHC-1: SCOPE

Add the following:

"This specification further covers the corrosion protection of all structural steel for the new structural steel monopole masts.

This specification shall be read in conjunction with the Eskom Corrosion Protection Specification document 34-1658.

All structural steel masts shall be hop dip galvanised to a minimum average dry film thickness of 150 micrometres, unless otherwise specified or required.

All structural steel masts for this Contract shall fall under the following corrosivity category classification (in accordance with Eskom Corrosion Protection Specification document DSP 34-1658, and be coated in accordance with the associated requirements:

a) Corrosivity category C5 (Very High - Coastal areas) complying with coating Detailed Specification (DS) number DS-13 as per Table B2."

8.7.2 PSHC-3: MATERIALS

PSHC-3.1: PACKAGING

Add the following:

"All materials, i.e. paint, solvents and cleaning agents for a specific paint system shall be supplied by the same manufacturer.

The coating containers shall be of a size large enough to allow mixing in the containers themselves."

Add the following new clause:

"PSHC-3.4: MATERIALS TESTING PRIOR TO DELIVERY TO SITE

PSHC-3.4.1: All materials (coatings) shall be regularly tested at the manufacturers' factories. The *Contractor* shall make sure that regular quality control tests are carried out to ensure that good quality of the materials is maintained.

PSHC-3.4.2: The following properties shall be closely monitored:

a) Quality of raw materials.
b) Analytical formulation of finished products.
c) Percentage solids by volume.
d) Specific gravity.
e) Colour and gloss.
f) Drying time.
g) Viscosity.

PSHC-3.4.3: Records of the batch numbers, expiry dates, dates of manufacturing of each type of system used, shall be retained by the *Contractor*. These records shall be presented to the *Employer*, prior to commencement of the *works*. The *Contractor* shall also ensure that the coating/material manufacturer retains a sample of each batch for at least the guarantee period."

8.7.3 PSHC-5: CONSTRUCTION

PSHC-5.2: GENERAL WORKMANSHIP

Add the following:

"Stringent precautions shall be taken to protect finished surfaces from injury or damage during assembly, transit, storage and erection.

Any material found to be damaged shall be made good or replaced by the *Contractor*.

When hot dip galvanizing needs to be repaired only materials endorsed by the Hot Dip Galvanizing Association or other material approved by the *Employer*, and as per Eskom requirements, may be used. Zinc-rich epoxy paint (of at least 100 microns) can be used.

Cold galvanising or galvanising paint shall not be used. Consideration can also be given to galvanising thermal spray as a method of repair on Site.

Water ingress into the mast structure shall be prevented at all times."

Add the following new clauses:

"PSHC-5.11: GALVANIC CORROSION PROTECTION

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer*.

The table below provides a general indication/guide only, of which metals can be connected to each other without the need of special measures to avoid interaction, and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The responsibility will remain with the *Contractor* to avoid bimetal/galvanic corrosion between different metal equipment.

Table 28 : Combinations of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	Stainless Steel	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Copper	Not Permissible	Not Permissible	Permissible	Permissible	Not Permissible	Permissible
Stainless Steel	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

8.7.4 PSHC-8: MEASUREMENT AND PAYMENT

Replace all payment clauses with the following:

"No separate pay items have been provided under this section to cover the cost for corrosion protection of structural steelwork. The cost of providing these items/services is deemed to be included under the pay items for each mast, as per the rates included in the bill of quantities for section PSH: STRUCTURAL STEELWORK."

9.0 PACKAGING, TRANSPORTATION AND HANDLING

The following general requirements are applicable to all equipment forming part of the *works:*

- If any equipment requires special maintenance or attention during storage, this shall be clearly stated prior to placement of orders and the *Employer's* attention shall be drawn to this fact.

- Crates supplied for transport shall be suitable for Site storage for a period up to 6 months to allow for delays in the installation of equipment.

- The *Contractor* shall be responsible for loading all materials and equipment at the suppliers or OEMs premises, rigging, transportation, handling and off-loading thereof on Site, including also any further handling of equipment until it is placed in the final, permanent positions. The same applies to any redundant equipment which must be delivered to Eskom's Brackenfell premises.

10.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as required by the *Employer* and Eskom.

11.0 INSPECTIONS, TESTING AND COMMISSIONING

11.1 General

The *Contractor* shall develop quality control procedures/plans, test plans and the like and shall provide all necessary resources for the management and implementation of these procedures and plans, in accordance with the general requirements as set forth in the accompanying Works Information. Further requirements as detailed below shall form an integral part of these quality management procedures.

The quality control procedures/plans shall include, but not be limited to, the designs, approvals, fabrication, inspections, transport, installation, testing and commissioning of equipment with associated hold points. These quality control procedures/plans shall be subject to review and approval by the *Employer*, who may also add further hold points as deemed appropriate.

The *Contractor* is advised to timeously submit all quality control documentation, to the *Employer* for review and approval, prior to commencement of the *works*, to prevent subsequent delays. Any delays in this regard will be to the *Contractor's* account. Reference is made also to the submittal processes as detailed in the Works Information.

All inspections, testing and commissioning shall be in accordance with these specifications, associated contract documentation, all relevant regulatory standards, industry best practices, *Employer* and Eskom requirements and the like.

The *Contractor* shall supply, operate and where applicable maintain all equipment and instruments required to perform all tests, inspections and commissioning, which shall only be undertaken by suitably qualified, experienced and competent persons, using only fit-for-purpose, correctly calibrated equipment.

The *Employer* may at his discretion instruct the *Contractor* to perform additional testing and/or commissioning activities, as well as provide any additional information as required to prove the functionality, operability and compliance of the infrastructure. Allowances shall be made by the *Contractor* in the scheduled rates included in the bill of quantities for such tests.

Should the *Contractor* fail to perform any test or properly commission equipment supplied and installed by the *Contractor*, or should any item of equipment or part of the installations fail any test or commissioning inspection, the *Employer* reserves the right to recover from the *Contractor* any reasonable cost to himself to witness the repeat of such test or commissioning.

The notice period and date(s) to be provided by the *Contractor* to the *Employer* for an event requirement shall be as stipulated in the *Contractor* Document Schedule, unless otherwise instructed or specified.

The *Contractor* shall at all times provide unimpeded access to the *Employer* to inspect the *works*. All equipment and instruments required to perform all tests and inspections shall be supplied, operated and maintained by the *Contractor*.

The *Contractor* shall rectify any defects noted during the final inspection prior to final hand-over.

11.2 Factory Inspections and Tests

All project specific, factory built equipment and any other *Employer* selected equipment, and as required by Eskom, shall be tested and inspected at the manufacturing premises or test facility prior to delivery to Site. The *Contractor* shall notify the *Employer* in advance of the tests and inspections.

The *Employer* may, at his discretion, wish to witness these tests and inspections. The provisions of these specifications and associated contract documentation apply.

11.3 Site Inspections and Tests

The *Contractor* shall notify the *Employer* at least seven (7) working days prior to the dates of key inspections and tests, including, but not limited to, the following:

- Masts.
- Foundations.
- Hardware Assemblies.
- Earthing.
- OTDR testing on OPGW and associated fibre optic installations.

11.4 Test Equipment and Certificates

Test reports and/or certificates shall be issued for all tests that are conducted. These certificates shall be signed by the *Contractor* and the manufacturer/test laboratory (as applicable). The number of copies to be issued to the *Employer* shall be as per the *Contractor* Document Schedule, unless otherwise instructed.

Unless separately scheduled, the cost of all equipment, instruments and tests shall be included in the scheduled rates for the relevant items.

Test reports and certificates that will be required include, but are not limited to, the following:

11.5 Final Inspection and Handover

Prior to practical completion and handover of the *works*, the *Contractor* shall arrange a final inspection with the *Employer*.

The *Contractor* shall give at least fourteen (14) working days' notice of the date of the final inspection, unless otherwise instructed or specified. Documentation to be submitted by the *Contractor* to the *Employer* at the final inspection shall include, but not be limited to, the following:

- Quality control plans.
- Test reports and certificates.
- As-built documentation and drawings.
- Certificate of Compliance(s).

The *Contractor* shall rectify any defects noted during the inspection prior to the hand-over inspection.

The *Contractor* shall provide signed off documentation by the equipment supplier/OEM, certifying that the installation of all equipment supplied by them conforms to the project requirements.

12.0 DESIGN APPROVAL, MANUFACTURING, INSPECTIONS, TESTING AND COMMISSIONING PROCEDURES

The following procedures shall apply to the design approval, manufacture, inspections, testing, installation and commissioning of the equipment/systems.

- *Contractor* appoints the specialist subcontractor/OEM.
- *The Contractor* provides the project and technical requirements to the specialist subcontractor/ OEM.
- The specialist subcontractor/OEM undertakes the design of the equipment/systems and submits drawings plus any other associated technical information for approval to the *Contractor*.
- *Contractor* checks the drawings and associated technical information as provided, for compliance with all the requirements of the specifications, Works Information, drawings and the like and submits three copies, signed off as checked, to the *Employer* for approval.
- *Employer* returns copies as approved, or for resubmission, to the *Contractor*.
- Manufacture of the equipment/systems commences after approval of the drawings and associated technical information, by the *Employer*.
- *Contractor* checks and inspects the manufactured equipment/systems at the specialist subcontractor/OEM's premises during all stages.
- *Contractor* presents the *Employer* with written confirmation that the equipment/systems are in full compliance with the project requirements and have been checked, inspected and fully tested. This confirmation, signed and dated by both the *Contractor* and the specialist subcontractor/OEM, is to accompany a written request for the *Employer* to witness factory acceptance tests (FAT), i.e. re-inspection and retesting of the equipment/systems.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list and approval by the *Employer*, the equipment/systems may be dispatched to Site.
- On arrival of the equipment/systems on Site, the *Contractor* shall request in writing that the *Employer* witness the associated Site acceptance tests (SAT) as applicable. After the tests, written confirmation shall be provided by the *Contractor* to the *Employer* that the equipment/systems are in full compliance. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval by the *Employer*, the equipment/systems may be installed.
- Once the equipment has been installed, tested for complete functionality, operability and compliance as per the contract, the *Contractor* shall request the *Employer* in writing to witness the installed equipment/systems.
- The installed equipment/systems shall be re-tested on Site so that the *Employer* may verify the functionality, operability and compliance requirements. Upon approval of the *Employer*, after the installation and tests, written confirmation shall be provided by the *Contractor* to the *Employer* that the equipment/systems are in full compliance and have been commissioned correctly. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/ OEM.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor.*
- Should the *Employer* determine that the final product does not fully meet the project requirements, functionality, operability and/or compliance requirements, the *Contractor* shall undertake the necessary repairs and re-testing, all at his own expense.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval received from the *Employer*, the equipment/systems shall be formally handed over to the *Employer*.
- Under no circumstances will the *Employer* enter into any discussions regarding conformance to the project requirements with the specialist subcontractor/OEM. All communications shall be between the *Employer* and *Contractor* only.
- The *Contractor* shall ensure that full copies of the project requirements, specifications, approved signed copies of the drawings and any other associated technical information, are at hand during all inspections.
- All relevant statutory testing, commissioning and certification of the equipment/systems shall be performed by the specialist subcontractor/OEM.
- The *Contractor* shall notify the *Employer* in advance of the tests and inspections, as indicated in the *Contractor* Documentation Schedule.

13.0 HANDOVER DOCUMENTATION

13.1 As-Built Documents

The *Contractor* shall maintain records and prepare as-built documentation for all design documents, drawings, quality control records, tests, pre-commissioning reports, commissioning reports, operation and maintenance manuals and the like. The as-built documents shall be comprehensive and shall demonstrate compliance with the project specifications and drawings. Reference shall also be made to the further requirements as detailed in the accompanying Works Information. The following details shall apply:

- The scope and format, including the required indexing, of the as-built information shall be discussed and agreed with the *Employer* prior to compilation and submission of the final documentation.
- All as-built documents shall be signed off by the *Contractor* and submitted to the *Employer* for approval, as these are developed and at completion of the *works*.
- All as-built documents shall be furnished to the *Employer* in both hard and soft copy formats.
- As-built documents shall be submitted as per the requirements as set out in the CDS, unless otherwise instructed by the *Employer*, and the further requirements as detailed below.

13.2 As-Built Drawings

The *Contractor* shall keep a separate set of project drawings for marking up changes to the original design as the *works* progress. Marked-up red lined hard copies of drawings shall be maintained by the *Contractor* during installation of the equipment and shall be included in the handover documentation.

As-built drawings shall include the drawings issued by the *Employer* as well as any drawings compiled by the *Contractor*.

Software copies of the “as-constructed” drawings shall be provided in ‘rvt’, ‘dgn’, ‘dwg’, ‘dxf’ and ‘PDF’ formats.

The final, as-constructed drawings shall be signed off by the *Contractor* and submitted to the *Employer* for approval at completion of the *works*.

13.3 Data Packs

Data packs for all equipment and materials shall be provided by the *Contractor* in electronic and hard-copy format and shall be neatly indexed and referenced to facilitate easy navigation by the *Employer* between documents. This shall include, but not be limited to, the following:

- Final design calculations, including native software files if applicable.
- Design approvals.
- Equipment specification sheets.
- Data sheets for instrumentation and equipment, including physical dimensions.
- Any other information as required by the *Employer* and Eskom.

13.4 Quality Control Records

The *Contractor* shall, as part of the handover documentation, provide the *Employer* with all quality control records, including, but not limited to:

- Equipment and material installation standards applicable to the relevant equipment or material supply.
- All calibration certificates.
- Material certificates.
- SABS certificates, where appropriate.
- All test and calibration certificates.
- Certificates of Compliance.

13.5 Further Handover Documentation

Further handover documentation shall include:

- All equipment guarantees, which shall be ceded to the *Employer* or Eskom upon completion of the *works*.
- Further information as advised by the *Employer* and Eskom, as required for the hand-over, commissioning, operation and maintenance of the installation.

14.0 MEASUREMENT AND PAYMENT

14.1 General

The tendered rates shall be deemed to include all and every cost item required for the completion, handover and commissioning of the *works,* in full compliance with these specifications, the Works Information, associated contract documentation, bill of quantities and the drawings, including, but not limited to, the following:

- Design (including shop drawings), supply and installation of the *works* that are required to deliver a complete, fully functional and fully compliant system.
- Supply, manufacture, transport, rigging and installation of equipment.
- All inspections, testing and commissioning activities that are required to get the installed equipment ready for operations.
- Compilation and submission of all handover documentation as described in these specifications.

Allowances to be made in the tendered rates are as described below.

14.2 Payment Items

14.2.1 Phase Conductors

The tendered rates for conductors shall cover all costs for the supply and installation of conductors at any height, including, but not limited to, procurement, transport, rigging, handling, storage and inspections.

14.2.2 Shield Wires

The tendered rates for shield wires shall cover all costs for the supply and installation of shield wires at any height, including, but not limited to, procurement, transport, rigging, handling, storage and inspections.

14.2.3 OPGW

The tendered rates for OPGW shall cover all costs for the supply and installation of OPGW at any height, including, but not limited to, procurement, transport, rigging, handling, storage and inspections.

14.2.4 Duct Fibre Optic Cables

The tendered rates for duct fibre optic cables shall cover all costs for the supply and installation of cables at any height, including, but not limited to, procurement, transport, handling, storage, inspection, laying in trenches and on specified cable management systems.

14.2.5 Earthing Conductors

The tendered rates shall cover all costs for the supply and installation of the earthing conductors at any height, including, but not limited to, procurement, transport, storage and inspections. The rates shall also include all additional accessories and equipment, fixings, screws, mounting brackets and the like.

14.2.6 Hardware, Assemblies, Insulators, Clamps and Strapping

The tendered rates shall cover all costs for the supply and installation of all hardware, assemblies, insulators, clamps and strapping at any height, including but not limited to procurement, transport, handling, storage and inspections. The rates shall also include all additional accessories and equipment, fixings, screws, mounting brackets and the like.

14.2.7 Cable Ladders and Trays

The tendered rates shall cover all costs for the supply and installation of all cable ladders and trays including, but not limited to, procurement, transport, handling, storage and inspections, installation at any height, plus all necessary fixings and accessories etc.

14.2.8 Welding and Brazing

The tendered rates shall cover all costs for the supply and installation of welding and brazing, including but not limited to, procurement, transport, handling, storage and inspections, moulds, shots, ignitors, brazing rods etc.

14.2.9 Dismantling and Removal of Redundant Equipment

The tendered rates shall cover all costs for the dismantling and removal of redundant equipment at any height, including but not limited to, temporary storage, transport, cable drums, crates, handling and the like.

14.2.10 Labels and Notices

The tendered rates shall cover all costs for the supply and installation of labels and notices at any height, including but not limited to, procurement, transport, handling, storage and inspections of the equipment, as well as any associated fixings and accessories etc.

14.2.11 Testing and Commission

The tendered rates shall cover all costs related to testing and commissioning activities, including but not limited to equipment, witnessing, transport, provision of certificates and the like.

15.0 STRINGING CHARTS

PLS-CADD Version 14.40x64 09:50:50 AM 19 June 2018
AECOM South Africa
Project Name: 'c:\pls\20180619 transnet blw_isc (with spot shots).DON'
Line Title: 'Optimized design: Time=10.5 Interval=10 Subopts=0 Dir= F'

Criteria Notes:
Tippler 3 - Bulk Power - Blouwater to Iscor 66kV Branch Line

Criteria based on SANS-10280-2013 & ESKOM spec DSP_34-1683 for sub-transmission lines constructed with steel pole structures.

Section Sagging Data

Sec. No.	Cable File Name	From Str.	To Str.	Voltage (kV)	Ruling Span (m)	Sagging Data Condition	Sagging Data Temp. (deg C)	Sagging Data Catenary Constant (m)	Sagging Data Horiz. Tension (N)	Display Weather Case	Display Condition	Display Catenary Constant (m)
1	ac-88-659.wir	BLOUWATER 1 GANTRY	1 BLW/ISC 1	0	31.7	Initial RS	15.0	300.0	2259.1	15°C EDT	Creep RS	287.1
2	ac-88-659.wir	1 BLW/ISC 1	1 BLW/ISC 3	0	224.8	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1821.3
3	ac-88-659.wir	1 BLW/ISC 3	2 BLW/ISC 4, 1 BLW/ISC 4	0	277.8	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1871.6
4	ac-88-659.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	0	266.1	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1860.9
5	ac-88-659.wir	2 BLW/ISC 7, 1 BLW/ISC 7	1 BLW/ISC 9	0	142.0	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1720.9
6	ac-88-659.wir	1 BLW/ISC 9	1 BLW/ISC 13	0	209.3	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1804.5
7	ac-88-659.wir	1 BLW/ISC 13	1 BLW/ISC 16	0	276.4	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1870.5
8	ac-88-659.wir	1 BLW/ISC 16	1 BLW/ISC 18	0	227.4	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1823.7
9	ac-88-659.wir	1 BLW/ISC 18	1 BLW/ISC 20	0	267.2	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1862.1
10	ac-88-659.wir	1 BLW/ISC 20	1 BLW/ISC 23	0	241.7	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1839.4
11	ac-88-659.wir	1 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	0	17.0	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1576.8
12	ac-88-659.wir	2 BLW/ISC 24, 1 BLW/ISC 24	2 BLW/ISC 25, 1 BLW/ISC 25	0	160.9	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1746.4
13	ac-88-659.wir	2 BLW/ISC 25, 1 BLW/ISC 25	2 BLW/ISC 27, 1 BLW/ISC 27	0	166.9	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1754.9
14	ac-88-659.wir	2 BLW/ISC 27, 1 BLW/ISC 27	2 BLW/ISC 28, 1 BLW/ISC 28	0	100.8	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1664.9
15	ac-88-659.wir	2 BLW/ISC 28, 1 BLW/ISC 28	2 BLW/ISC 29, 1 BLW/ISC 29	0	168.6	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1757.4
16	ac-88-659.wir	2 BLW/ISC 29, 1 BLW/ISC 29	2 BLW/ISC 30, 1 BLW/ISC 30	0	131.0	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1706.4
17	ac-88-659.wir	2 BLW/ISC 30, 1 BLW/ISC 30	1 BLW/ISC 31	0	40.7	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1593.9
18	ac-88-659.wir	1 BLW/ISC 31	1 BLW/ISC 32/1	0	125.3	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1699.1
19	ac-88-659.wir	1 BLW/ISC 32/1	ISCOR 1 GANTRY	0	45.0	Initial RS	15.0	300.0	2259.1	15°C EDT	Creep RS	292.7
20	ac-88-659.wir	2 BLW/ISC 32/1	ISCOR 2 GANTRY	0	28.9	Initial RS	15.0	300.0	2259.1	15°C EDT	Creep RS	285.2
21	ac-88-659.wir	2 BLW/ISC 32/3	YSTERVARK 2 GANTRY	0	44.0	Initial RS	15.0	300.0	2259.1	15°C EDT	Creep RS	292.3
22	ac-88-659.wir	2 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	0	98.8	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1662.5
23	ac-88-659.wir	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	2 BLW/ISC 32/3	0	160.4	Initial RS	15.0	2100.0	15813.9	15°C EDT	Creep RS	1745.2
24	chickadee.wir	BLOUWATER 1 GANTRY	1 BLW/ISC 1	66	29.9	Initial RS	15.0	300.0	1889.6	70°C Hot	Creep RS	155.7
25	chickadee.wir	1 BLW/ISC 1	1 BLW/ISC 3	66	224.8	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1021.6
26	chickadee.wir	1 BLW/ISC 3	2 BLW/ISC 4, 1 BLW/ISC 4	66	277.6	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1145.5
27	chickadee.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	66	266.0	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1120.6
28	chickadee.wir	2 BLW/ISC 3	2 BLW/ISC 1	66	222.6	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1015.6
29	chickadee.wir	2 BLW/ISC 1	BLOUWATER 2 GANTRY	66	28.6	Initial RS	15.0	300.0	1889.6	70°C Hot	Creep RS	151.3
30	chickadee.wir	2 BLW/ISC 7, 1 BLW/ISC 7	1 BLW/ISC 9	66	141.9	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	761.9
31	chickadee.wir	1 BLW/ISC 9	1 BLW/ISC 13	66	209.3	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	979.4
32	chickadee.wir	1 BLW/ISC 13	1 BLW/ISC 16	66	276.4	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1142.9
33	chickadee.wir	1 BLW/ISC 16	1 BLW/ISC 18	66	227.4	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1028.1
34	chickadee.wir	1 BLW/ISC 18	1 BLW/ISC 20	66	267.2	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1122.7
35	chickadee.wir	1 BLW/ISC 20	1 BLW/ISC 23	66	241.7	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1064.3
36	chickadee.wir	1 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	66	15.6	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	158.2
37	chickadee.wir	2 BLW/ISC 9	2 BLW/ISC 13	66	213.2	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	990.2
38	chickadee.wir	2 BLW/ISC 13	2 BLW/ISC 16	66	279.2	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1148.9
39	chickadee.wir	2 BLW/ISC 16	2 BLW/ISC 18	66	249.2	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1081.9
40	chickadee.wir	2 BLW/ISC 18	2 BLW/ISC 20	66	248.3	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1079.8
41	chickadee.wir	2 BLW/ISC 20	2 BLW/ISC 23	66	245.4	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1072.9
42	chickadee.wir	2 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	66	18.1	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	173.5
43	chickadee.wir	2 BLW/ISC 24, 1 BLW/ISC 24	2 BLW/ISC 25, 1 BLW/ISC 25	66	160.2	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	827.2
44	chickadee.wir	2 BLW/ISC 25, 1 BLW/ISC 25	2 BLW/ISC 27, 1 BLW/ISC 27	66	167.2	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	851.1
45	chickadee.wir	2 BLW/ISC 27, 1 BLW/ISC 27	2 BLW/ISC 28, 1 BLW/ISC 28	66	100.8	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	593.9
46	chickadee.wir	2 BLW/ISC 28, 1 BLW/ISC 28	2 BLW/ISC 29, 1 BLW/ISC 29	66	168.6	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	855.4
47	chickadee.wir	2 BLW/ISC 29, 1 BLW/ISC 29	2 BLW/ISC 30, 1 BLW/ISC 30	66	130.1	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	716.9
48	chickadee.wir	1 BLW/ISC 31	1 BLW/ISC 32/1	66	125.4	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	698.1
49	chickadee.wir	2 BLW/ISC 31	2 BLW/ISC 32/1	66	149.7	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	790.2
50	chickadee.wir	2 BLW/ISC 24, 1 BLW/ISC 24	2 BLW/ISC 25, 1 BLW/ISC 25	66	161.7	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	832.4

51	chickadee.wir	2 BLW/ISC 25, 1 BLW/ISC 25	2 BLW/ISC 27, 1 BLW/ISC 27	66	166.6	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	848.9
52	chickadee.wir	2 BLW/ISC 27, 1 BLW/ISC 27	2 BLW/ISC 28, 1 BLW/ISC 28	66	100.8	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	593.9
53	chickadee.wir	2 BLW/ISC 28, 1 BLW/ISC 28	2 BLW/ISC 29, 1 BLW/ISC 29	66	168.6	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	855.4
54	chickadee.wir	2 BLW/ISC 29, 1 BLW/ISC 29	2 BLW/ISC 30, 1 BLW/ISC 30	66	131.8	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	723.5
55	chickadee.wir	2 BLW/ISC 30, 1 BLW/ISC 30	1 BLW/ISC 31	66	39.9	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	286.6
56	chickadee.wir	1 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	66	118.8	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	671.0
57	chickadee.wir	2 BLW/ISC 32/1	ISCOR 2 GANTRY	66	29.3	Initial RS	15.0	300.0	1889.6	70°C Hot	Creep RS	153.8
58	chickadee.wir	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	1 BLW/ISC 32/3	66	135.5	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	737.9
59	chickadee.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	66	266.3	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1121.0
60	chickadee.wir	2 BLW/ISC 7, 1 BLW/ISC 7	2 BLW/ISC 9	66	142.0	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	762.3
61	chickadee.wir	1 BLW/ISC 32/1	ISCOR 1 GANTRY	66	45.4	Initial RS	15.0	300.0	1889.6	70°C Hot	Creep RS	198.2
62	chickadee.wir	2 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	66	99.1	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	586.0
63	chickadee.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 3	66	281.3	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	1153.2
64	chickadee.wir	2 BLW/ISC 30, 1 BLW/ISC 30	2 BLW/ISC 31	66	43.2	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	301.3
65	chickadee.wir	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	2 BLW/ISC 32/3	66	160.6	Initial RS	15.0	1800.0	11337.7	70°C Hot	Creep RS	828.5
66	kingbird	2 BLW/ISC 32/3	YSTERVARK 2 GANTRY	66	44.2	Initial RS	15.0	300.0	3025.5	70°C Hot	Creep RS	195.3
67	kingbird	1 BLW/ISC 32/3	YSTERVARK 1 GANTRY	66	37.7	Initial RS	15.0	300.0	3025.5	70°C Hot	Creep RS	179.0
68	oak	2 BLW/ISC 3	2 BLW/ISC 1	0	222.6	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1701.0
69	oak	2 BLW/ISC 9	2 BLW/ISC 13	0	213.2	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1687.5
70	oak	2 BLW/ISC 31	2 BLW/ISC 32/1	0	149.7	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1588.4
71	oak	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	1 BLW/ISC 32/3	0	136.0	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1563.7
72	oak	1 BLW/ISC 32/3	YSTERVARK 1 GANTRY	0	37.6	Initial RS	15.0	300.0	956.4	15°C EDT	Creep RS	283.7
73	oak	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	0	266.2	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1757.1
74	oak	2 BLW/ISC 1	BLOUWATER 2 GANTRY	0	29.0	Initial RS	15.0	300.0	956.4	15°C EDT	Creep RS	277.0
75	oak	2 BLW/ISC 7, 1 BLW/ISC 7	2 BLW/ISC 9	0	141.9	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1574.0
76	oak	2 BLW/ISC 32/3	YSTERVARK 2 GANTRY	0	44.0	Initial RS	15.0	300.0	956.4	15°C EDT	Creep RS	287.3
77	oak	1 BLW/ISC 32/3	YSTERVARK 1 GANTRY	0	37.6	Initial RS	15.0	300.0	956.4	15°C EDT	Creep RS	283.7
78	oak	1 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	0	119.1	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1532.0
79	oak	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 3	0	281.2	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1773.7
80	oak	2 BLW/ISC 30, 1 BLW/ISC 30	2 BLW/ISC 31	0	42.8	Initial RS	15.0	2100.0	6694.8	15°C EDT	Creep RS	1407.1
81	opgw prismiam 48core 12ka	2 BLW/ISC 13	2 BLW/ISC 16	0	279.2	Initial RS	15.0	2100.0	10218.1	15°C EDT	Creep RS	1806.0
82	opgw prismiam 48core 12ka	2 BLW/ISC 16	2 BLW/ISC 18	0	249.2	Initial RS	15.0	2100.0	10218.1	15°C EDT	Creep RS	1773.1
83	opgw prismiam 48core 12ka	2 BLW/ISC 18	2 BLW/ISC 20	0	248.3	Initial RS	15.0	2100.0	10218.1	15°C EDT	Creep RS	1771.9
84	opgw prismiam 48core 12ka	2 BLW/ISC 20	2 BLW/ISC 23	0	245.4	Initial RS	15.0	2100.0	10218.1	15°C EDT	Creep RS	1768.4
85	opgw prismiam 48core 12ka	2 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	0	18.0	Initial RS	15.0	2100.0	10218.1	15°C EDT	Creep RS	1420.2

Section Geometry Data

Notes: Lengths are arc lengths along the wire at 15 (deg C), Creep.
Lengths are adjusted for the number of phases, the number of subconductors and to exclude the length of strain insulators.
Lengths are computed with any concentrated loads removed.

Sec. No.	Cable File Name	From Str.	To Str.	Number of Phases	Wires Per Phase	Min. Span (m)	Max. Span (m)	Ruling Span (m)	Total Cable Length (m)
1	ac-88-659.wir	BLOUWATER 1 GANTRY	1 BLW/ISC 1	1	1	32.6	32.6	31.7	32.3
2	ac-88-659.wir	1 BLW/ISC 1	1 BLW/ISC 3	1	1	222.6	227.2	224.8	450.3
3	ac-88-659.wir	1 BLW/ISC 3	2 BLW/ISC 4, 1 BLW/ISC 4	1	1	277.8	277.8	277.8	278.1
4	ac-88-659.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	1	1	251.8	278.1	266.1	797.7
5	ac-88-659.wir	2 BLW/ISC 7, 1 BLW/ISC 7	1 BLW/ISC 9	1	1	102.6	162.1	142.0	264.8
6	ac-88-659.wir	1 BLW/ISC 9	1 BLW/ISC 13	1	1	158.7	264.6	209.3	786.4
7	ac-88-659.wir	1 BLW/ISC 13	1 BLW/ISC 16	1	1	253.1	293.9	276.4	825.8
8	ac-88-659.wir	1 BLW/ISC 16	1 BLW/ISC 18	1	1	206.3	243.8	227.4	450.4
9	ac-88-659.wir	1 BLW/ISC 18	1 BLW/ISC 20	1	1	237.4	289.5	267.2	527.4
10	ac-88-659.wir	1 BLW/ISC 20	1 BLW/ISC 23	1	1	229.7	248.6	241.7	724.5
11	ac-88-659.wir	1 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	1	1	17.1	17.1	17.0	17.1
12	ac-88-659.wir	2 BLW/ISC 24, 1 BLW/ISC 24	2 BLW/ISC 25, 1 BLW/ISC 25	1	1	160.9	160.9	160.9	161.0
13	ac-88-659.wir	2 BLW/ISC 25, 1 BLW/ISC 25	2 BLW/ISC 27, 1 BLW/ISC 27	1	1	151.2	179.2	166.9	330.5
14	ac-88-659.wir	2 BLW/ISC 27, 1 BLW/ISC 27	2 BLW/ISC 28, 1 BLW/ISC 28	1	1	100.8	100.8	100.8	100.8
15	ac-88-659.wir	2 BLW/ISC 28, 1 BLW/ISC 28	2 BLW/ISC 29, 1 BLW/ISC 29	1	1	168.6	168.6	168.6	168.7
16	ac-88-659.wir	2 BLW/ISC 29, 1 BLW/ISC 29	2 BLW/ISC 30, 1 BLW/ISC 30	1	1	131.1	131.1	131.0	131.2
17	ac-88-659.wir	2 BLW/ISC 30, 1 BLW/ISC 30	1 BLW/ISC 31	1	1	40.7	40.7	40.7	40.7
18	ac-88-659.wir	1 BLW/ISC 31	1 BLW/ISC 32/1	1	1	126.2	126.2	125.3	127.1
19	ac-88-659.wir	1 BLW/ISC 32/1	ISCOR 1 GANTRY	1	1	48.1	48.1	45.0	50.3
20	ac-88-659.wir	2 BLW/ISC 32/1	ISCOR 2 GANTRY	1	1	30.6	30.6	28.9	31.2

21	ac-88-659.wir	2 BLW/ISC 32/3	YSTERVARK 2 GANTRY	1	1	45.9	45.9	44.0	46.9
22	ac-88-659.wir	2 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	1	1	99.6	99.6	98.8	100.4
23	ac-88-659.wir	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	2 BLW/ISC 32/3	1	1	160.5	160.5	160.4	160.6
24	chickadee.wir	BLOUWATER 1 GANTRY	1 BLW/ISC 1	3	1	30.8	30.8	29.9	91.7
25	chickadee.wir	1 BLW/ISC 1	1 BLW/ISC 3	3	1	222.6	227.2	224.8	1351.4
26	chickadee.wir	1 BLW/ISC 3	2 BLW/ISC 4, 1 BLW/ISC 4	3	1	277.6	277.6	277.6	834.1
27	chickadee.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	3	1	251.8	278.0	266.0	2393.9
28	chickadee.wir	2 BLW/ISC 3	2 BLW/ISC 1	3	1	216.0	228.8	222.6	1336.7
29	chickadee.wir	2 BLW/ISC 1	BLOUWATER 2 GANTRY	3	1	29.5	29.5	28.6	87.9
30	chickadee.wir	2 BLW/ISC 7, 1 BLW/ISC 7	1 BLW/ISC 9	3	1	102.6	162.0	141.9	794.4
31	chickadee.wir	1 BLW/ISC 9	1 BLW/ISC 13	3	1	158.7	264.6	209.3	2360.0
32	chickadee.wir	1 BLW/ISC 13	1 BLW/ISC 16	3	1	253.1	293.9	276.4	2478.6
33	chickadee.wir	1 BLW/ISC 16	1 BLW/ISC 18	3	1	206.3	243.8	227.4	1348.3
34	chickadee.wir	1 BLW/ISC 18	1 BLW/ISC 20	3	1	237.4	289.5	267.2	1579.5
35	chickadee.wir	1 BLW/ISC 20	1 BLW/ISC 23	3	1	229.7	248.6	241.7	2174.5
36	chickadee.wir	1 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	3	1	15.7	15.7	15.6	41.9
37	chickadee.wir	2 BLW/ISC 9	2 BLW/ISC 13	3	1	137.9	266.3	213.2	2373.4
38	chickadee.wir	2 BLW/ISC 13	2 BLW/ISC 16	3	1	249.9	296.5	279.2	2498.6
39	chickadee.wir	2 BLW/ISC 16	2 BLW/ISC 18	3	1	247.4	251.1	249.2	1493.9
40	chickadee.wir	2 BLW/ISC 18	2 BLW/ISC 20	3	1	211.4	273.6	248.3	1453.5
41	chickadee.wir	2 BLW/ISC 20	2 BLW/ISC 23	3	1	240.3	251.6	245.4	2210.4
42	chickadee.wir	2 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	3	1	18.2	18.2	18.1	49.4
43	chickadee.wir	2 BLW/ISC 24, 1 BLW/ISC 24	2 BLW/ISC 25, 1 BLW/ISC 25	3	1	160.2	160.2	160.2	469.6
44	chickadee.wir	2 BLW/ISC 25, 1 BLW/ISC 25	2 BLW/ISC 27, 1 BLW/ISC 27	3	1	151.9	179.2	167.2	982.9
45	chickadee.wir	2 BLW/ISC 27, 1 BLW/ISC 27	2 BLW/ISC 28, 1 BLW/ISC 28	3	1	100.8	100.8	100.8	291.3
46	chickadee.wir	2 BLW/ISC 28, 1 BLW/ISC 28	2 BLW/ISC 29, 1 BLW/ISC 29	3	1	168.6	168.6	168.6	495.0
47	chickadee.wir	2 BLW/ISC 29, 1 BLW/ISC 29	2 BLW/ISC 30, 1 BLW/ISC 30	3	1	130.2	130.2	130.1	380.0
48	chickadee.wir	1 BLW/ISC 31	1 BLW/ISC 32/1	3	1	126.2	126.2	125.4	377.8
49	chickadee.wir	2 BLW/ISC 31	2 BLW/ISC 32/1	3	1	149.8	149.8	149.7	446.6
50	chickadee.wir	2 BLW/ISC 24, 1 BLW/ISC 24	2 BLW/ISC 25, 1 BLW/ISC 25	3	1	161.7	161.7	161.7	474.3
51	chickadee.wir	2 BLW/ISC 25, 1 BLW/ISC 25	2 BLW/ISC 27, 1 BLW/ISC 27	3	1	150.4	179.2	166.6	978.2
52	chickadee.wir	2 BLW/ISC 27, 1 BLW/ISC 27	2 BLW/ISC 28, 1 BLW/ISC 28	3	1	100.8	100.8	100.8	291.3
53	chickadee.wir	2 BLW/ISC 28, 1 BLW/ISC 28	2 BLW/ISC 29, 1 BLW/ISC 29	3	1	168.6	168.6	168.6	495.0
54	chickadee.wir	2 BLW/ISC 29, 1 BLW/ISC 29	2 BLW/ISC 30, 1 BLW/ISC 30	3	1	131.9	131.9	131.8	385.1
55	chickadee.wir	2 BLW/ISC 30, 1 BLW/ISC 30	1 BLW/ISC 31	3	1	39.9	39.9	39.9	114.1
56	chickadee.wir	1 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	3	1	118.9	118.9	118.8	347.9
57	chickadee.wir	2 BLW/ISC 32/1	ISCOR 2 GANTRY	3	1	30.5	30.5	29.3	88.5
58	chickadee.wir	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	1 BLW/ISC 32/3	3	1	135.9	135.9	135.5	397.7
59	chickadee.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	3	1	251.8	278.5	266.3	2395.7
60	chickadee.wir	2 BLW/ISC 7, 1 BLW/ISC 7	2 BLW/ISC 9	3	1	100.2	162.5	142.0	788.6
61	chickadee.wir	1 BLW/ISC 32/1	ISCOR 1 GANTRY	3	1	48.1	48.1	45.4	145.7
62	chickadee.wir	2 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	3	1	99.8	99.8	99.1	292.9
63	chickadee.wir	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 3	3	1	281.3	281.3	281.3	845.2
64	chickadee.wir	2 BLW/ISC 30, 1 BLW/ISC 30	2 BLW/ISC 31	3	1	43.2	43.2	43.2	124.0
65	chickadee.wir	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	2 BLW/ISC 32/3	3	1	160.7	160.7	160.6	471.8
66	kingbird	2 BLW/ISC 32/3	YSTERVARK 2 GANTRY	3	1	45.6	45.6	44.2	132.2
67	kingbird	1 BLW/ISC 32/3	YSTERVARK 1 GANTRY	3	1	38.7	38.7	37.7	110.4
68	oak	2 BLW/ISC 3	2 BLW/ISC 1	1	1	216.0	228.8	222.6	445.4
69	oak	2 BLW/ISC 9	2 BLW/ISC 13	1	1	137.9	266.3	213.2	790.9
70	oak	2 BLW/ISC 31	2 BLW/ISC 32/1	1	1	149.8	149.8	149.7	150.0
71	oak	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	1 BLW/ISC 32/3	1	1	136.2	136.2	136.0	136.4
72	oak	1 BLW/ISC 32/3	YSTERVARK 1 GANTRY	1	1	39.2	39.2	37.6	39.6
73	oak	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 7, 1 BLW/ISC 7	1	1	251.8	278.4	266.2	798.2
74	oak	2 BLW/ISC 1	BLOUWATER 2 GANTRY	1	1	29.9	29.9	29.0	29.8
75	oak	2 BLW/ISC 7, 1 BLW/ISC 7	2 BLW/ISC 9	1	1	100.2	162.4	141.9	262.8
76	oak	2 BLW/ISC 32/3	YSTERVARK 2 GANTRY	1	1	45.9	45.9	44.0	46.9
77	oak	1 BLW/ISC 32/3	YSTERVARK 1 GANTRY	1	1	39.2	39.2	37.6	39.6
78	oak	1 BLW/ISC 32/1	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	1	1	119.2	119.2	119.1	119.4
79	oak	2 BLW/ISC 4, 1 BLW/ISC 4	2 BLW/ISC 3	1	1	281.2	281.2	281.2	281.5
80	oak	2 BLW/ISC 30, 1 BLW/ISC 30	2 BLW/ISC 31	1	1	42.8	42.8	42.8	42.8
81	opgw prismiam 48core 12ka	2 BLW/ISC 13	2 BLW/ISC 16	1	1	249.9	296.5	279.2	832.5
82	opgw prismiam 48core 12ka	2 BLW/ISC 16	2 BLW/ISC 18	1	1	247.4	251.1	249.2	499.0
83	opgw prismiam 48core 12ka	2 BLW/ISC 18	2 BLW/ISC 20	1	1	211.4	273.6	248.3	485.5
84	opgw prismiam 48core 12ka	2 BLW/ISC 20	2 BLW/ISC 23	1	1	240.3	251.6	245.4	736.5
85	opgw prismiam 48core 12ka	2 BLW/ISC 23	2 BLW/ISC 24, 1 BLW/ISC 24	1	1	18.1	18.1	18.0	18.2

Stringing Chart Report

Section #1 from structure #BLOUWATER 1 GANTRY to structure #1 BLW/ISC 1, start set #1 'EW', end set #3 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 31.6926
Sagging data: Catenary (m) 300, Horiz. Tension (N) 2259.14 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.2 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
32.6	0.35	0.39	0.42	0.45	0.49	0.52	0.55	0.57	0.60	0.63	BLOUWATER 1 GANTRY	7.75

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
2934	2661	2440	2257	2111	1987	1879	1788	1707	1635

Stringing Chart Report

Section #2 from structure #1 BLW/ISC 1 to structure #1 BLW/ISC 3, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 224.834
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 4.6 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
227.2	2.73	2.84	2.95	3.07	3.19	3.32	3.44	3.57	3.70	3.83	1	BLW/ISC 1	0.54
222.6	2.62	2.73	2.84	2.95	3.07	3.19	3.31	3.43	3.55	3.68	1	BLW/ISC 2	9.52

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
17811	17115	16442	15815	15211	14641	14108	13609	13147	12696

Stringing Chart Report

Section #3 from structure #1 BLW/ISC 3 to structure #2 BLW/ISC 4, 1 BLW/ISC 4, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 277.801
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 19.0 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 5.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
277.8	4.17	4.31	4.45	4.59	4.74	4.88	5.03	5.17	5.32	5.46	1 BLW/ISC 3	0.35

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
17419	16855	16314	15821	15339	14880	14457	14052	13671	13307

Stringing Chart Report

Section #4 from structure #2 BLW/ISC 4, 1 BLW/ISC 4 to structure #2 BLW/ISC 7, 1 BLW/ISC 7, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 266.07
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 5.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
266.7	3.83	3.96	4.10	4.24	4.38	4.52	4.66	4.80	4.94	5.08	2 BLW/ISC 4, 1 BLW/ISC 4	8.26
251.8	3.41	3.53	3.66	3.78	3.90	4.03	4.15	4.28	4.40	4.53	2 BLW/ISC 5, 1 BLW/ISC 5	-7.37
278.1	4.17	4.31	4.46	4.61	4.76	4.91	5.07	5.22	5.37	5.53	2 BLW/ISC 6, 1 BLW/ISC 6	-8.75

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
17493	16905	16340	15810	15316	14833	14385	13961	13561	13185

Stringing Chart Report

Section #5 from structure #2 BLW/ISC 7, 1 BLW/ISC 7 to structure #1 BLW/ISC 9, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 141.985
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.9 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 2.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
162.1	1.33	1.40	1.48	1.56	1.65	1.75	1.85	1.95	2.06	2.18	2 BLW/ISC 7, 1	BLW/ISC 7	-2.02
102.6	0.53	0.56	0.59	0.63	0.66	0.70	0.74	0.78	0.83	0.87	2 BLW/ISC 8, 1	BLW/ISC 8	2.08

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
18589	17642	16716	15822	14973	14158	13389	12666	11991	11363

Stringing Chart Report

Section #6 from structure #1 BLW/ISC 9 to structure #1 BLW/ISC 13, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 209.329
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 4.2 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
184.5	1.79	1.86	1.94	2.03	2.11	2.20	2.29	2.38	2.47	2.57	1 BLW/ISC 9	-4.28
158.7	1.32	1.38	1.44	1.50	1.56	1.63	1.70	1.76	1.83	1.90	1 BLW/ISC 10	5.51
177.9	1.66	1.73	1.81	1.89	1.96	2.05	2.13	2.21	2.30	2.39	1 BLW/ISC 11	-2.32
264.6	3.67	3.83	4.00	4.17	4.35	4.53	4.71	4.90	5.09	5.28	1 BLW/ISC 12	1.36

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
17958	17202	16492	15804	15176	14569	13999	13463	12963	12487

Stringing Chart Report

Section #7 from structure #1 BLW/ISC 13 to structure #1 BLW/ISC 16, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 276.447
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 5.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
277.9	4.17	4.31	4.45	4.60	4.74	4.89	5.03	5.18	5.32	5.47	1	BLW/ISC 13	-1.57
253.1	3.46	3.58	3.69	3.81	3.93	4.05	4.18	4.29	4.42	4.54	1	BLW/ISC 14	3.12
293.9	4.67	4.83	4.98	5.14	5.31	5.47	5.63	5.79	5.96	6.12	1	BLW/ISC 15	-7.70

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
17419	16855	16327	15821	15339	14881	14445	14046	13659	13295

Stringing Chart Report

Section #8 from structure #1 BLW/ISC 16 to structure #1 BLW/ISC 18, start set #1 'Earthwire', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 227.362
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 4.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
243.8	3.15	3.27	3.40	3.54	3.68	3.82	3.96	4.11	4.25	4.40	1 BLW/ISC 16	-2.07
206.3	2.25	2.34	2.44	2.53	2.64	2.74	2.84	2.94	3.04	3.15	1 BLW/ISC 17	4.05

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
17787	17103	16442	15815	15210	14653	14132	13634	13171	12733

Stringing Chart Report

Section #9 from structure #1 BLW/ISC 18 to structure #1 BLW/ISC 20, start set #1 '', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 267.183
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 5.6 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
237.4	3.03	3.14	3.25	3.35	3.46	3.57	3.68	3.80	3.91	4.02	1 BLW/ISC 18	2.35
289.5	4.51	4.67	4.83	4.99	5.15	5.32	5.48	5.65	5.82	5.98	1 BLW/ISC 19	-7.94

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
17492	16905	16340	15822	15316	14845	14397	13974	13574	13197

Stringing Chart Report

Section #10 from structure #1 BLW/ISC 20 to structure #1 BLW/ISC 23, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 241.748
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 5.0 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
229.7	2.81	2.92	3.03	3.14	3.26	3.37	3.49	3.61	3.73	3.85	1	BLW/ISC 20	-2.03
248.6	3.29	3.42	3.55	3.68	3.81	3.95	4.09	4.23	4.37	4.51	1	BLW/ISC 21	-1.12
245.7	3.21	3.34	3.46	3.59	3.73	3.86	3.99	4.13	4.26	4.40	1	BLW/ISC 22	1.39

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
17689	17029	16404	15825	15258	14738	14241	13768	13330	12917

Stringing Chart Report

Section #11 from structure #1 BLW/ISC 23 to structure #2 BLW/ISC 24, 1 BLW/ISC 24, start set #1 'Earthwire', end set #4 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 16.9739
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 15.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
17.1	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	1 BLW/ISC 23	1.69

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
19386	18202	17011	15814	14610	13424	12207	11007	9800	8586

Stringing Chart Report

Section #12 from structure #2 BLW/ISC 24, 1 BLW/ISC 24 to structure #2 BLW/ISC 25, 1 BLW/ISC 25, start set #1 '', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 160.93
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 17.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 3.2 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
160.9	1.33	1.39	1.47	1.54	1.62	1.71	1.79	1.89	1.98	2.08	2 BLW/ISC 24, 1 BLW/ISC 24	-0.18

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18395	17520	16642	15820	15021	14279	13584	12912	12300	11723

Stringing Chart Report

Section #13 from structure #2 BLW/ISC 25, 1 BLW/ISC 25 to structure #2 BLW/ISC 27, 1 BLW/ISC 27, start set #1 '', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 166.91
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 17.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 3.2 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
151.2	1.17	1.23	1.29	1.36	1.43	1.50	1.58	1.66	1.74	1.82	2 BLW/ISC 25, 1 BLW/ISC 25	-2.21
179.2	1.65	1.73	1.82	1.91	2.01	2.11	2.22	2.33	2.44	2.55	2 BLW/ISC 26, 1 BLW/ISC 26	2.80

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18347	17471	16617	15808	15045	14328	13633	12986	12386	11834

Stringing Chart Report

Section #14 from structure #2 BLW/ISC 27, 1 BLW/ISC 27 to structure #2 BLW/ISC 28, 1 BLW/ISC 28, start set #1 '', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 100.784
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 1.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
100.8	0.50	0.53	0.57	0.60	0.64	0.69	0.74	0.79	0.85	0.91	2 BLW/ISC 27, 1 BLW/ISC 27	-0.42

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18952	17886	16839	15812	14828	13865	12947	12074	11248	10480

Stringing Chart Report

Section #15 from structure #2 BLW/ISC 28, 1 BLW/ISC 28 to structure #2 BLW/ISC 29, 1 BLW/ISC 29, start set #1 '', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 168.581
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 17.5 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 3.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
168.6	1.46	1.53	1.61	1.69	1.78	1.87	1.96	2.06	2.16	2.26	2 BLW/ISC 28, 1 BLW/ISC 28	-0.93

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18323	17459	16617	15820	15045	14328	13645	13010	12410	11859

Stringing Chart Report

Section #16 from structure #2 BLW/ISC 29, 1 BLW/ISC 29 to structure #2 BLW/ISC 30, 1 BLW/ISC 30, start set #1 '', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 130.989
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 2.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
131.1	0.87	0.91	0.97	1.02	1.08	1.15	1.22	1.29	1.37	1.45	2 BLW/ISC 29, 1 BLW/ISC 29	-4.65

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18686	17716	16741	15810	14925	14085	13266	12519	11805	11140

Stringing Chart Report

Section #17 from structure #2 BLW/ISC 30, 1 BLW/ISC 30 to structure #1 BLW/ISC 31, start set #1 '', end set #1 'Earthwire'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 40.7033
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 15.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
40.7	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.17	2 BLW/ISC 30, 1 BLW/ISC 30	0.57

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
19314	18153	16987	15814	14659	13498	12355	11206	10101	9039

Stringing Chart Report

Section #18 from structure #1 BLW/ISC 31 to structure #1 BLW/ISC 32/1, start set #1 'Earthwire', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 125.346
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.5 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 2.2 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
126.2	0.81	0.85	0.90	0.95	1.01	1.08	1.14	1.21	1.29	1.37	1 BLW/ISC 31	14.91

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18735	17740	16765	15823	14913	14036	13217	12432	11706	11028

Stringing Chart Report

Section #19 from structure #1 BLW/ISC 32/1 to structure #ISCOR 1 GANTRY, start set #1 '', end set #1 'EW'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 44.9723
Sagging data: Catenary (m) 300, Horiz. Tension (N) 2259.14 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
48.1	0.91	0.95	0.99	1.03	1.07	1.11	1.14	1.18	1.22	1.25	1 BLW/ISC 32/1	-18.25

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
2568	2451	2350	2259	2178	2103	2036	1975	1918	1866

Stringing Chart Report

Section #20 from structure #2 BLW/ISC 32/1 to structure #ISCOR 2 GANTRY, start set #1 '', end set #1 'EW'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 28.9047
Sagging data: Catenary (m) 300, Horiz. Tension (N) 2259.14 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.0 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
30.6	0.30	0.34	0.38	0.41	0.45	0.48	0.51	0.54	0.57	0.60	2 BLW/ISC 32/1	-10.58

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
3091	2746	2473	2258	2088	1948	1827	1728	1641	1566

Stringing Chart Report

Section #21 from structure #2 BLW/ISC 32/3 to structure #YSTERVARK 2 GANTRY, start set #1 '', end set #1 'EW'
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 43.9921
Sagging data: Catenary (m) 300, Horiz. Tension (N) 2259.14 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.2 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
45.9	0.80	0.84	0.88	0.92	0.96	0.99	1.02	1.06	1.09	1.12	2 BLW/ISC 32/3	-13.84

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
2581	2461	2354	2259	2173	2097	2027	1963	1906	1853

Stringing Chart Report

Section #22 from structure #2 BLW/ISC 32/1 to structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2, start set #5 '', end set #6 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 98.8031
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 1.9 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
99.6	0.50	0.53	0.56	0.59	0.63	0.68	0.73	0.78	0.84	0.90	2 BLW/ISC 32/1	12.74

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18952	17910	16864	15836	14829	13865	12922	12049	11198	10430

Stringing Chart Report

Section #23 from structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2 to structure #2 BLW/ISC 32/3, start set #6 '', end set #1 ''
Cable 'd:\pls\cables\ac-88-659.wir', Ruling span (m) 160.4
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 15813.9 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 17.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 3.0 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
160.5	1.32	1.38	1.46	1.53	1.61	1.70	1.79	1.88	1.97	2.07	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	-4.92

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
18420	17520	16642	15808	15021	14279	13572	12912	12287	11710

Stringing Chart Report

Section #24 from structure #BLOUWATER 1 GANTRY to structure #1 BLW/ISC 1, start set #2 'Main Set', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 29.8766
Sagging data: Catenary (m) 300, Horiz. Tension (N) 1889.62 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 4.2 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
30.8	0.26	0.31	0.36	0.41	0.45	0.49	0.53	0.57	0.60	0.63	BLOUWATER 1 GANTRY	7.50

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
2962	2475	2134	1888	1706	1562	1447	1353	1275	1208

Stringing Chart Report

Section #25 from structure #1 BLW/ISC 1 to structure #1 BLW/ISC 3, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 224.837
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 24.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 17.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
227.2	3.11	3.26	3.42	3.58	3.75	3.92	4.09	4.26	4.43	4.60	1	BLW/ISC 1	0.69
222.6	2.99	3.14	3.29	3.45	3.61	3.77	3.93	4.10	4.26	4.43	1	BLW/ISC 2	9.37

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
13064	12451	11878	11337	10840	10370	9938	9537	9168	8832

Stringing Chart Report

Section #26 from structure #1 BLW/ISC 3 to structure #2 BLW/ISC 4, 1 BLW/ISC 4, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 277.622
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 26.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 22.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
277.6	4.80	4.98	5.17	5.35	5.54	5.74	5.93	6.12	6.31	6.49	1 BLW/ISC 3	-1.15

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
12657	12194	11749	11340	10952	10585	10244	9927	9629	9351

Stringing Chart Report

Section #27 from structure #2 BLW/ISC 4, 1 BLW/ISC 4 to structure #2 BLW/ISC 7, 1 BLW/ISC 7, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 266.038
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 26.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 21.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
266.7	4.40	4.58	4.76	4.94	5.13	5.32	5.50	5.69	5.87	6.06	2 BLW/ISC 4, 1 BLW/ISC 4	8.26
251.8	3.92	4.08	4.24	4.41	4.57	4.74	4.91	5.07	5.24	5.40	2 BLW/ISC 5, 1 BLW/ISC 5	-7.37
278.0	4.78	4.98	5.17	5.37	5.58	5.78	5.98	6.18	6.38	6.59	2 BLW/ISC 6, 1 BLW/ISC 6	-8.75

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
12735	12239	11777	11342	10926	10545	10185	9853	9545	9252

Stringing Chart Report

Section #28 from structure #2 BLW/ISC 3 to structure #2 BLW/ISC 1, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 222.57
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 24.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 17.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
216.0	2.81	2.95	3.10	3.24	3.40	3.55	3.71	3.87	4.02	4.18	2	BLW/ISC 3	-10.81
228.8	3.15	3.31	3.47	3.63	3.81	3.98	4.16	4.33	4.51	4.68	2	BLW/ISC 2	-0.37

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13081	12469	11887	11346	10831	10361	9924	9518	9149	8803

Stringing Chart Report

Section #29 from structure #2 BLW/ISC 1 to structure #BLOUWATER 2 GANTRY, start set #2 'Main Circuit', end set #2 'Main Set'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 28.5766
Sagging data: Catenary (m) 300, Horiz. Tension (N) 1889.62 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 4.2 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
29.5	0.23	0.28	0.33	0.37	0.42	0.46	0.50	0.53	0.57	0.60	2 BLW/ISC 1	-7.45

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
3080	2535	2156	1888	1692	1542	1422	1325	1245	1179

Stringing Chart Report

Section #30 from structure #2 BLW/ISC 7, 1 BLW/ISC 7 to structure #1 BLW/ISC 9, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 141.913
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 10.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
162.0	1.49	1.59	1.70	1.82	1.96	2.10	2.25	2.40	2.57	2.73	2 BLW/ISC 7, 1 BLW/ISC 7	-2.02
102.6	0.60	0.64	0.68	0.73	0.78	0.84	0.90	0.96	1.03	1.09	2 BLW/ISC 8, 1 BLW/ISC 8	3.58

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13861	12991	12148	11344	10572	9866	9199	8596	8059	7571

Stringing Chart Report

Section #31 from structure #1 BLW/ISC 9 to structure #1 BLW/ISC 13, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 209.33
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 24.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 16.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
184.5	2.03	2.14	2.25	2.37	2.48	2.61	2.73	2.85	2.98	3.10	1 BLW/ISC 9	-4.13
158.7	1.51	1.58	1.67	1.75	1.84	1.93	2.02	2.11	2.21	2.30	1 BLW/ISC 10	5.51
177.9	1.89	1.99	2.09	2.20	2.31	2.42	2.54	2.65	2.77	2.89	1 BLW/ISC 11	-2.32
264.6	4.18	4.40	4.63	4.87	5.11	5.36	5.61	5.87	6.13	6.39	1 BLW/ISC 12	1.21

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13184	12539	11915	11338	10796	10288	9827	9396	9001	8639

Stringing Chart Report

Section #32 from structure #1 BLW/ISC 13 to structure #1 BLW/ISC 16, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 276.446
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 26.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 22.2 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
277.9	4.80	4.99	5.18	5.36	5.56	5.75	5.94	6.13	6.32	6.51	1 BLW/ISC 13	-1.42
253.1	3.98	4.14	4.29	4.45	4.61	4.77	4.93	5.09	5.25	5.40	1 BLW/ISC 14	3.12
293.9	5.37	5.58	5.79	6.00	6.22	6.43	6.65	6.87	7.08	7.29	1 BLW/ISC 15	-7.85

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
12666	12194	11749	11340	10943	10580	10240	9918	9620	9342

Stringing Chart Report

Section #33 from structure #1 BLW/ISC 16 to structure #1 BLW/ISC 18, start set #2 'Main Circuit', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 227.365
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 24.9 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 17.9 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
243.8	3.59	3.77	3.94	4.13	4.32	4.51	4.70	4.90	5.09	5.29	1 BLW/ISC 16	-1.92
206.3	2.57	2.70	2.82	2.96	3.09	3.23	3.37	3.51	3.65	3.78	1 BLW/ISC 17	3.90

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
13038	12434	11869	11337	10848	10388	9957	9565	9197	8861

Stringing Chart Report

Section #34 from structure #1 BLW/ISC 18 to structure #1 BLW/ISC 20, start set #2 '', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 267.165
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 26.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 21.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
237.4	3.48	3.63	3.77	3.91	4.06	4.21	4.35	4.50	4.65	4.79	1 BLW/ISC 18	3.19
289.5	5.18	5.40	5.61	5.83	6.04	6.26	6.48	6.70	6.92	7.13	1 BLW/ISC 19	-8.78

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
12735	12239	11776	11337	10930	10549	10195	9863	9550	9261

Stringing Chart Report

Section #35 from structure #1 BLW/ISC 20 to structure #1 BLW/ISC 23, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 241.749
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 25.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 19.0 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
229.7	3.21	3.36	3.51	3.67	3.82	3.98	4.14	4.29	4.45	4.61	1	BLW/ISC 20	-1.88
248.6	3.77	3.94	4.11	4.29	4.48	4.66	4.84	5.03	5.22	5.40	1	BLW/ISC 21	-1.12
245.7	3.68	3.85	4.02	4.19	4.37	4.55	4.73	4.91	5.10	5.28	1	BLW/ISC 22	1.24

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
12926	12363	11832	11335	10874	10451	10048	9677	9334	9014

Stringing Chart Report

Section #36 from structure #1 BLW/ISC 23 to structure #2 BLW/ISC 24, 1 BLW/ISC 24, start set #2 'Main Circuit', end set #3 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 15.6164
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 15.9 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
15.7	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.05	1 BLW/ISC 23	1.82

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
14736	13639	12501	11339	10116	8868	7574	6255	4930	3668

Stringing Chart Report

Section #37 from structure #2 BLW/ISC 9 to structure #2 BLW/ISC 13, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 213.199
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 24.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 16.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
137.9	1.14	1.20	1.26	1.32	1.39	1.45	1.52	1.59	1.66	1.72	2 BLW/ISC 9	-1.57
197.9	2.35	2.46	2.59	2.72	2.85	2.99	3.13	3.27	3.41	3.55	2 BLW/ISC 10	3.71
188.2	2.12	2.23	2.34	2.46	2.58	2.71	2.83	2.96	3.09	3.21	2 BLW/ISC 11	-2.39
266.3	4.25	4.46	4.69	4.93	5.17	5.42	5.67	5.92	6.18	6.43	2 BLW/ISC 12	0.96

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13150	12513	11905	11329	10804	10306	9855	9434	9044	8688

Stringing Chart Report

Section #38 from structure #2 BLW/ISC 13 to structure #2 BLW/ISC 16, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 279.23
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 26.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 22.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
285.1	5.06	5.26	5.45	5.65	5.85	6.05	6.25	6.45	6.64	6.84	2	BLW/ISC 13	-0.34
249.9	3.89	4.04	4.19	4.34	4.49	4.64	4.80	4.95	5.10	5.25	2	BLW/ISC 14	2.76
296.5	5.48	5.69	5.90	6.11	6.33	6.54	6.76	6.98	7.19	7.40	2	BLW/ISC 15	-8.20

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
12648	12185	11748	11335	10952	10594	10254	9936	9643	9365

Stringing Chart Report

Section #39 from structure #2 BLW/ISC 16 to structure #2 BLW/ISC 18, start set #2 'Main Circuit', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 249.226
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 25.5 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 19.6 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
251.1	3.86	4.03	4.20	4.38	4.56	4.74	4.92	5.10	5.28	5.47	2	BLW/ISC 16	-2.41
247.4	3.75	3.91	4.08	4.25	4.43	4.60	4.78	4.95	5.13	5.30	2	BLW/ISC 17	5.98

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
12865	12328	11814	11334	10892	10478	10094	9733	9404	9090

Stringing Chart Report

Section #40 from structure #2 BLW/ISC 18 to structure #2 BLW/ISC 20, start set #2 '', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 248.319
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 25.5 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 19.6 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
211.4	2.73	2.85	2.98	3.10	3.23	3.36	3.49	3.62	3.75	3.88	2 BLW/ISC 18	1.54
273.6	4.58	4.79	4.99	5.20	5.42	5.63	5.85	6.07	6.28	6.50	2 BLW/ISC 19	-8.95

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
12874	12328	11814	11339	10892	10478	10085	9728	9395	9081

Stringing Chart Report

Section #41 from structure #2 BLW/ISC 20 to structure #2 BLW/ISC 23, start set #2 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 245.436
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 25.3 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 19.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
240.3	3.53	3.69	3.85	4.01	4.18	4.35	4.52	4.69	4.86	5.03	2	BLW/ISC 20	-1.84
251.6	3.87	4.04	4.22	4.40	4.58	4.76	4.95	5.14	5.32	5.51	2	BLW/ISC 21	-0.90
244.0	3.64	3.80	3.97	4.14	4.31	4.48	4.66	4.83	5.01	5.18	2	BLW/ISC 22	0.74

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
12891	12345	11823	11335	10883	10464	10071	9705	9367	9052

Stringing Chart Report

Section #42 from structure #2 BLW/ISC 23 to structure #2 BLW/ISC 24, 1 BLW/ISC 24, start set #2 'Main Circuit', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 18.0784
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
18.2	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.05	0.07	2 BLW/ISC 23	2.10

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
14736	13639	12501	11339	10116	8868	7594	6295	4993	3755

Stringing Chart Report

Section #43 from structure #2 BLW/ISC 24, 1 BLW/ISC 24 to structure #2 BLW/ISC 25, 1 BLW/ISC 25, start set #2 '', end set #3 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 160.152
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 11.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
160.2	1.48	1.57	1.67	1.78	1.90	2.02	2.15	2.28	2.42	2.55	2 BLW/ISC 24, 1 BLW/ISC 24	-0.18

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13676	12870	12077	11333	10644	9995	9398	8845	8351	7908

Stringing Chart Report

Section #44 from structure #2 BLW/ISC 25, 1 BLW/ISC 25 to structure #2 BLW/ISC 27, 1 BLW/ISC 27, start set #2 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 167.2
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 12.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
151.9	1.34	1.42	1.51	1.60	1.71	1.81	1.92	2.03	2.15	2.27	2 BLW/ISC 25, 1 BLW/ISC 25	-2.12
179.2	1.86	1.97	2.10	2.23	2.37	2.52	2.67	2.83	2.99	3.15	2 BLW/ISC 26, 1 BLW/ISC 26	2.71

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13608	12818	12059	11342	10662	10041	9463	8941	8458	8026

Stringing Chart Report

Section #45 from structure #2 BLW/ISC 27, 1 BLW/ISC 27 to structure #2 BLW/ISC 28, 1 BLW/ISC 28, start set #2 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 100.784
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 19.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 6.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
100.8	0.56	0.60	0.65	0.70	0.77	0.84	0.92	1.01	1.10	1.20	2 BLW/ISC 27, 1 BLW/ISC 27	-0.42

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
14260	13282	12307	11355	10409	9521	8684	7925	7247	6647

Stringing Chart Report

Section #46 from structure #2 BLW/ISC 28, 1 BLW/ISC 28 to structure #2 BLW/ISC 29, 1 BLW/ISC 29, start set #2 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 168.581
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 12.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
168.6	1.65	1.75	1.86	1.97	2.10	2.23	2.36	2.50	2.64	2.78	2 BLW/ISC 28, 1 BLW/ISC 28	-0.93

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13592	12801	12059	11333	10671	10050	9482	8955	8477	8050

Stringing Chart Report

Section #47 from structure #2 BLW/ISC 29, 1 BLW/ISC 29 to structure #2 BLW/ISC 30, 1 BLW/ISC 30, start set #2 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 130.143
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.0 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 9.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
130.2	0.96	1.02	1.10	1.18	1.27	1.37	1.47	1.59	1.70	1.82	2 BLW/ISC 29, 1 BLW/ISC 29	-4.65

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
13978	13077	12201	11344	10536	9773	9067	8422	7852	7332

Stringing Chart Report

Section #48 from structure #1 BLW/ISC 31 to structure #1 BLW/ISC 32/1, start set #2 'Main Circuit', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 125.369
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 20.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 8.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
126.2	0.90	0.96	1.03	1.11	1.20	1.30	1.40	1.51	1.63	1.75	1 BLW/ISC 31	14.71

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
14028	13111	12219	11336	10518	9736	9009	8344	7764	7232

Stringing Chart Report

Section #49 from structure #2 BLW/ISC 31 to structure #2 BLW/ISC 32/1, start set #2 'Main Circuit', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 149.662
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.0 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 10.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
149.8	1.28	1.37	1.46	1.56	1.67	1.78	1.91	2.03	2.16	2.29	2 BLW/ISC 31	6.78

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
13777	12939	12121	11343	10609	9921	9284	8711	8186	7720

Stringing Chart Report

Section #50 from structure #2 BLW/ISC 24, 1 BLW/ISC 24 to structure #2 BLW/ISC 25, 1 BLW/ISC 25, start set #3 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 161.708
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 11.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
161.7	1.51	1.60	1.71	1.82	1.93	2.06	2.19	2.32	2.46	2.59	2 BLW/ISC 24, 1 BLW/ISC 24	-0.18

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13659	12853	12077	11333	10644	10004	9407	8874	8380	7937

Stringing Chart Report

Section #51 from structure #2 BLW/ISC 25, 1 BLW/ISC 25 to structure #2 BLW/ISC 27, 1 BLW/ISC 27, start set #3 '', end set #3 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 166.625
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 12.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
150.4	1.31	1.39	1.48	1.57	1.67	1.78	1.88	1.99	2.11	2.22	2 BLW/ISC 25, 1 BLW/ISC 25	-2.12
179.2	1.86	1.97	2.10	2.23	2.37	2.52	2.67	2.83	2.99	3.15	2 BLW/ISC 26, 1 BLW/ISC 26	2.71

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13608	12818	12059	11342	10662	10032	9463	8932	8448	8016

Stringing Chart Report

Section #52 from structure #2 BLW/ISC 27, 1 BLW/ISC 27 to structure #2 BLW/ISC 28, 1 BLW/ISC 28, start set #3 '', end set #3 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 100.784
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 19.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 6.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
100.8	0.56	0.60	0.65	0.70	0.77	0.84	0.92	1.01	1.10	1.20	2 BLW/ISC 27, 1 BLW/ISC 27	-0.42

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
14260	13282	12307	11355	10409	9521	8684	7925	7247	6647

Stringing Chart Report

Section #53 from structure #2 BLW/ISC 28, 1 BLW/ISC 28 to structure #2 BLW/ISC 29, 1 BLW/ISC 29, start set #3 '', end set #3 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 168.581
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 12.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
168.6	1.65	1.75	1.86	1.97	2.10	2.23	2.36	2.50	2.64	2.78	2 BLW/ISC 28, 1 BLW/ISC 28	-0.93

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13592	12801	12059	11333	10671	10050	9482	8955	8477	8050

Stringing Chart Report

Section #54 from structure #2 BLW/ISC 29, 1 BLW/ISC 29 to structure #2 BLW/ISC 30, 1 BLW/ISC 30, start set #3 '', end set #4 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 131.837
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.2 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 9.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
131.9	0.98	1.05	1.13	1.21	1.30	1.40	1.51	1.62	1.74	1.86	2 BLW/ISC 29, 1 BLW/ISC 29	-4.65

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
13961	13060	12184	11344	10536	9782	9086	8451	7882	7372

Stringing Chart Report

Section #55 from structure #2 BLW/ISC 30, 1 BLW/ISC 30 to structure #1 BLW/ISC 31, start set #3 '', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 39.8768
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 1.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
39.9	0.09	0.09	0.10	0.11	0.12	0.14	0.16	0.19	0.22	0.27	2 BLW/ISC 30, 1 BLW/ISC 30	0.47

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
14655	13588	12466	11339	10172	8982	7811	6660	5598	4665

Stringing Chart Report

Section #56 from structure #1 BLW/ISC 32/1 to structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2, start set #3 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 118.751
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 20.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 7.9 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
118.9	0.79	0.85	0.91	0.98	1.06	1.15	1.25	1.35	1.46	1.57	1 BLW/ISC 32/1	5.06

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
14094	13163	12237	11336	10482	9680	8924	8247	7625	7087

Stringing Chart Report

Section #57 from structure #2 BLW/ISC 32/1 to structure #ISCOR 2 GANTRY, start set #3 '', end set #2 'Main Set'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 29.3155
Sagging data: Catenary (m) 300, Horiz. Tension (N) 1889.62 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 4.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
30.5	0.25	0.31	0.36	0.40	0.45	0.49	0.53	0.57	0.61	0.64	2 BLW/ISC 32/1	-8.88

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
3005	2502	2145	1891	1700	1553	1436	1342	1263	1196

Stringing Chart Report

Section #58 from structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2 to structure #1 BLW/ISC 32/3, start set #3 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 135.546
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.2 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 9.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
135.9	1.05	1.12	1.20	1.29	1.38	1.49	1.60	1.71	1.83	1.96	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	-9.53

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
13927	13043	12183	11335	10554	9810	9123	8509	7951	7452

Stringing Chart Report

Section #59 from structure #2 BLW/ISC 4, 1 BLW/ISC 4 to structure #2 BLW/ISC 7, 1 BLW/ISC 7, start set #4 'Main Circuit', end set #4 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 266.258
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 26.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 21.4 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
266.9	4.41	4.59	4.77	4.95	5.14	5.32	5.51	5.70	5.88	6.07	2 BLW/ISC 4, 1 BLW/ISC 4	8.26
251.8	3.92	4.08	4.24	4.41	4.57	4.74	4.91	5.07	5.24	5.40	2 BLW/ISC 5, 1 BLW/ISC 5	-7.37
278.5	4.80	4.99	5.19	5.39	5.59	5.80	6.00	6.20	6.40	6.61	2 BLW/ISC 6, 1 BLW/ISC 6	-8.75

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
12735	12239	11776	11342	10926	10545	10185	9853	9545	9252

Stringing Chart Report

Section #60 from structure #2 BLW/ISC 7, 1 BLW/ISC 7 to structure #2 BLW/ISC 9, start set #4 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 141.965
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 10.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
162.5	1.50	1.60	1.71	1.83	1.97	2.11	2.26	2.42	2.58	2.75	2 BLW/ISC 7, 1 BLW/ISC 7	-2.02
100.2	0.57	0.61	0.65	0.70	0.75	0.80	0.86	0.92	0.98	1.04	2 BLW/ISC 8, 1 BLW/ISC 8	2.97

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13861	12991	12148	11344	10572	9866	9199	8605	8059	7571

Stringing Chart Report

Section #61 from structure #1 BLW/ISC 32/1 to structure #ISCOR 1 GANTRY, start set #4 '', end set #2 'Main Set'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 45.4471
Sagging data: Catenary (m) 300, Horiz. Tension (N) 1889.62 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 4.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
48.1	0.85	0.91	0.96	1.02	1.07	1.12	1.17	1.22	1.26	1.31	1 BLW/ISC 32/1	-16.55

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
2272	2123	1997	1889	1797	1716	1646	1582	1526	1475

Stringing Chart Report

Section #62 from structure #2 BLW/ISC 32/1 to structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2, start set #4 '', end set #4 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 99.0529
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 19.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 6.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
99.8	0.55	0.59	0.64	0.70	0.76	0.83	0.91	1.00	1.10	1.20	2 BLW/ISC 32/1	12.67

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
14276	13299	12308	11355	10410	9511	8665	7895	7207	6607

Stringing Chart Report

Section #63 from structure #2 BLW/ISC 4, 1 BLW/ISC 4 to structure #2 BLW/ISC 3, start set #5 'Main Circuit', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 281.312
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 26.5 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 22.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
281.3	4.93	5.12	5.31	5.50	5.69	5.88	6.08	6.27	6.46	6.65	2	BLW/ISC 4, 1 BLW/ISC 4	2.26

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
12639	12176	11739	11340	10951	10598	10263	9950	9657	9384

Stringing Chart Report

Section #64 from structure #2 BLW/ISC 30, 1 BLW/ISC 30 to structure #2 BLW/ISC 31, start set #5 '', end set #2 'Main Circuit'
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 43.1664
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 1.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
43.2	0.10	0.11	0.12	0.13	0.14	0.16	0.19	0.22	0.26	0.31	2 BLW/ISC 30, 1 BLW/ISC 30	0.79

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
14638	13571	12466	11321	10171	9020	7850	6741	5702	4802

Stringing Chart Report

Section #65 from structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2 to structure #2 BLW/ISC 32/3, start set #5 '', end set #2 ''
Cable 'd:\pls\transnet\chickadee.wir', Ruling span (m) 160.563
Sagging data: Catenary (m) 1800, Horiz. Tension (N) 11337.7 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 22.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 11.8 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
160.7	1.49	1.58	1.69	1.79	1.91	2.04	2.17	2.30	2.44	2.57	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	-6.90

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13676	12853	12077	11342	10644	9995	9397	8855	8361	7918

Stringing Chart Report

Section #66 from structure #2 BLW/ISC 32/3 to structure #YSTERVARK 2 GANTRY, start set #2 '', end set #2 'Main Set'
Cable 'd:\pls\transnet\kingbird', Ruling span (m) 44.2135
Sagging data: Catenary (m) 300, Horiz. Tension (N) 3025.5 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 4.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
45.6	0.73	0.79	0.84	0.89	0.94	0.99	1.03	1.07	1.11	1.16	2 BLW/ISC 32/3	-11.29

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
3677	3421	3208	3024	2870	2736	2616	2512	2419	2334

Stringing Chart Report

Section #67 from structure #1 BLW/ISC 32/3 to structure #YSTERVARK 1 GANTRY, start set #2 '', end set #2 'Main Set'
Cable 'd:\pls\transnet\kingbird', Ruling span (m) 37.7264
Sagging data: Catenary (m) 300, Horiz. Tension (N) 3025.5 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 4.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.5 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
38.7	0.49	0.54	0.59	0.64	0.69	0.73	0.77	0.81	0.85	0.89	1 BLW/ISC 32/3	-8.80

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
3990	3589	3275	3025	2822	2654	2510	2385	2277	2183

Stringing Chart Report

Section #68 from structure #2 BLW/ISC 3 to structure #2 BLW/ISC 1, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\transnet\oak', Ruling span (m) 222.566
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 12.6 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
216.0	2.35	2.49	2.63	2.78	2.94	3.10	3.26	3.43	3.60	3.76	2	BLW/ISC 3	-10.96
228.8	2.63	2.78	2.95	3.12	3.29	3.47	3.66	3.84	4.03	4.22	2	BLW/ISC 2	-0.22

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
7938	7495	7083	6696	6340	6008	5706	5433	5180	4950

Stringing Chart Report

Section #69 from structure #2 BLW/ISC 9 to structure #2 BLW/ISC 13, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\transnet\oak', Ruling span (m) 213.198
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 17.9 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 12.2 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
137.9	0.95	1.01	1.07	1.13	1.20	1.27	1.34	1.41	1.48	1.55	2 BLW/ISC 9	-1.72
197.9	1.95	2.07	2.20	2.33	2.47	2.61	2.75	2.90	3.05	3.20	2 BLW/ISC 10	3.71
188.2	1.77	1.88	1.99	2.11	2.23	2.36	2.49	2.62	2.76	2.89	2 BLW/ISC 11	-2.39
266.3	3.54	3.76	3.99	4.22	4.47	4.73	4.99	5.25	5.52	5.79	2 BLW/ISC 12	1.11

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
7985	7524	7093	6697	6322	5982	5671	5385	5123	4885

Stringing Chart Report

Section #70 from structure #2 BLW/ISC 31 to structure #2 BLW/ISC 32/1, start set #1 'Earthwire', end set #1 ''
Cable 'd:\pls\transnet\oak', Ruling span (m) 149.653
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.5 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 8.9 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
149.8	1.08	1.16	1.24	1.34	1.44	1.55	1.67	1.79	1.92	2.05	2 BLW/ISC 31	6.98

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
8306	7749	7206	6699	6224	5781	5378	5011	4673	4374

Stringing Chart Report

Section #71 from structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2 to structure #1 BLW/ISC 32/3, start set #1 '', end set #1 ''
Cable 'd:\pls\transnet\oak', Ruling span (m) 135.96
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 8.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
136.2	0.88	0.95	1.02	1.11	1.19	1.29	1.40	1.51	1.62	1.74	2 BLW/ISC 32/2, 1 BLW/ISC 32/2	-7.58

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
8372	7787	7234	6695	6197	5732	5303	4914	4560	4245

Stringing Chart Report

Section #72 from structure #1 BLW/ISC 32/3 to structure #YSTERVARK 1 GANTRY, start set #1 '', end set #1 'EW'
Cable 'd:\pls\transnet\oak', Ruling span (m) 37.6043
Sagging data: Catenary (m) 300, Horiz. Tension (N) 956.4 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 7.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
39.2	0.50	0.56	0.61	0.67	0.71	0.76	0.81	0.85	0.89	0.93	1 BLW/ISC 32/3	-11.35

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
1261	1137	1037	957	891	835	788	749	713	683

Stringing Chart Report

Section #73 from structure #2 BLW/ISC 4, 1 BLW/ISC 4 to structure #2 BLW/ISC 7, 1 BLW/ISC 7, start set #3 'Earthwire', end set #3 'Earthwire'
Cable 'd:\pls\transnet\oak', Ruling span (m) 266.226
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 14.9 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length (m)	Mid Span Sag 0 C (m)	Mid Span Sag 5 C (m)	Mid Span Sag 10 C (m)	Mid Span Sag 15 C (m)	Mid Span Sag 20 C (m)	Mid Span Sag 25 C (m)	Mid Span Sag 30 C (m)	Mid Span Sag 35 C (m)	Mid Span Sag 40 C (m)	Mid Span Sag 45 C (m)	Left Struct Number	Span Vertical Projection (m)
266.8	3.67	3.85	4.04	4.24	4.44	4.64	4.84	5.04	5.25	5.45	2 BLW/ISC 4, 1 BLW/ISC 4	8.26
251.8	3.27	3.43	3.60	3.78	3.95	4.13	4.31	4.49	4.67	4.85	2 BLW/ISC 5, 1 BLW/ISC 5	-7.37
278.4	3.99	4.20	4.40	4.62	4.83	5.05	5.27	5.49	5.71	5.93	2 BLW/ISC 6, 1 BLW/ISC 6	-8.75

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
7740	7368	7021	6694	6397	6120	5866	5632	5413	5213

Stringing Chart Report

Section #74 from structure #2 BLW/ISC 1 to structure #BLOUWATER 2 GANTRY, start set #3 'Earthwire', end set #3 'EW2'
Cable 'd:\pls\transnet\oak', Ruling span (m) 28.9883
Sagging data: Catenary (m) 300, Horiz. Tension (N) 956.4 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 6.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
29.9	0.25	0.29	0.34	0.38	0.43	0.47	0.51	0.55	0.58	0.62	2 BLW/ISC 1	-7.70

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
1492	1258	1085	958	860	783	722	673	632	597

Stringing Chart Report

Section #75 from structure #2 BLW/ISC 7, 1 BLW/ISC 7 to structure #2 BLW/ISC 9, start set #3 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\transnet\oak', Ruling span (m) 141.928
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 16.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 8.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
162.4	1.26	1.35	1.46	1.57	1.69	1.83	1.97	2.12	2.28	2.44	2 BLW/ISC 7, 1 BLW/ISC 7	-2.02
100.2	0.48	0.52	0.55	0.60	0.65	0.70	0.75	0.81	0.87	0.93	2 BLW/ISC 8, 1 BLW/ISC 8	1.47

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
8344	7768	7224	6695	6206	5754	5334	4958	4612	4305

Stringing Chart Report

Section #76 from structure #2 BLW/ISC 32/3 to structure #YSTERVARK 2 GANTRY, start set #3 '', end set #3 'EW2'
Cable 'd:\pls\transnet\oak', Ruling span (m) 43.9921
Sagging data: Catenary (m) 300, Horiz. Tension (N) 956.4 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.8 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 7.9 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
45.9	0.75	0.81	0.86	0.92	0.97	1.02	1.07	1.12	1.16	1.20	2 BLW/ISC 32/3	-13.84

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
1172	1086	1016	957	905	861	823	788	758	730

Stringing Chart Report

Section #77 from structure #1 BLW/ISC 32/3 to structure #YSTERVARK 1 GANTRY, start set #4 '', end set #3 'EW2'
Cable 'd:\pls\transnet\oak', Ruling span (m) 37.6043
Sagging data: Catenary (m) 300, Horiz. Tension (N) 956.4 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 3.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 7.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
39.2	0.50	0.56	0.61	0.67	0.71	0.76	0.81	0.85	0.89	0.93	1 BLW/ISC 32/3	-11.35

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
1261	1137	1037	956	891	835	788	749	713	683

Stringing Chart Report

Section #78 from structure #1 BLW/ISC 32/1 to structure #2 BLW/ISC 32/2, 1 BLW/ISC 32/2, start set #5 '', end set #1 ''
Cable 'd:\pls\transnet\oak', Ruling span (m) 119.112
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 15.7 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 7.3 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
119.2	0.67	0.72	0.78	0.85	0.92	1.00	1.09	1.19	1.29	1.39	1 BLW/ISC 32/1	5.16

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
8447	7834	7253	6695	6161	5661	5201	4783	4405	4066

Stringing Chart Report

Section #79 from structure #2 BLW/ISC 4, 1 BLW/ISC 4 to structure #2 BLW/ISC 3, start set #6 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\transnet\oak', Ruling span (m) 281.159
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 19.0 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 15.7 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
281.2	4.10	4.30	4.50	4.71	4.91	5.12	5.33	5.54	5.75	5.96	2 BLW/ISC 4, 1 BLW/ISC 4	0.76

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
7679	7326	6997	6694	6414	6155	5911	5690	5484	5292

Stringing Chart Report

Section #80 from structure #2 BLW/ISC 30, 1 BLW/ISC 30 to structure #2 BLW/ISC 31, start set #6 '', end set #1 'Earthwire'
Cable 'd:\pls\transnet\oak', Ruling span (m) 42.7801
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 6694.8 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 13.6 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 2.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
42.8	0.08	0.09	0.10	0.11	0.12	0.13	0.15	0.17	0.20	0.23	2 BLW/ISC 30, 1 BLW/ISC 30	0.92

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
8703	8022	7356	6687	6045	5412	4806	4221	3674	3171

Stringing Chart Report

Section #81 from structure #2 BLW/ISC 13 to structure #2 BLW/ISC 16, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\transnet\opgw prismiam 48core 12ka', Ruling span (m) 279.232
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 10218.1 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.4 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
285.1	4.29	4.47	4.65	4.84	5.03	5.22	5.41	5.60	5.79	5.98	2 BLW/ISC 13	-0.49
249.9	3.29	3.43	3.57	3.72	3.86	4.01	4.16	4.30	4.45	4.60	2 BLW/ISC 14	2.76
296.5	4.64	4.83	5.03	5.24	5.44	5.65	5.86	6.06	6.27	6.48	2 BLW/ISC 15	-8.05

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
11539	11075	10632	10221	9834	9474	9138	8827	8541	8266

Stringing Chart Report

Section #82 from structure #2 BLW/ISC 16 to structure #2 BLW/ISC 18, start set #1 'Earthwire', end set #1 ''
Cable 'd:\pls\transnet\opgw prismiam 48core 12ka', Ruling span (m) 249.223
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 10218.1 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.2 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
251.1	3.27	3.43	3.59	3.75	3.92	4.10	4.27	4.44	4.61	4.78	2 BLW/ISC 16	-2.56
247.4	3.17	3.33	3.49	3.64	3.81	3.98	4.14	4.31	4.48	4.64	2 BLW/ISC 17	6.13

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
11733	11194	10685	10224	9776	9369	8994	8643	8317	8020

Stringing Chart Report

Section #83 from structure #2 BLW/ISC 18 to structure #2 BLW/ISC 20, start set #1 '', end set #1 'Earthwire'
Cable 'd:\pls\transnet\opgw prismiam 48core 12ka', Ruling span (m) 248.336
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 10218.1 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.0 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
211.4	2.32	2.43	2.54	2.66	2.78	2.90	3.02	3.15	3.27	3.39	2 BLW/ISC 18	0.70
273.6	3.88	4.07	4.26	4.46	4.66	4.86	5.07	5.28	5.48	5.69	2 BLW/ISC 19	-8.11

Horiz Tension 0 C	Horiz Tension 5 C	Horiz Tension 10 C	Horiz Tension 15 C	Horiz Tension 20 C	Horiz Tension 25 C	Horiz Tension 30 C	Horiz Tension 35 C	Horiz Tension 40 C	Horiz Tension 45 C
(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)
11733	11194	10694	10215	9776	9369	8986	8635	8313	8016

Stringing Chart Report

Section #84 from structure #2 BLW/ISC 20 to structure #2 BLW/ISC 23, start set #1 'Earthwire', end set #1 'Earthwire'
Cable 'd:\pls\transnet\opgw prismiam 48core 12ka', Ruling span (m) 245.435
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 10218.1 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 21.0 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number		Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)			(m)
240.3	2.99	3.13	3.28	3.44	3.59	3.75	3.92	4.08	4.24	4.40	2	BLW/ISC 20	-1.99
251.6	3.27	3.43	3.60	3.77	3.94	4.11	4.29	4.47	4.64	4.82	2	BLW/ISC 21	-0.90
244.0	3.08	3.23	3.39	3.55	3.71	3.87	4.04	4.20	4.37	4.54	2	BLW/ISC 22	0.89

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
11758	11211	10702	10215	9777	9361	8977	8618	8291	7985

Stringing Chart Report

Section #85 from structure #2 BLW/ISC 23 to structure #2 BLW/ISC 24, 1 BLW/ISC 24, start set #1 'Earthwire', end set #1 ''
Cable 'd:\pls\transnet\opgw prismiam 48core 12ka', Ruling span (m) 18.0203
Sagging data: Catenary (m) 2100, Horiz. Tension (N) 10218.1 Condition I Temperature (deg C) 15
Weather case for final after creep 15°C EDT, Equivalent to 18.1 (deg C) temperature increase
Weather case for final after load 15°C 1050Pa max Wind, Equivalent to 0.1 (deg C) temperature increase
Results below for condition 'Initial RS'
Calculations done using actual span lengths and vertical projections

Span Length	Mid Span Sag 0 C	Mid Span Sag 5 C	Mid Span Sag 10 C	Mid Span Sag 15 C	Mid Span Sag 20 C	Mid Span Sag 25 C	Mid Span Sag 30 C	Mid Span Sag 35 C	Mid Span Sag 40 C	Mid Span Sag 45 C	Left Struct Number	Span Vertical Projection
(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)		(m)
18.1	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.05	2 BLW/ISC 23	2.00

Horiz Tension 0 C (N)	Horiz Tension 5 C (N)	Horiz Tension 10 C (N)	Horiz Tension 15 C (N)	Horiz Tension 20 C (N)	Horiz Tension 25 C (N)	Horiz Tension 30 C (N)	Horiz Tension 35 C (N)	Horiz Tension 40 C (N)	Horiz Tension 45 C (N)
13223	12234	11232	10233	9202	8175	7134	6078	5044	4015

Technical Specification Tippler 3 Bulk Power Supply -

Low Voltage Installations

Document Number 1924701-2-300-E-SP-0008

Document Details

Ref (SA)	1924701-2-300-E-SP-0008
Date	01 June 2016
Prepared by	Ludaan Kohrs
Reviewed by	Brett Sansom, Colin Pym
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	13 April 2018	Issued for Construction	Colin Pym	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

The specification covers the low voltage installations and equipment required as part of the scope of *works,* including the small power and lighting infrastructure, fire detection systems, access control systems and associated equipment for the three Substations New Main Intake, M and N respectively.

1.2 Purpose

The purpose of this specification is to set out the minimum technical requirements for quality and workmanship for the design (where required), fabrication, supply, installation, construction, testing and commissioning of the following equipment/infrastructure:

- Low voltage cables, conductors and associated infrastructure.
- Earthing and lightning protection systems and associated infrastructure.
- Distribution boards and BTU's.
- Uninterruptable power supplies.
- Building and yard lighting, complete with switching and associated infrastructure.
- Small power installations and associated infrastructure.
- Cable management systems and associated infrastructure.
- Fire detection systems.
- Access control systems.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site information.
- Drawings.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
A	Ampere
AC	Alternating Current
AM	Amplitude Modulation
API	Applied Programming Interface
BTU	Battery Terminal Unit
CCR	Central Control Room
CCTV	Close Circuit Television
CD	Compact Disc
CDEGS	Current Distribution, Electromagnetic Fields, Grounding and Soil Structure Analysis
CoC	Certificate of Compliance
CPU	Central Processing Unit
Cu	Copper
Db	Decibel
DB	Distribution Board
DC	Direct Current
DoL	Direct on Line

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
EOL	End of Life
EPROM	Erasable Programmable Read-Only Memory
FAT	Factory Acceptance Tests
ECSA	Engineering Council of South Africa
EPO	Emergency Power Off
EVA	Ethylene-Vinyl Acetate
Hz	Hertz
HMI	Human-machine Interface
HVAC	Heating, Ventilation, Air-Conditioning
IEC	Independent Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IGBT	Insulated Gate Bipolar Transistor
IGCT	Integrated Gate Commutated Thyristor
I/O	Input – Output
IP	Ingress Protection
IP	Internet Protocol
ISO	International Standards Organisation
LCD	Liquid Crystal Display
LPS	Lightning Protection System
LV	Low Voltage
MDB	Main Distribution Board
MTTR	Mean Time To Repair
MV	Medium Voltage
MVA	Mega Volt Ampere
Native	Original electronic file format of documentation
NTC	Negative temperature coefficient
OEM	Original Equipment Manufacturer
OHS	Occupational Health and Safety
O&M	Operating and Maintenance
^{o}C	Degree Celsius
PC	Personal Computer
PIESA	The Power Institute for East and Southern Africa
PLC	Programmable Logic Controller
PTR	Platinum Resistance Thermometers

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
PTC	Positive Temperature Coefficient Thermistor
PVC	Polyvinyl chloride
QA	Quality Assurance
RAM	Random Access Memory
RIO	Remote Input Output device
RMS	Route-Mean Square
RPM	Revolutions per Minute
SABS	South African Bureau of Standards
SANS	South African National Standards
SAT	Site Acceptance Tests
SCADA	Supervisory Control and Data Acquisition
SCR	Silicon Controlled Rectifier
SDB	Sub-Distribution Board
SHE	Safety, Health and Environment
TCP	Transnet Capital Projects
TCP/IP	Transmission Control Protocol/Internet Protocol
TFR	Transnet Freight Rail
THD	Total Harmonic Distortion
TNPA	Transnet National Ports Authority
TPT	Transnet Port Terminals
USB	Universal Serial Bus
UPS	Uninterruptable Power Supply
UV	Ultra-violet
VSD	Variable Speed Drive
W	Watt
kWhr	Kilowatt Hours
XLPE	Cross Linked Polyethylene

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

All infrastructure that falls under the Eskom 'Ystervark' portion of the new Main Intake Substation, including equipment to be installed at Eskom's existing Blouwater and Iscor substations, shall comply fully to Eskom's standards, specifications and requirements.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer's premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 *Employer's* Standards

The *Contractor* shall be responsible for compliance of all *works* with all the *Employer* standards and specifications, including, but not limited to, the following:

Table 3 : *Employer's* Standards and Specifications

Standard	Description
EEM-Q-008	Corrosion Protection Specification
EEM-Q-012	General Electrical Equipment
EEM-Q-013	Commissioning and Handover
EEM-Q-018	Lighting on Equipment
EEM-Q-019	Cable Reel Systems
EEM-Q-020	Test on Electrical Equipment
EEM-Q-021	Electronic Equipment
SYS-P-0001	Business Codification
H500100-2-000-J-STD-0008	Instrumentation Identifications Standard
H500100-2-000-J-STD-0009	Tag Naming Standard

It is the responsibility of the *Contractor* to ensure that he obtains all of the *Employer's* standards (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the *works* by the *Contractor* to the standards.

3.4 South African and International Standards

The *Contractor* shall also ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standards shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include, but are not necessarily limited to, the following.

Table 4 : South African Standards

Code	Standard Title
SANS 10098	Public Lighting - All applicable parts
SANS 10139	Fire Detection and Alarm Systems for Buildings – System Design, Installation and Servicing
SANS 10142-1	The wiring of premises. Part 1: Low-voltage installations
SANS 1019	Standard voltages, currents and insulation levels for electricity supply
SANS 10198	The selection, handling and installation of electric power cables of rating not exceeding 33 kV. – All applicable parts
SANS 10199	The design and installation of earth electrodes

Table 4 : South African Standards

Code	Standard Title
SANS 10292	Earthing of low-voltage (LV) distribution systems
SANS 10313	Protection against lightning
SANS 10389	Exterior lighting - All applicable parts
SANS 1091	National Colour Standard
SANS 1239	Plugs, socket-outlets and couplers for industrial purposes
SANS 1507	Electrical Cables with extruded dielectric Insulation for fixed Installations (300/500V to 1 900/3 300 V – All applicable parts
SANS 1765	Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA
SANS 1777	Photoelectric control units for lighting (PECUs)
SANS 1799	Watt-hour meters – AC electronic meters for active energy
SANS 1973	Low-voltage switchgear and controlgear assemblies – All applicable parts
SANS 556	Low-voltage switchgear – All applicable parts
SANS 60044	Instrument transformers – All applicable parts
SANS 60309	Plugs, socket-outlets and couplers for industrial purposes – All applicable parts
SANS 60439	Low-voltage switchgear and controlgear assemblies – All applicable parts
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 60669	Switches for household and similar fixed electrical installations – All applicable parts
SANS 60947	Low-voltage switchgear and controlgear – All applicable parts
SANS 61084	Cable Trunking and Ducting Systems for electrical Installations – All applicable parts
SANS 61312	Protection against lightning electromagnetic impulse – All applicable parts
SANS 61386	Conduit systems for cable management – All applicable parts
SANS 61439-1	Low-voltage switchgear and controlgear assemblies – All applicable parts
SANS 61643	Low-voltage surge protective devices – All applicable parts
SANS 61936	Power Installations exceeding 1 kV AC – A applicable parts
SANS 62053	Electricity metering equipment (a.c.) – All applicable parts
SANS 62262	Degrees of Protection provided by Enclosures for Electrical Equipment against external Mechanical Impacts (IK Code)
SANS 62305	Protection against lightning – All applicable parts
SANS 62561	Lightning Protection System Components (LPSC) – All applicable parts
SANS 725	IEEE Guide for Safety in AC Substation Grounding
SANS 767	Earth leakage protection units – All applicable parts
SANS 950	Unplasticized polyvinyl chloride rigid conduit and fittings for use in electrical installations

International standards shall include, but are not necessarily limited to, the following.

Table 5 : International Standards

Code	Standard Title
EN 54	Fire Detection and Fire Alarm Systems – All applicable parts
EN 62040	Uninterruptible Power Systems (UPS) – All applicable parts
PIESA 003	Low-Voltage (600/1 000 V) Cable Systems for underground Electrical Distribution – All applicable parts

3.5 Eskom Standards

The *Contractor* shall also ensure that all *works* undertaken at the Eskom sections, as applicable, comply with all their standards. The latest edition of such standards, specifications and requirements shall apply, which shall include, but not be limited to, the following.

Table 6 : Eskom Standards

Code	Standard Title
240-64100247	Standard for Earthing of Secondary Plant Equipment in Substations
240-64636794	Standard for Wiring and Cable Marking in Substations
240-55151908	AC Reticulation Application Design Guideline for Substations
240-83382076	Standard for Operational Floodlighting in Substations
240-83382122	Emergency Lighting in Substations
240-91190304	Specification for CCTV Surveillance with Intruder Detection
240-96393507	Soil Resistivity Testing for Substation Applications
DISASAAA0	Standard for Passive Fire Protection in Distribution Substation Yards
34-1245 DST	Substation Earthing
34-1613 DSP	Specification for CCTV Surveillance and Alarm System Installations at Distribution Substations
34-1617	Specification for Infrared Detectors Used at Distribution Substations
34-304	Substations, Section 2: Generic Substation Design
34-1985 DST	MV and LV Distribution Earthing

It is the responsibility of the *Contractor* to ensure that he obtains all of Eskom's standards (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the specific *works* by the *Contractor* to the standards.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 7 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 SCOPE OF *WORKS*

5.1 *Works* Included

The *Contractor's* scope of *works* shall include the detailed design, as applicable, fabrication, supply, installation, construction, testing and commissioning of all low voltage installations and equipment, as required for the substation installations, programming, testing, integration with - and commissioning of all communication links between equipment. These *works* include, but are not limited to, the following:

- All detailed designs, drawings and documentation as required in terms of this specification. The *Contractor* shall engage the services of approved specialist subcontractors and OEM's, to be approved by the *Employer*, as necessary.
- All management, personnel, labour and other resources that are required to execute the *Contractor's* scope of *works*, in accordance with the requirements of this specification.
- Co-ordination between other services to be maintained to ensure correct and proper integration of the electrical systems.
- Quality management, as described in the Works Information and these specifications.
- Supply of commissioning and operational spares, required for normal wear and tear during plant operation for the period of one year after commissioning.
- Operating and maintenance manuals, training and back-up support.
- Pre-commissioning and commissioning of all the new installations, including supporting documentation.
- All as-constructed documentation.

This specification covers the low voltage installations and equipment to be provided as part of the *works,* which includes the small power and lighting infrastructure, fire detection systems, access control systems, UPS systems, earthing and lightning protection systems and associated infrastructure for the Substations New Main Intake, M and N respectively, including, but not limited to, the following:

- Detailed designs, supply and installation of the access control systems for the new substations buildings, including the integration with other associated infrastructure/systems. The access control and/or intruder alarm systems that may be required at Eskom's new 'Ystervark' 132 kV control building shall be to their requirements.
- Access control systems control panels, setup/monitor stations, door controllers, door equipment and associated infrastructure.
- Detailed designs, supply and installation of the new substations buildings fire detection systems, including integration with other associated systems. Cognisance shall be taken of any associated requirements as set forth in the Fire Safety Design Report (Doc No 1924701-2-510-M-RPT-0001), forming part of the contract documentation.
- Fire detection system control panels, visual-and-audible indication, detectors, manual call points, interface units, emergency stops and associated infrastructure.
- Detailed designs, supply and installation of the entire earthing and lightning protection systems for the substations by a SANS accredited/certified specialist subcontractor/OEM, to be appointed by the *Contractor*, subject to approval by the *Employer*. This shall include undertaking a lightning risk assessment and compilation of a comprehensive report, to be submitted to the *Employer*, as well as soil resistivity tests where required and provision of the results in a report to the *Employer*.
- Earthing and lightning protection system conductors, rods, spikes, straps, bars, braids, anodes, clamps, terminations, welds and associated infrastructure.
- Detailed designs, supply and installation of all new UPS systems at the substations buildings, as well as complete integration with other systems, including the supply and installation of a BTU at the new Eskom 132 kV control building.
- Detailed designs, supply and installation of all electrical and communications infrastructure of the substations buildings HVAC, and, where applicable, fire suppression systems.
- Low voltage cables, conductors, terminations, joints and associated infrastructure.
- Low voltage control cables, conductors, terminations and associated infrastructure.
- Distribution boards, junction boxes, termination boards and associated infrastructure.
- Luminaires, mounting brackets, light switches, photocells and associated infrastructure.
- Socket outlets, isolators and associated infrastructure.
- Cable trays, ladders, racks, ducts, power skirting/trunking, conduits, clamps/cleats, straps, ties and associated infrastructure.

The systems shall be designed, installed and commissioned by the *Contractor* to provide a fully functional, operable and compliant system, in accordance with these specifications, Works Information, drawings, bill of quantities and all other related contract documentation.

It will be the responsibility of the *Contractor* to ensure that the specialist subcontractor(s)/OEM's fully co-operates, co-ordinates and furnishes all technical support and associated technical information to the *Employer* and Others as required, to ensure that the new infrastructure and systems are fully and correctly integrated.

Should there be any discrepancies or misunderstandings regarding the *works* to be undertaken by the *Contractor*, the *Contractor* shall immediately notify the *Employer*.

5.2 *Works* Excluded

The following LV items are excluded from the *Contractor's* scope of *works*:

- The centralised SCADA system for the port.
- LV power supply to Tippler 3 building main monitoring and control infrastructure. The network switch is to be provided by the *Contractor*. A socket outlet supply will be made available by Others responsible for the Tippler 3 vault, tunnels and shed.
- The Tippler 3 building earthing and lightning protection systems. The *Contractor* will only be required to provide the main MV/LV transformer main/raw earth bar inside the Tippler 3 building transformer room, connected to the transformer and to Substation M's main/raw earth bar(s).
- Any other dedicated earthing and/or lightning protection systems to be supplied by Others.
- All low voltage power supply infrastructure for the conveyors within Substations M and N, i.e. main conveyor LV distribution boards, conveyor monitoring and control infrastructure and the like, which will be supplied and installed by Others. The *Contractor* shall only provide a supply circuit breaker inside the main LV distribution boards at Substations M and N, as shown on the drawings.
- All cable management systems for any electrical and/or electronic infrastructure to be provided by Others.

5.3 Designs, Calculations and Drawings by the *Contractor*

5.3.1 General

The *Contractor* shall, as a minimum, provide the following, calculations, designs (where specified), drawings (design and construction), reports and the like, to be approved by the *Employer*:

- Earthing systems.
- Lightning protection systems.
- Distribution boards, junction boxes, termination boards.
- Uninterruptable power supplies and BTU's.
- Luminaires and light switches.
- Socket outlets and isolators.
- Cable trays, ladders, racks, ducts, power skirting/trunking and conduits.
- Fire detection systems.
- Access control systems.

Documentation to be produced by the *Contractor* shall be compiled and submitted in accordance with the procedures included in the Works Information as well as the further requirements as detailed below. All documents, for which prior approvals are required, shall be timeously submitted to the *Employer* for review and approval, prior to placement of orders, fabrication or manufacture.

The *Contractor* shall, as necessary, appoint specialist subcontractors and/or OEMs to undertake the designs (where specified), calculations and drawings, which shall be prepared and checked by suitably qualified and experienced professional engineers, registered with the Engineering Council of South Africa (ECSA) or an equivalent institution recognised by ECSA.

The design engineers shall be appointed by the *Contractor,* subject to approval by the *Employer*. Designs, calculations and drawings shall not be prepared and checked by the same person and shall be reviewed by the *Employer* before the commencement of fabrication and installation.

The *Employer* will provide the *Contractor* with the necessary formats for documents that are to be submitted for approval.

The *Employer* may, at his sole discretion, request additional design calculations, drawings and associated information, as deemed necessary for verification of the correctness and compliance of the designs. The cost of providing such additional information shall be deemed to be included in the tendered rates, i.e. further payments for such information will not be made.

5.3.2 Designs and Calculations by the *Contractor*

The *Contractor* shall submit all required calculations in a neat and legible manner. Where calculations are performed using specialised software programs, the *Contractor* shall also furnish copies of the final native software files, without any exclusions. The calculations shall be provided in a professional, neat format, to include, but not be limited to, the following, in the order as stated below:

- Summary of assumptions and conclusions.
- Table of contents.
- List of all associated drawings.
- List of compliancy standards.
- List of all text and references used.
- Nomenclature.
- Calculations

5.3.3 Drawings by the *Contractor*

All design and construction drawings shall be submitted in hard and soft copies. Soft copies shall be in 'rvt', 'dgn', 'dwg', 'dxf' and PDF formats as required by the *Employer*. Three hard copies are to be provided, which shall be fully signed off, unless specified otherwise.

The *Contractor* shall be solely responsible for the submission of any drawings that are to be provided by his appointed specialist subcontractors and/or OEM's.

5.4 Safety

Reference is made to the environmental and safety requirements as detailed in the Works Information and the particular requirements as described below.

The *Contractor* shall take all necessary safety precautions to prevent static electricity discharge, sparking and any other unsafe condition, which could pose a safety risk to personnel, property and/or equipment.

If applicable, the location and extent of potentially explosive atmospheres are to be identified and indicated on hazardous area classification drawings. In conjunction with the aforementioned, all electrical equipment and instruments for use in hazardous classified areas shall be supplied with a hazardous area certificate issued by a certifying authority approved by SABS/SANS/IEC.

All *works* shall be performed under strict lockout/disconnection conditions and a register shall be kept of all isolated circuits. The *Employer's* requirements shall also be incorporated in all safety procedures. Provision shall be made for the following:

- The switching and lockout procedures shall form part of the *Contractor's* HSE documentation.
- Whenever a live circuit must be isolated, the *Employer* shall be notified.
- The *Contractor* shall maintain a full key lockout system, with appropriate registers and signatures.
- Under no circumstances shall the *Contractor* do any switching/lockout *works*. All switching shall be undertaken by the *Employer*/Eskom's authorised personnel.

5.5 South African Electrical Compliance

Any equipment designed and fabricated/manufactured overseas shall have an electrical certificate of compliance to South African Regulations before it is delivered and operated in South Africa. The compliance certificate(s) shall fully cover high voltage, medium voltage and low voltage equipment. These certificates shall be issued by an accredited South African professional engineer, or approved other party.

5.6 *Employer* QA Representative

The *Contractor*'s QA requirements shall be as set out in the accompanying Works Information.

The *Employer* may choose to appoint a QA/QC representative to monitor and report on some or all aspects of the production and fabrication processes. Full cooperation shall be extended to the appointed QA/QC representative. Associated costs for such services will be borne by the *Employer*.

5.7 *Contractor*'s Subcontractor Declaration

Where *works* are to be performed by a subcontractor/OEM, the *Contractor* shall provide notices and obtain the *Employer's* approval prior to the appointment of the subcontractor. This shall include all subcontractors/OEMs providing design, fabrication, assembly, installation and related services.

6.0 SPECIFICATIONS

6.1 LV Cables

6.1.1 General

Cables shall be of the XLPE insulated, Cu, EVA bedding, EVA sheathed, armoured and unarmoured, 600/1000V, fire retardant, self-extinguishing zero toxic emission type, in accordance with SANS 1507, unless otherwise specified, shown on the drawings, in BoQ or instructed by the *Employer*. Cables shall be all 600/1000V rated and shall bear the SABS mark of approval, unless otherwise specified.

Cables shall be transported and stored in accordance with SANS 10198-6. Stored cables shall have the cable ends thoroughly sealed prior to termination to prevent the ingress of moisture.

Damaged cables and/or drums delivered to Site will not be accepted. Where the drum and/or cable are damaged, the entire cable reel will be rejected and shall be replaced at the *Contractor's* expense. The *Employer* may, at his sole discretion and at the *Contractor's* expense, request appropriate tests to be performed on the delivered cables to prove that no ingress of moisture or any other form of damage to the cables has occurred.

The *Contractor* shall furnish all relevant factory certificates for the cables whenever requested to do so by the *Employer*.

All LV cables and associated material to be used for new and existing Eskom-owned and operated infrastructure shall fully comply with their requirements.

6.1.2 LV Cable Installation

The installation of cables shall be in accordance with SANS 10142-1, SANS 10198-8 and other referenced or relevant specifications. The *Contractor* shall ensure that only appropriate tools and equipment are used for the installation of cables. Cables shall only be pulled over cable rollers that have been firmly fixed. A pulling sock shall be used when pulling cables. The *Contractor* shall be responsible for making off of cables at both ends.

The *Contractor* shall be responsible for the planning of all cable routes. This applies in particular to buried cables. The *Contractor* shall take account of other services and shall at all stages endeavour to identify and optimise the cable routes. The *Contractor* shall work closely with Others to ensure that the installed cables do not interfere or adversely impact upon other services. The final routes shall be confirmed with the *Employer* and the *Contractor* shall submit a detailed cabling diagram, showing all cable feeds, sizes, location and the like, for approval.

During installation the *Contractor* shall ensure that the maximum tensile forces and bending radii of the cables, as prescribed by the cable manufacturer, are not exceeded. Cables shall be buried belowground or installed on trays, ladders, racks or in ducts, as applicable. Small diameter cables may be installed in conduits only where no practical alternative exists and a specific instruction is issued by the *Employer.*

Where LV cables are installed on trays, ladders, wire meshes or racks, the cables shall be strapped/fixed with heavy duty 316L stainless steel bandit strapping, unless otherwise instructed by the *Employer*. Where steel bandit strapping is used to fix cables, extra cable insulation shall be placed between the cable and the steel strapping to prevent damage to the cable.

The spacing of the strapping fixings shall not be greater than 500 mm, to avoid sagging of the cables. The *Contractor* may propose alternate fixing spacings for consideration and approval by the *Employer.* Such alternate proposals shall be accompanied by a proper analysis and calculations covering the cable loads on trays, wire meshes, ladders or racks. Proof shall also be provided that the manufacturer's requirements will in all cases be adhered to.

LV cables shall not be installed in or along the same cable management systems as the LV conductors or data/communications/signalling and/or control cables, unless specific approval has been obtained from the *Employer*. LV cables shall also not be installed in conduits. Different voltage level cables shall also not be installed in or along the same cable management systems.

Where LV cables are to be installed below ground, they shall be installed at a final depth of 850 mm below finished ground level, measured to the top of the cable (laid on a 150 mm bedding layer and covered by a 150 mm layer of padding material).

The following minimum clearances/spacing shall be adhered to, unless specified, instructed or shown otherwise on the drawings (Note: The *Contractor* may request approval from the *Employer* for relaxation on the below clearances where deemed necessary by the *Contractor*. The *Contractor* may not implement any reduced clearance unless specific approval has been obtained from the *Employer*):

- Between electrical and electronic cables (horizontally): At least 650 mm.
- Between electrical and electronic cables (vertically): At least 650 mm.
- Between electrical/electronic cables and other services (horizontally): At least 650 mm.
- Between electrical/electronic cables and other services (vertically): At least 650 mm.
- Between LV cables (horizontally and vertically): At least 300 mm.
- Between LV and MV cables (horizontally and vertically): At least 300 mm.

The designs for the installation of the same voltage rating cables on trays, wire meshes, ladders and racks, or ducts, allow for the cables to be in contact with one another. The *Contractor* is however strongly advised to provide the maximum possible spacing between cables.

In trenches, where electrical cables cross other electrical cables of different voltage levels, or telecommunications cables, or other services, protective concrete slabs shall be installed up to 2 m to either side of the crossing. Concrete slabs shall be placed between the cables or other services, as specified in SANS 10198-8. Where such crossings occur, protective sleeves shall also be provided and cover tiles shall be placed in conjunction with the protective slab. All further requirements included in SANS 10198-8 and other relevant standards shall be adhered to. Details of the adopted measures for providing minimum clearances and protection shall be subject to approval by the *Employer*.

A maximum number of four cables may be installed through one sleeve. The number of cables that may be installed in one sleeve shall be confirmed with and approved by the *Employer*.

450 mm wide, 150 micron thick PVC electrical danger warning tape shall be installed above all LV electrical cables 300 mm below finished ground level. The electrical warning/danger tape shall, as a minimum, include the wording “DANGER/INGOZI/GEVAAR” and shall have a black thunder flash symbol and be orange in colour.

The cable types (armoured/non-armoured) and coating of cables and joints inside buildings shall be as indicated in Table 8 below. All coating of cables shall be of the intumescent, zero toxic emission, fire stopping type, to be applied in strict accordance with the manufacturer’s recommendations.

Table 8 : Coating of LV Cables

<table>
<tr><th rowspan="2">Cable Size</th><th colspan="2">Cable Type</th><th rowspan="2">Extent of Coating</th></tr>
<tr><th>External of Building</th><th>Internal of Building</th></tr>
<tr><td rowspan="4">LV Cables
< 120mm^2</td><td colspan="2">Armoured :
zero toxicity</td><td>None</td></tr>
<tr><td colspan="2">Armoured :
high toxicity</td><td>Full length of cable, from outside of building up to equipment</td></tr>
<tr><td>Armoured :
high toxicity</td><td>Non-Armoured :
zero toxicity</td><td rowspan="2">Full length of joint plus 1.0 m either side of joint including entire cable entering buildings</td></tr>
<tr><td rowspan="2">LV Cables
≥ 120mm^2</td><td>Armoured :
high toxicity</td><td>Non-Armoured :
zero toxicity</td></tr>
<tr><td>Armoured :
zero toxicity</td><td>Non-Armoured :
zero toxicity</td><td>None</td></tr>
</table>

LV cables installed inside concrete trenches shall be fixed to suitable cable trays, racks or ladders as required, unless specified or instructed otherwise by the *Employer*. LV cables within Eskom's outdoor yard section of the Main Intake Substation's shall be installed as per their standards. This includes cables and connections onto or through foundations and the like.

6.1.3 LV Cable Terminations and Joints

Suitably sized tinned lugs (with associated bolts/nuts/washers where applicable), terminals and other fittings shall be used to match the different sizes and methods of construction for cables that are to be terminated onto applicable equipment. Cable lugs with a colour coded heat shrink covering (in accordance with the cable core colour), and suitably sized bolts and washers shall be used for all bolted terminations. The correct type of crimping tools shall be used to crimp lugs, terminals and other fittings onto cable cores.

Only glands of the correct size, matching the cable to which it must be fixed to, shall be used. Glands shall be for indoor and outdoor use and shall have suitable corrosion protection coatings to cater for a highly corrosive environment. For outdoor environments, glands shall have a minimum ingress protection rating of IP66 to prevent ingress of moisture or any other foreign material. Where glands are used outdoors, they shall be equipped with a protective PVC UV stabilised black colour shroud.

No joints shall be allowed in the cables unless specific approval has been granted by the *Employer* or this is specified. Should any cable be damaged during installation, the *Contractor* shall replace the entire length of the cable at his own expense. Where approval has been granted for the use of joints or joints are specified, only manufacturer-prescribed SABS approved heat shrink joints shall be used.

6.1.4 Testing

When cable reels are unrolled from the drums immediately prior to installation, the cables shall be tested to ensure electrical and structural integrity. The *Employer* may, at his sole discretion, request that appropriate tests be performed on the delivered cables to prove that no ingress of moisture or any other types of damage to the cables has occurred. Such tests will be at the expense of the *Contractor* and shall be provided for in the tendered rates.

During the commissioning stages all LV cables shall be tested to determine phase rotation, insulation and continuity and to verify the correctness of all connections, along with any other tests as required by relevant SANS standards and, where applicable, *Employer* specific requirements. Notwithstanding the requirements of the Certificates of Compliance (CoC), test certificates with the following minimum information shall be issued to the *Employer* immediately after tests:

- Phase rotation
- Insulation Resistance
- Continuity

Further tests and/or information may be required by the *Employer* to demonstrate compliance with the relevant SANS standards or to verify the standards of materials and workmanship for the cables and cable systems. Allowance shall be made in the tendered rates for these tests.

All tests shall be carried out using fit-for-purpose, correctly calibrated equipment.

The above requirements do not absolve the *Contractor* of his responsibility to ensure that all cables are tested in accordance with SANS 10142-1 and other relevant standards.

6.1.5 Labelling

Labelling of the LV cables and terminations shall be by means of a combination of white Traffolyte labels, fastened by black UV resistant cable ties on the cable itself, with engraved black wording, sized accordingly for the specific application, and clip on lettering labels.

On the terminations (on individual cores/wires) at the distribution boards, marshalling kiosks, junction boxes and the like, labelling shall be by means of clip-on lettering-type markers (e.g. CAB 3 type markers), sized accordingly for the specific core wire. All cabling shall, as a minimum, be labelled at both termination points.

Prior to fixing the labels, the *Contractor* shall present samples, including the wording, to the *Employer* for approval.

6.2 LV Conductors

6.2.1 General

The LV conductors shall be of the insulated 600/1000V, Cu, fire retardant, self-extinguishing type, in accordance with SANS 1507. Where relevant SANS standards do allow for the aforementioned conductors to also be of the zero toxic emissions type, the C*ontractor* shall use these types and include in the tendered rates.

Installation and testing of the conductors shall be in accordance with SANS 10142-1 and other relevant and applicable standards. Particular attention shall be given to the number of conductors that can be properly and safely installed in conduit, ducts, power skirting/trunking and/or cable trays/ladders and the like.

Colour coding for the different electrical voltage levels and for earthing/bonding conductors shall be in accordance with SANS 10142-1 and the *Employer's* standards. Prior to commencement of installations, the *Contractor* shall submit a cabling diagram showing all conductor feeds, sizes, colouring, locations and the like for approval by the *Employer*.

All LV conductors and associated material to be used for new and existing Eskom-owned and operated infrastructure shall fully comply with their requirements.

6.2.2 LV Conductor Installation

The *Contractor* shall ensure that only appropriate tools and equipment are used for the installation of conductors. Conductors shall only be installed in conduit.

As the conductors are unarmoured, they shall not be installed bare on trays, ladders, wire meshes, racks or ducts or any other surfaces, unless this is explicitly specified, or if a specific instruction has been issued, or prior approval has been granted by the *Employer*. In all such instances all trays, ladders, racks or ducts and the like shall be provided with suitable coverings.

Where conductors are installed on trays, ladders, wire meshes or racks, the conductors shall be strapped/fixed with heavy duty 316L stainless steel bandit strapping, unless otherwise instructed by the *Employer*. Where steel bandit strapping is used to fix cables, extra cable insulation shall be placed between the cable and the steel strapping to prevent damage to the cable.

LV conductors shall not be installed in or along the same cable management systems as electrical or data/communications/signalling and/or control cables, unless specific approval has been obtained from the *Employer.* Conductors shall also not be installed in areas where they will be directly exposed to UV and/or sunlight. Different voltage level LV conductors shall also not be installed in or along the same cable management systems.

6.2.3 LV Conductor Terminations and Joints

Suitably sized tinned lugs (with associated bolts/nuts/washers where applicable), terminals and other fittings shall be used to match the different sizes and types of conductors to be terminated onto applicable equipment.

Lugs with a colour-coded heat shrink covering (in accordance with the conductor colour), and suitably sized bolts and washers shall be used for all bolted terminations. The correct type of crimping tools shall be used to crimp lugs, terminals and other fittings onto cable cores.

No joints shall be allowed in conductors, unless specific approval has been granted by the *Employer* or if such joints are explicitly specified. Should any conductor be damaged during the installation, the *Contractor* shall replace the entire length of the conductor at his own expense. In the event where approval has been given for the use of joints, or such joints are specified, only manufacturer-prescribed, SABS approved heat shrink joints shall be used.

6.2.4 Conductor Colour Requirements

The following conductor colouring requirements shall apply to the project, unless otherwise specified or instructed by the *Employer*: Note: Eskom wiring colour requirements shall apply to their specifications and standards accordingly.

Table 9 : Wiring Colour Requirements

Type	Colour Requirements
Three Phase Cables up to 3.3kV	Phases: L1 - Red L2 - Yellow L3 - Blue Neutral: Black Earth - Green/Yellow
Single Phase AC Supply	Live - Red, Neutral - Black Earth - Green/Yellow
24V Signal	Grey
DC Control Circuits (+)	Grey
DC return (0V)	Black
Analog Signal (+)	Pink
Analog Signal (-)	White
Earth	Green/Yellow

Note: The *Contractor* shall confirm all wiring/cable colour requirements with the *Employer* prior to ordering and installation of the wires/cables.

6.2.5 Testing

Prior to installation the conductors shall be tested to verify their electrical and structural integrity. The *Employer* may, at his sole discretion, request appropriate tests to be performed on the delivered conductors, to confirm that ingress of moisture has not occurred and that the conductors are free of any other forms of damage. The cost of such tests shall be to the *Contractor's* account.

During the commissioning stages, all LV conductors shall be tested to determine phase rotation (if applicable), insulation, continuity and correctness of installation of all connections. Further tests, as required by the relevant SANS standards, shall also be undertaken. Where so instructed by the *Employer,* further tests shall be undertaken to verify that all applicable requirements have been met. The costs of these tests shall be allowed for by the *Contractor* in the tendered rates.

Notwithstanding the requirements of the Certificates of Compliance, test certificates with the following minimum information shall be issued to the *Employer* immediately after tests:

- Phase rotation
- Insulation Resistance
- Continuity

Further tests and/or information may be required by the *Employer* to demonstrate compliance with the relevant SANS standards or to verify the standards of materials and workmanship for the conductor systems. Allowance shall be made in the tendered rates for these tests.

All tests shall be carried out using fit-for-purpose, correctly calibrated equipment.

The above requirements do not absolve the *Contractor* of his responsibility to ensure that all conductors are tested in accordance with SANS 10142-1 and other relevant standards.

6.2.6 Labelling

Labelling of conductors shall be by means of clip-on lettering type markers (e.g. CAB 3 type markers), sized according to the size of the respective wire. All wiring shall be labelled at both termination points and at each inspection/junction box or the like. Prior to installation, the *Contractor* shall present to the *Employer* samples of the labels, including the wording, for approval.

6.3 Surface Mounted vs Flush Mounted Infrastructure

The *Contractor* shall take note of the table below indicating the *Employer's* general substation buildings areas and the allowed installation methods for cable and conductor support infrastructure in the second column. The *Contractor* shall strictly follow the specified installation methods, unless specified otherwise or instructed differently by the *Employer*.

Failure to do so shall result in rework at the *Contractor's* expense. For any other areas not listed, the *Employer* shall instruct the *Contractor* to the installation methods to be used. The *Contractor* shall ensure that as far as practically possible, aesthetically unpleasing installations shall be hidden.

Installation methods for new and existing Eskom-owned and operated infrastructure shall fully comply with their requirements.

Table 10 : Support Infrastructure

Area	Support Infrastructure Installation
Service levels (for distribution of services)	Surface and flush installations permitted, flush mounted preferred
Trenches	Surface installations, but flush installations shall also be excepted
Equipment Levels (MV Gear, LV Gear, Transformers, VSD, HVAC etc.)	Flush installations only, however surface installations where specified and/or only accepted on approval from the *Employer*
Service vertical shafts (where applicable) (for distribution of services)	Surface and flush installations permitted, flush mounted preferred
Inside Ceiling Voids	Surface installations, but flush installations shall also be excepted
Access staircases (where applicable) (for vertical circulation)	Flush installations only
External	Flush installations only, unless otherwise specified or approved by the *Employer*

6.4 Cable/Wire Trays, Ladders, Racks and Ducts

6.4.1 Supply and Installation

The *Contractor* shall supply and install all cable trays, ladders, wire meshes, racks and ducts complete and ready for laying of cables and/or installing of equipment. This shall make allowance for the installation of all cables, conductors and/or data and control cables, as applicable, and shall include all fixing materials, deviations, bends, angles, tees, reducers, covers, end pieces and all other components as required.

All material shall be unpainted 316L stainless steel, unless specified otherwise. The cable trays, ladders, wire meshes, racks, ducts and the like shall be as specified in the bill of quantities or as shown on the drawings and/or material specifications, as applicable. Equipment and installations for new and existing Eskom-owned and operated infrastructure shall fully comply with their requirements.

It shall be the responsibility of the *Contractor* to plan all routes for the trays, wire meshes, ladders, racks and ducts as best and as optimally as possible, taking account of all other services. The *Contractor* shall work closely with Others to ensure that the installed cable trays, ladders, wire meshes, racks and ducts do not interfere with or adversely impact upon other services. Final routes shall be confirmed with the *Employer* before installation.

The correct types of fixing materials shall be selected and installed along the route for the trays, ladders, wire meshes, racks or ducts at all applicable locations. The spacing of supports shall take account of the loading and shall be designed in accordance with the manufacturer specifications, to avoid excessive and unacceptable sagging.

Minimum shoulder heights shall be as follows:

- Trays, ladders and racks up to 300 mm wide : 38 mm minimum
- Trays, ladders and racks wider than 300 mm : 76 mm minimum
- Ducts up to 76 mm wide : 25 mm minimum
- Ducts wider than 76 mm wide : 76 mm minimum

If necessary, suitable strength 316L stainless steel cable trays, ladders, wire meshes, racks or ducts, as applicable, may be reinforced along their lengths with angle iron or similar stiffening members as needed and/or specified by the manufacturer.

The final cable trays, ladders, wire meshes, racks or duct sizes shall be as specified in the bill of quantities or as shown on the drawings, with the bends, tees, corners, covers, end pieces and the like matching the specified unit sizes.

Cable trays shall be manufactured of slotted/perforated or wire mesh steel, as specified, with a minimum thickness of 1.6 mm. Cable ladders and racks shall have a minimum thickness of 4.0 mm, unless otherwise specified. Ducting shall have a minimum thickness of 1.5 mm with wire meshes a minimum diameter of 5 mm.

All cable/wire trays, ladders, wire meshes, racks and ducts shall be of the heavy duty type. All corners, bends, joints, tees, covers, end pieces and the like shall be properly angled to ensure compliance with the minimum cable radius and to ensure proper, neat installations.

Cable runs shall be laid on top (not underside) of the tray, ladder, wire meshes or rack and secured by means of saddles or approved straps to present a neat appearance. The brackets or hangers (if applicable) shall be constructed to permit the easy removal of any cable from the units. The tray, ladder, wire meshes or rack shall always be of such a width and strength to permit the addition of 4 additional cables with the same diameter as the largest diameter of the installed group.

Surface mounted cable trays, ladders, racks or ducts shall be fixed so that the wider side is in full contact with the wall. The fixing materials for non-suspended trays, ladders, racks and ducts shall be spaced at least 50 mm away from the surface to which it is fixed, unless otherwise specified or instructed by the *Employer* or required differently by the OEM's installation instructions.

Where cable trays, ladders, wire meshes, racks and/or ducts are to be fixed to bricks, concrete or steel, the fixing methods shall be durable and strong enough to meet or exceed the requirements of the intended application and shall be correctly spaced, aligned and installed in accordance with the specified procedures of the manufacturer. Shot-fired type fixing shall only be permitted for specific purposes and provided written approvals have been granted by the *Employer*.

Supports, brackets and the like may only be drilled and bolted to structural steel members where prior permission from the *Employer* has been obtained. Welding of fixing material onto structural steel *works* and/or machinery shall not be permitted under any circumstances.

Where there is any doubt about height restrictions or other considerations affecting the position of cable trays, ladders, racks or ducts, the *Contractor* shall immediately advise the *Employer,* who will provide further instructions as required.

All cable trays, ladders, wire meshes, racks and ducts, including any associated fixing material, shall be mechanically and electrically continuous and be bonded to earth. This shall, as a minimum, comprise of a UV stabilised, 25 mm² sized insulated green/yellow earth conductor. All associated lugs and associated bolts/washers for the earth bonding conductor shall be of the tinned type. All bonding shall be in accordance with SANS 10142-1 (latest revision) and other relevant standards or specifications.

Cable trays, ladders, wire meshes, racks or ducts shall not be installed in any walkways, areas of work, or in any other areas where they may cause obstructions or be a safety hazard. Cable trays, ladders, racks or ducts may not be installed closer than 750 mm to any other services such as gas, steam or water pipes and the like. Clear distances shall exceed the minimum distances specified in the relevant SANS standards. Where these clearances cannot be met for any specific reason, the *Contractor* shall immediately advise the *Employer,* who will provide further instructions as required.

6.5 Conduit

6.5.1 General

The *Contractor* shall install conduit to accommodate all the electrical conductors and electronic wires/cables for the respective buildings. The conduit sizes, type to be used and the like shall be as specified in the bill of quantities or as shown on the drawings and/or material specifications.

All plastic conduit and associated equipment shall be of the rigid fire retardant, self-extinguishing zero toxic emission, UV resistant type. Screws for inspection boxes and other associated fixings shall be 316L stainless steel. Where plastic conduit is used, it shall only be cast into walls (i.e. no surface mounting), unless otherwise specified.

In the unlikely event that the required zero toxic plastic conduit and associated equipment type cannot be sourced locally in South Africa, or any current/new statutory regulations/standards prohibit the use of these types, the *Contractor* shall notify the *Employer* immediately with the provision of evidence proving the claim. Upon acceptance of the evidence the *Employer* shall instruct the *Contractor* as to what plastic type conduit plus associated equipment to use.

Steel conduit and all associated equipment and fixings shall be unpainted 316L stainless steel and may be cast into walls or be surface mounted. Galvanised 1.5 mm diameter draw wire shall be installed along the whole length of all unwired conduit.

The conduit sizes shall be as specified in the bill of quantities or as shown on the drawings. All joints, tees and the like shall match the specified unit sizes.

Conduit and associated material/installations for new and existing Eskom-owned and operated infrastructure shall fully comply with their requirements.

6.5.2 Other Services

Conduits may not be installed closer than 750 mm to any other services such as gas, steam or water pipes, electrical/telecommunications cables which are not installed in conduits. Clear distances shall exceed the minimum distances stipulated in the relevant SANS standards. Where these clearances cannot be met for any specific reason, the *Contractor* shall immediately advise the *Employer,* who will provide further instructions as required.

6.5.3 Installation of Conduit

It shall be the responsibility of the *Contractor* to plan all conduit routes as best and optimally as possible, taking account all other services. The *Contractor* shall work closely with Others to ensure that the installed conduits do not interfere or adversely impact upon other services. Final routes shall be confirmed with the *Employer* prior to installation of conduits.

Conduits may be installed in concrete/brick wall cavities. Where chasing is required for the installation of the conduit in concrete/brick walls, explicit approval shall be required from the *Employer*. Conduit installed within concrete slabs, beams, columns or walls shall be firmly fixed in position before the concrete is cast.

Conduits shall, as far as possible, be flush mounted (cast in) in concrete/brick walls, unless otherwise specified.

Conduits shall be surface mounted on structural steel and concrete/brick elements only where permitted by the *Employer.* The manufacturer's specified fixing materials shall be used. Conduits shall not be installed in any walkways, working areas or in any other areas where they may cause obstructions or be a safety hazard.

For surface mounted conduit, spacing of the fixing materials shall take account of the loadings of the conduit and associated conductors. Account shall be taken of the maximum weight, allowing for the maximum number of the largest sized conductors within the conduit, to avoid sagging of the conduit. Shot-fired type fixing shall only be permitted for specific purposes and provided that written permission has been obtained from the *Employer*.

Conduit runs shall be as straight as possible and shall be provided with suitably sized draw boxes at intervals of no more than 20 m. Where conduits are located within roof spaces, ceiling voids and other exposed areas, the runs must be parallel and at right angles to the structural elements. Diagonal runs will not be allowed. Where conduit is bent or jointed, these bends or joints shall be properly angled to ensure compliance with minimum cable radii. Care shall be taken to ensure that the interior surfaces of conduits have no sharp protrusions of metal which may damage the cables. All open ends of conduit shall be provided with suitable end caps.

All steel conduits, including accessories/fixing materials, shall be securely bonded, to ensure complete electrical and mechanical continuity throughout. Every steel conduit run shall be bonded to earth, which shall, as a minimum, comprise of UV stabilised, 25 mm² sized insulated green/yellow earth conductor(s), unless otherwise specified or instructed by the *Employer*.

All associated lugs and bolts for the earth bonding conductor(s) shall be of the tinned type. All bonding shall be in accordance with SANS 10142-1 and all other relevant standards and specifications.

Conduit shall either be screwed to or lock-nutted on both sides and glanded on the inside of the box or appliance in which it is terminated. All glands shall have a minimum IP65 rating.

Where false floors are provided over concrete, conduits shall be run on the surface of the concrete. All running joints shall be provided with locknuts to ensure that all connections in the installation are secure.

Care shall be taken to prevent the ingress of dirt or moisture in partially completed runs and all open ends shall be temporarily plugged whilst work is not in progress. A maximum of two 90° bends or the equivalent displacement shall be allowed between outlets and/or boxes.

Draw boxes shall, as far as possible, be flush mounted. At concrete/brick walls draw boxes may be installed flush mounted, provided that conduits are also installed flush mounted. All draw boxes/inspection boxes and the like shall have a minimum ingress protection rating of IP65, irrespective of whether draw boxes are surface or flush mounted. Draw boxes shall be securely fastened to the main structure to which they are fastened. The IP rating of the draw box shall remain intact once fastened in place.

Draw or inspection boxes shall not be installed in positions where they will be inaccessible after completion of the installation. The positions of draw or inspection boxes shall be subject to the approval of the *Employer*. Larger draw or inspection boxes shall be used in positions where more than two conduits are joined. Excess holes in draw-boxes or other conduit accessories shall be securely blanked off by means of suitable end plugs.

6.6 Power Skirting and Trunking

The *Contractor* shall supply and install all power skirting/trunking, including all associated accessories and fixing materials, as applicable. The power skirting/trunking shall be surface mounted only and also as shown on the drawings, where applicable. Power skirting and trunking shall only be used indoors, within the respective building(s), DB boards and the like, unless otherwise specified or instructed by the *Employer*.

The power skirting/trunking sizes and amount of compartments shall be as specified in the bill of quantities or as shown on the drawings and/or material specifications. Power skirting/trunking and associated material/installations for new and existing Eskom-owned and operated infrastructure shall fully comply with their requirements.

Where plastic power skirting/trunking has been specified, they and all associated accessories shall be of the plastic, fire retardant, self-extinguishing, zero toxic emissions type, hospital grey colour. Any steel equipment and fixing materials shall be unpainted 316L stainless steel. In the unlikely event that the required zero toxic plastic power skirting/trunking and associated accessories type cannot be sourced locally in South Africa, or any current/new statutory regulations/standards prohibit the use of these types, the *Contractor* shall notify the *Employer* immediately with the provision of evidence proving the claim. Upon acceptance of the evidence the *Employer* shall instruct the *Contractor* as to what plastic type power skirting/trunking plus associated accessories to use.

Where steel power skirting/trunking is specified, it shall be of the of 316L stainless steel type, powder coated to colour 'G29' light grey as per SANS 1091, unless specified otherwise. The powder coating shall be in accordance with the *Employer's* corrosion specifications and applicable SANS standards. **Note: Prior to manufacturing and delivering to Site, the *Contractor* shall confirm the colour with the *Employer*.**

The power skirting/trunking shall be supplied and installed complete with all joints, elbows/bends, tee's, covers, angles, end caps and the like. All fixing materials shall be installed as per the manufacturer's instructions.

The *Contractor* shall plan and optimize the power skirting/trunking runs and routes and confirm these with the *Employer*, to avoid unnecessary wastage and to avoid clashes with any other services within the buildings. The clearances and the installation of the power skirting/trunking shall also be strictly in accordance with SANS 10142-1 and other applicable standards and shall also take account of the drawings and technical specifications, as applicable.

The power skirting/trunking shall be installed so as not to adversely impact upon any other electrical, data/communications/signalling and/or control cables/conductors. Safe bending radii, as prescribed by the manufacturer, shall be maintained at all times.

It is strictly forbidden to install electrical cables or conductors with different voltage levels inside the same power skirting/trunking, nor shall any electrical cables/conductors be installed in the same power skirting/trunking used for data/communications/signalling and/or control cables/conductors.

Armoured and non-armoured electrical cables shall also not be installed inside the same power skirting/trunking. Where specified or instructed by the *Employer*, dedicated skirting/trunking shall be supplied and installed to accommodate optic fibre cabling, as may be necessary.

All steel power skirting/trunking and accessories/fixing materials shall be securely bonded, ensuring complete electrical and mechanical continuity throughout. Every steel power skirting/trunking run shall be bonded to earth, which shall as a minimum be by means of UV stabilised, 25 mm² sized insulated green/yellow conductor(s), unless otherwise specified. All associated lugs and associated bolts/lugs for the earth bonding conductor(s) shall be of the tinned type. All bonding shall be in accordance with SANS 10142-1 and other relevant standards and specifications.

Where the power skirting/trunking is to enter into distribution boards, electronic equipment enclosures, false floors/ceilings and the like, the position, type, size and method shall be suitable to neatly accommodate any associated cables/conductors without undue dislocation and/or damage to any equipment.

In addition, where power skirting/trunking enters any distribution boards, electronic equipment enclosures and/or false floors/ceilings, suitably designed covers/angles shall be installed to create a neat and tidy

termination. The *Contractor* shall obtain the approval of the *Employer* for the exact type of termination to be installed at each respective location.

6.7 Power, Data/Telephone Outlets, Switches and Isolators

The power, data/telephone (if specified) outlets, switches and isolators shall be a combination of flush, surface, power skirting/trunking and/or duct mounted, as applicable. Further details for each installation, including current ratings, number of poles and the like, are indicated in the bill of quantities, drawings and these specifications, as applicable.

The following shall apply to flush, surface and/or duct mounted units, unless specified otherwise in these specifications, bill of quantities and/or drawings.

- Housing boxes, including cradles, covers, screws and other associated materials, shall be 316L stainless steel.
- Standard covers shall be powder coated ‘white’, in accordance with relevant SANS standards.
- Covers for dedicated switch socket outlets shall be powder coated ‘signal red’, in accordance with the relevant SANS standards.
- Covers for dedicated UPS switch socket outlets shall be powder coated ‘national blue’, in accordance with the relevant SANS standards.
- For surface and duct mounted units, both the housing boxes and covers shall be powder coated ‘white’.
- Units which come complete, such as surface mounted lockable isolators and the like, shall be supplied in accordance with the specified requirements where applicable. All fixing materials shall be 316L stainless steel.
- Units which come complete, such as surface mounted lockable isolators and the like, shall as a minimum be IP65 rated, irrespective of whether they are mounted internally or externally.
- All units based externally, which are supplied in separate sections, e.g. socket outlets and the like, shall be housed in appropriate minimum IP65 rated 316L stainless steel flush/semi-flush mounted enclosures with associated doors, fixing materials and the like. The covers for the socket outlets shall be powder coated ‘white’ in colour and the enclosure electric orange ‘B26’ in accordance with SANS 1091.

Units shall be supplied in separate sections and/or complete, as applicable, unless otherwise specified.

Power skirting/trunking mounted units shall be supplied and installed complete, to include the following, unless specified otherwise in these specifications, bill of quantities and/or drawings:

- Cradles, covers, screws and other associated materials shall be 316L stainless steel.
- Standard covers shall be powder coated 'white' in colour, in accordance with relevant SANS standards.
- Covers for dedicated switch socket outlets shall be powder coated ‘signal red’, in accordance with the relevant SANS standards.
- Covers for dedicated UPS switch socket outlets shall be powder coated ‘national blue’, in accordance with the relevant SANS standards.

Further to the above, the following shall also be applicable to the equipment:

- All equipment shall comply fully with SANS requirements and bear the SABS mark of approval.
- Data outlet points shall be the RJ45 type (supplied via CAT 6A cable), if required.
- Telephone outlet points shall be the RJ11 type (supplied via CAT 6A cable), if required.
- Switches and isolators shall be of the ‘switch-disconnector’ type.
- All isolators used for single-phase fixed appliances shall make use of double-pole isolators and for three-phase fixed appliances four-pole isolators, unless required otherwise. Where specified, isolators shall also be of the lockable type.
- All socket outlets shall be of the switched type, unless specified otherwise.
- Dedicated switch socket outlets shall have an earth socket that has been chamfered as per SANS requirements.
- Positions of equipment as shown on the drawings are illustrative. Final locations are to be confirmed with the *Employer.*
- All steel material shall be mechanically and electrically continuous and shall be correctly bonded to earth as per SANS requirements.
- Labelling of the equipment shall be by means of suitably rated Traffolyte labelling, properly glued and permanently fixed onto the respective equipment. The glue shall be of the UV/Heat resistant, long-lasting type.

- Where this is feasible, labelling may be screwed onto the equipment. This shall however not adversely affect the equipment in any way.

Power, data/telephone outlets, switches, isolators and associated material/installations for new and existing Eskom-owned and operated infrastructure shall fully comply with their requirements.

Note: Prior to manufacturing and delivering to Site, the *Contractor* shall confirm the colour requirements and material make-up of the respective equipment with the *Employer*.

6.8 Lighting and Luminaires

Lighting shall be provided inside and outside of the new substation buildings. Area lighting shall also be provided for the outdoor yard areas of the new Main Intake Substation. All luminaires shall be of the LED type and shall be supplied complete, with all associated fixing materials and the like.

The fixing materials, including all accessories, shall be 316L stainless steel. All luminaires and associated equipment shall bear the SABS mark of approval and shall furthermore comply with the drawings, bill of quantities and material specifications, as applicable. Any incorporated cabtyre wire of the luminaires shall be of the fire retardant, self-extinguishing type, and if allowed by SANS standards also have zero toxic emissions qualities, and sized accordingly for the applicable power load.

The positons of the luminaires, as well as the minimum light and associated uniformity levels, shall take account of the statutory requirements of the OHS Act and all relevant SANS standards. Final positions shall also be confirmed on Site in conjunction with the *Employer*.

The *Contractor* shall provide samples of the luminaires to the *Employer* for approval prior to ordering. All fittings shall be new and unused and shall be delivered to Site in crates or boxes as packed by the supplier.

All luminaires shall be new and in good working order, as per the specified requirements, when the buildings are handed over. The permanent luminaires shall not be used for temporary lighting during construction.

Where specified, luminaires shall come with incorporated bird spikes. The bird spikes shall be designed to prevent birds from sitting and/or nesting on the luminaires. The bird spikes shall not adversely affect the luminaires in any way and shall be as per the manufacturer(s) design and construction. Bird spikes and associated fixing materials made of steel shall be unpainted 316L stainless steel. If polycarbonate or similar materials are used, they shall be completely UV resistant. The polycarbonate type is preferred.

All luminaires shall be provided with suitable power factor compensation, ensuring a power factor equal to or better than 0.95. The luminaires shall also have low harmonic distortion content.

The mounting of all fittings shall be in accordance with the drawings and the manufacturer's recommendations/requirements. No luminaires shall be suspended on a conduit outlet box only. The body of a luminaire shall not be used as a wireway to supply adjacent luminaires. Each luminaire shall be fixed at no less than two points (other than the conduit outlet box).

6.9 Panel Colours

Table 11 : Colour Requirements

Panel/Section Type	Colour
All Electrical Field DB Panels etc.	Electrical Orange 'B26'
Substation DB Panels	Electrical Orange 'B26'
UPS Panels, UPS Sections Inside Conventional DB's and Battery Cabinets	Purple (Dark Violet - 'F06')

Note: Prior to manufacturing and delivery to Site, the *Contractor* shall confirm all panel/enclosure colour requirements with the *Employer*, including for those which may not have been listed in the table above. This shall include all respective panels for electronic equipment as well. All Eskom panels shall confirm to their colour requirements.

6.10 Distribution Boards

6.10.1 General

The following new distribution boards shall be installed at the new substations buildings:

- Substation M
  - Main distribution board (MDB).
  - MV equipment sub distribution board (SDB-MVE).
  - ACP-L0-01.
  - ACP-L0-02.
  - Separate DB(s) for HVAC control equipment.
- Substation N
  - Main distribution board (MDB).
  - MV equipment sub distribution board (SDB-MVE).
  - ACP-L0-01.
  - ACP-L0-02.
  - Separate DB(s) for HVAC control equipment.
- Main Intake Substation
  - Main distribution board (MDB).
  - MV equipment sub distribution board (SDB-MVE).
  - ACP-L1-01 for HVAC.
  - ACP-L2-01 for HVAC.
  - Separate DB(s) for HVAC control equipment.

The requirements for the distribution boards are shown on the schematic drawings, in the bill of quantities and in the specifications. All distribution boards, enclosures, cabinets and junction boxes shall bear the SABS/SANS mark of approval.

The units shall be manufactured in accordance with the relevant SANS specifications and further standards as applicable, these specifications and the drawings. The position of the units shall be as indicated on the drawings. All final positions are to be confirmed on Site with the *Employer* prior to installation.

Special care shall be taken to ensure that the protective paintwork is not damaged during handling and installation. The height of floor standing units shall not exceed 2 000 mm. The general mounting height for flush or surface mounted units shall not exceed 1 900 mm to the top of the respective unit. The boards shall be manufactured to suit the layouts indicated on the drawings.

Where applicable, distribution boards shall be compartmentalised between normal and UPS sections.

All units shall be provided with face plates. Enclosure colour(s), including internal sections etc. shall be as per these specifications, drawings and bill of quantities. Unequipped spaces in the sections/faceplate, which are reserved for future equipment, shall be fitted with dummy circuit breakers.

Suitably sized plastic hospital grey colour slotted trunking with covers shall be provided inside the distribution boards, which shall be installed so that all wiring can be placed inside the trunking to ensure neat runs to all the respective equipment. Reference is made to the relevant sections of these specifications and further requirements covering power skirting/trunking.

Over and above the technical requirements of the equipment as indicated in the schematic drawings, bill of quantities and material specifications, all equipment shall, as applicable, also comply with the following minimum requirements:

- Circuit breakers : Icu = Ics100%
- Circuit breakers : Cascading type, with upstream supply breakers
- Protection devices : Full co-ordination (Type 2)
- All circuit breaker and isolators : Physical lockable mechanism(s) incorporated
- Contactors : AC3 type
- Full rated tinned copper busbars to be incorporated.
- DIN rail mounting incorporation.
- Equipment operable from the front, i.e. face plate to have suitable openings for equipment operating mechanism to be operated and/or monitored without the need for removing the face plate.
- Removable eye bolt lifting lugs shall be furnished and installed on all panels.

- Gland plates shall be 316L stainless steel.
- Non-extendable modular type.
- The main distribution boards for Substations M and N shall be of the same type, size and have the same dimensions and appearance as the DB boards to be installed by Others, responsible for the Tippler 3 Conveyor installations, to ensure uniformity of the boards. These boards will be of the ABB ArTu range, or approved equivalent, with:
  i. Floor mounting.
  ii. Typical Dimensions = 1.9m (H) x 0.9m (W) x 0.8m (D).
  iii. Toughened glass incorporated into main door with handle.
  iv. Incorporated base.
  v. Compartments for T3 normal and UPS supply infrastructure (where applicable).
  vi. Top and bottom cable entries shall be allowed for in the design of the DB boards.
  vii. The above details and requirements as applicable shall also apply to the main distribution board for the new Main Intake Substation.
- The HVAC DB's for the substations shall also comply with the above however they shall be of the wall mounted type and sized to suit. Furthermore these DB's shall have solid doors, i.e. no incorporated glass viewing panels. The *Contractor* shall obtain permission from the *Employer* for the use of floor standing HVAC DB's.
- All wall-mounted distribution boards shall be appropriately sized and shall also be of the ABB ArTu range or approved equivalent type. This applies in particular to the HVAC power and control distribution boards, SDB-MVE DB's and the like.
- All DB boards located inside the substations buildings and not exposed directly to the environment shall be constructed of 3CR12 steel with colour as specified in this specification, drawings and bill of quantities. Such DB boards shall have a minimum ingress protection rating of IP54.
- Any other DB boards that will be exposed to the environment shall be constructed of 316L stainless steel, with colours as detailed in these specifications or as shown on the drawings and the bill of quantities. Such DB boards shall have a minimum ingress protection rating of IP65. Furthermore these DB's shall be of the "double door" arrangement for internal equipment protection from the environment when opening the first door. The arrangement shall also be such that windows will be installed on the inner door to view critical equipment where needed. Equipment such as stop/start buttons, circuit breakers/isolators etc. must be able to be operated without the need to open the inner door. The aforementioned shall also be provided with additional protection against the environment should the first door be opened or accidentally left open etc.
- The final positions of the HVAC control DB's shall be confirmed on Site with the *Employer*.
- The UPS's shall be custom built, so that their enclosures have the same appearance and dimensions as specified for the floor standing DB's. The UPS's shall be provided with additional doors, incorporated toughened glass in the door and other features as required for purposes of uniformity. The enclosures shall be colour coated as per these specifications, drawings and bill of quantities and have a minimum ingress protection rating of IP54. The enclosure shall be constructed from 3CR12 steel.
- The battery cabinet(s) shall be custom built, so that the enclosure has the same appearance and dimensions as specified for the floor standing distribution boards, except that the door will be solid with no incorporated glass viewing panels. The colour of the cabinets shall be as per these specifications, drawings and bill of quantities and have a minimum ingress protection rating of IP54. The cabinets shall be constructed of 3CR12 steel.
- All fixing materials shall be 316L stainless steel.
- All distribution boards/enclosures/cabinets shall have a minimum free space of 30% for future Tippler 3 equipment supplies.

All materials for the DB's shall be in accordance with the requirements included under separate sections of these specifications.

Should there be any discrepancies or misunderstandings, the *Contractor* shall immediately notify the *Employer*. If no queries are received, it shall be assumed that the information available conveys the exact requirements of the distribution boards/enclosures/cabinets plus associated equipment/materials.

6.10.2 Testing

The testing and commissioning of the DB Boards shall be in accordance with all applicable SANS/IEC standards and any other standards as applicable. The *Employer* may, at his discretion, instruct the *Contractor* to perform additional tests and/or provide additional information as required to prove the functionality and compliance of the DB boards. Allowances shall be made by the *Contractor* in the scheduled rates included in the bill of quantities for such tests.

6.10.3 Labelling

All boards, enclosures, equipment, circuits and associated cabling/wiring shall be labelled/numbered as indicated on the drawings and as described below, unless otherwise specified or required by the *Employer's* standards.

The faceplates on the boards and on equipment, such as contactors, latching relays and the like, labelling shall be by means of suitably sized, permanently fastened Traffolyte labels.

All cables and wiring shall be labelled/numbered in accordance with the requirements stated under the sections of these specifications titled 'LV Cables' and 'LV Conductors', as well as per document 1924701-2-300-E-SP-0010 for communications cables and the like, as applicable. The schematic drawings shall be updated accordingly to include the labelling/numbering of the circuits.

6.11 HVAC and Fire Suppression Electrical/Communications Infrastructure

The electrical and communications/control infrastructure for the HVAC and fire suppression' installations shall be designed by the *Contractor*/OEM's and shall be installed by registered electricians employed by the *Contractor*/OEM's. The designs shall be done by suitably qualified and experienced professional engineers/technicians and shall be subject to approval by the *Employer*.

These installations shall be in full compliance with all applicable requirements as listed in this specification, Works Information, bill of quantities and all other, related contract documentation.

6.12 Yard Termination, Junction, Cable and Plug Enclosures/Boxes

The following enclosures and boxes shall be supplied and installed as specified below, as listed in the bill of quantities and as shown on the layout drawings. The quantity, detail, free space and the like required for the internal equipment and the units shall be as per the applicable Eskom specifications. Reference shall also be made to Doc No 1924701-2-300-E-SP-0009.

6.12.1 Junction Enclosures/Boxes

- 316L stainless steel.
- IP65.
- Powder coated colour (SANS 1091 'B26').
- Hinged door.
- Pad-lockable lever lock and hinges – 3-way locking mechanism.
- Terminal and circuit breaker rails.
- Circuit breakers, earth leakage units, switch-disconnector/Isolator where required.
- Terminal blocks including mounting brackets.
- All fixing materials and all other accessories as required.
- All fixing materials, screws and accessories shall be 316L stainless steel.

6.12.2 Termination Boards/Enclosures (Inside Lightning Masts for Lighting Infrastructure)

- 316L stainless steel.
- IP65.
- Un-painted.
- Hinged door.
- Pad-lockable lever lock and hinges.
- Terminal and circuit breaker rails.
- Circuit breakers.
- Terminal blocks including mounting brackets.
- All fixing materials and all other accessories as required.
- All fixing materials, screws and accessories shall be 316L stainless steel.

6.12.3 Plug Boxes

- 316L stainless steel.
- IP65.
- Powder coated colour (SANS 1091 'B26').
- Hinged door
- Pad-lockable lever lock and hinges.
- Terminal and circuit breaker rails.
- Circuit breakers, earth leakage units, switch-disconnector/Isolator where required.
- Terminal blocks including mounting brackets.
- All fixing materials and all other accessories as required.
- All fixing materials, screws and accessories shall be 316L stainless steel.

6.12.4 Cable Junction Boxes in Trenches

- IP68 cable box.
- Reinforced, impact and corrosion resistant.
- Terminal blocks.
- Screws and all fixing materials and all other accessories as required.
- All fixing materials, screws and accessories shall be 316L stainless steel.

Note: The *Contractor* shall confirm, with the *Employer*, all enclosures, boxes etc. requirements prior to manufacturing and delivery to site.

6.13 Approved Motor Starting Methods

The starting principle of motor loads shall be as follows:

- 0 to ≤ 1 kW = Direct Online (DoL): 400/230 VAC for normal applications. Specific applications may however dictate use of soft starters or variable speed drives.
- Above 1 kW up to and including 30 kW = soft starter: 400/230 VAC for normal applications. Specific applications may however dictate the use of variable speed drives.
- Above 30 kW up to but not including 132 kW = variable speed drives: 400/230 VAC.
- 132 kW and above = variable speed drives: 3.3 kVAC.

All soft starters and variable speed drives shall be capable of driving both variable and constant torque type motors. All motors shall be rated for use of soft starters and variable speed drives.

6.14 Soft Starters

6.14.1 General

This section describes the minimum requirements for 400/230Vac three-phase soft starters. The soft starter units shall be provided by the OEM, appointed by the *Contractor*, in a configuration suitable for panel mounting. The units must be suitable for mounting in defined pollution degree 3 environments. All power devices must be inaccessible during routine maintenance or set-up.

The soft starter shall utilize a thyristor (SCR) bridge, consisting of at least two SCR's per phase to control the starting and stopping of industry standard motors. The thyristor shall be controlled by the "current limit/voltage ramp/torque regulation" so that a smooth and linear acceleration ramp is ensured, independent of motor load.

The soft starter shall be controlled by a microprocessor that continuously monitors and protects the motor and the soft starter. All soft starter units, regardless of power rating, shall utilize the same type of control module.

The soft starter unit shall be provided with a HMI display and adjustment interface/keypad for setting and monitoring. All settable parameters shall be accessible, without the need for an additional connection to a computer. The soft starters shall however also be supplied with a USB port for programming purposes and retrieval of data. All programming shall be undertaken by the *Contractor* in conjunction with the specialist subcontractor/OEM, appointed by the *Contractor* and shall incorporate the input requirements as specified by the *Employer*.

The soft starters shall be supplied with all critical and recommended spare parts. All soft starters shall be of the fully integrated "plug and play" type. All 3rd party certification, safety and protection requirements shall comprehensively cover the entire soft starter system. Certification or protection of individual system elements or components will not be accepted. All power devices shall be inaccessible during routine maintenance or set-up.

Any modifications to a standard product that is provided in accordance with this specification shall be performed by the soft starter OEM only. Before dispatch the soft starter systems shall be completely factory pre-wired, assembled and tested by the soft starter OEM as a complete package, to ensure that a properly coordinated, fully integrated drive system is delivered to Site.

The procedures governing the design approval, manufacturing, inspections, testing, commissioning and minimum requirements of the equipment/systems are covered in the further sections below.

6.14.2 Technical Requirements

i. Minimum Requirements

The soft starters unit shall be designed and be capable of operating under the conditions as listed below:

- Rated operational voltage (continuously): 230/400 VAC -15%, +10%.
- Rated control voltage: 24 V AC/DC, +10%/-15%.
- Adapt automatically to the main frequency of 50 Hz.
- Total efficiency of no less than 96.0% at full load and 95% at 50% load.
- Maintained minimum 0.95 power factor, from between 30% to 100% of rated speed.
- Total harmonic distortion (THD): Less than 5% on linear and non-linear loads.
- Degree of protection: Minimum IP20.
- Full Type 2 co-ordination, with in-line contactor and with thermal overload.
- At ambient temperature between 0^{o} C to 40^{o} C without derating. Operation up to 60^{o} C should be possible with a maximum derating of 0.8% for every ^{o}C. Allowance to be made for an environment with a relative humidity of up to 93% without condensation.
- In altitudes up to 1000m. For higher altitudes, derating shall not be more than 2.2% for each additional 100m.
- Shall have standard load starting capabilities, i.e. 10 start times per hour at ambient temperature of 40^{o} C, without the need of an auxiliary fan.
- Starting current limitation, adjustable from 150% up to 700%, depending on the load requirement.
- Starting capacity: 4 x Ie for 10 sec.

- All soft starter units are to be full duty cycle rated with internal bypass.
- Built-in protection for regenerative power absorption/braking facilities.
- Built-in facility to drive both variable and constant torque motors, without the need for any changes to the unit.
- All soft starter systems shall be of the 2 quadrant type.
- No regenerative power absorption/braking facilities are required. The soft starters shall have built-in protection for the aforementioned.

ii. Minimum Main Settings

- Setting current.
- Ramp time during start.
- Ramp time during stop.
- Initial/end voltage.
- Current limit.
- Torque control for start.
- Torque control for stop.
- Kick start.

iii. Minimum Interface/Data Display Requirements

The soft starter unit shall be provided with the minimum features for the operator interface as listed below. Data shall be provided in a 4-digit, 7-segment LCD HMI display (English), with 2 selection keys and 2 navigation keys and with a resolution of at least ±0.01% and an accuracy of 1%. The minimum data to be displayed is:

- Input current in Amperes.
- Output current in Amperes.
- Input voltage.
- Output voltage.
- Input frequency in Hertz.
- Output frequency in Hertz.
- Motor power factor.
- Motor active power.
- Total 3-phase kW output.
- Motor torque/load.
- Motor thermal status.
- Motor operating time.
- Phase rotation direction.
- Last fault detected.

The HMI display shall be face-plate mounted.

iv. Minimum Warning Provisions

- Current underload warning.
- Current imbalance warning.
- Voltage imbalance warning.
- Thyristor overload warning (SCR).
- Electronic overload time-to-trip.
- Short circuit warning (for limp mode).
- Over voltage warning.
- Under voltage warning.
- Power factor underload warning.
- Locked rotor warning.
- Faulty fan warning.
- THD (U) - total harmonic distortion warning.
- Motor runtime limit warning.
- Phase loss warning (for standby).
- EOL warning.

v. Minimum External Faults Detection

- Power supply failure.
- Low control supply voltage.
- Phase loss.
- Current underload warning.
- Overload current.
- Lock rotor fault.
- Prolong starting fault.
- Motor thermal fault detected by PTC.
- Starter overheated.
- Line frequency out of tolerance.
- Control line failure.
- Faulty usage (e.g. using limp mode inside-delta).
- Faulty connection/Serial link fault.
- Bad network quality.

vi. Minimum Internal Faults Detection

- Thyristor overload.
- Short circuit.
- Open circuit thyristor or gate.
- Heat sink over temperature.
- Shunt fault.

vii. Minimum PTC Inputs

- Switch-off resistance: 2825 ohm ± 20%.
- Switch-on resistance.

viii. Power Quality Metering

Power quality metering shall be incorporated in the soft starter system to continuously monitor and display input and output power quality. This shall allow easy customer-verification of power quality and efficiency of the soft starter system. The power quality data shall include the following:

- Input and output voltage (average rms value).
- Input and output current (individual phase rms values and average rms value).
- Input and output frequency.
- Power factor.
- kW, kVAr.
- kWHr.
- THD (average of 3 phases).
- Calculation of total input current or voltage harmonic demand distortion.
- Drive efficiency.
- Motor voltage (rms).
- Motor current (rms).
- Motor speed (in RPM or %).
- Motor flux (%).
- Motor torque current (%).

ix. Adjustment

The soft starter unit shall be pre-set at the factory to have the capability to start, operate and protect the motor and starter without any adjustment for standard motors ranging from above 1kW up to and including 30kW.

The soft starter shall have the necessary functionalities to allow modifications to be made on Site of the parameters as listed in the table below:

Table 12 : Soft Starter Adjustment Parameters

Description	Range
Acceleration	1 to 60 sec
Deceleration	1 to 60 sec
Stopping	Free wheel / deceleration / brake
Voltage boost	50% to 100%
Current limitation	150% to 700%
Phase rotation	On / Off
Under load protection by torque	Off / 20% - 100%
Time before starts	0 – 999 seconds
Initial torque	0% to 100%

x. Protection Functions:

The OEM-recommended proper circuit breaker (cascaded type) with magnetic tripping for power protection and complete with contactor for isolation shall be used. These components shall be in accordance with IEC 947-4-1 type 2 coordination, sized according to AC3, and shall be incorporated into the panel. The soft starter unit protection functions shall, as a minimum, include the features as described below.

Minimum Motor/Main Protection

- Starting Protection: A programmable tripping curve, equivalent to SANS 60947-4-1 thermal protection Class 2, 10A, 10, 15, 20, 25 or 30, for different types of operation duty shall be provided.
- Electronic overload and thermal protection.
- Dual overload (separate overload for start and run).
- PTC connection.
- PT-100 connection.
- Locked rotor protection: If the motor reaches 5 times the rated current or higher, the soft starter shall shut down within 200 ms.
- Current underload protection.
- Overspeed.
- Current imbalance protection.
- Power factor underload protection.
- Under voltage protection (input and output of soft starter).
- Over voltage protection (input and output of soft starter).
- Voltage imbalance protection.
- Earth fault protection / ground fault protection.
- Phase reversal and single phasing protection (input and output of soft starter).
- 24 V output protection.
- Frequency range protection.
- Bypass open protection.
- User defined protection.
- Too long current limit protection.
- HMI failure protection.
- Fieldbus/communications failure protection.
- Extension I/O failure protection.
- Max number of starts/hour.
- Too long start time protection.
- Thermal memory, capable of memorising the thermal status of the motor at events including the loss of power at the incoming or control supply. Thermal condition of motor shall be modelled according to time event during loss of control supply.

- Time between starts, including recognition that a previous stop command had been activated and will only restart the motor after a pre-set delay. This delay shall be adjustable between 0 to 999 minutes.

Soft Starter Unit Protection

- Withstand up to 13 times rated current for 20 ms.
- Build in thermal protection switch.
- Protection against micro interrupt < 200 ms, to minimise tripping due to voltage dips.
- Integrated circulation fan control by auto heatsink thermal on/off switch.
- Preheating capability when motor not running.
- Short circuit of internal circuitry.

Mechanical Protection

- The system shall be able to pick up the spinning load at any speed and any direction and respect the acceleration setting, catch on fly.
- The system shall provide the possibility of detection of low load torque and provide alarm or shut down the soft starter unit. Current detection is not acceptable.
- The system shall provide linear deceleration in order to eliminate water hammering in the case that a water pump is used.
- The system shall provide self-adapt long starting time in case of high inertia fan loading.
- On load and off load starting.
- The soft starter shall have the capability to have two parameter settings programmed and the user shall have the choice to choose off-load or on-load starting in cases where it is necessary to start on load.
- The system shall provide detection of phase rotation to avoid operation in wrong direction in case of supply sequence change, especially in the case of a generator supply.

xi. Other Functions

- Real time clock.
- Event log and fault history. The soft starter unit must be able to store 8 pass faults with abbreviated English language code. These codes shall be stored in non-volatile memory.
- Emergency mode.
- Automatic restart.
- Secure settings.
- Keypad password.
- Electronic overload time-to-cool.
- Thyristor runtime measurement.
- Auto phase sequence detection.
- Electricity metering.
- Motor heating.
- Stand still brake.
- Voltage sag detection.
- Limp mode with two-phase motor control if one set of thyristors is shorted.
- The soft starter shall include small motor test capability, to allow full functional testing using a motor not larger than 4 kW, regardless of the unit rating.

xii. I/O Control Points

The soft starter shall be designed to provide, as a minimum, the following I/O's for surveillance and protection purposes:

- 1 relay output for safety interlock.
- 1 relay output for end start-up.
- Relay outputs for hard-wire protection functions to other protection equipment, i.e. switchgear/external transformer protection and the like.
- Digital and analogue inputs/ outputs for:
  i. Motor thermal/winding temperature alarm/protection.
  ii. Motor powered.
  iii. Motor current alarm/protection.

iv. Motor underload alarm/protection.
v. Motor PTC alarm/protection.
vi. Second motor parameter selected.
vii. Bearing temperature alarm/protection.
viii. Oil temperature alarm/protection.
ix. Low oil alarm/protection.
x. Motor vibration alarm/protection.
xi. Input shaft speed monitoring/alarm/protection.
xii. Output shaft speed monitoring/alarm/protection.

- 2 logic input for start/stop control.
- 2 additional logic inputs for:
  i. Forced freewheel.
  ii. External fault.
  iii. Motor preheating.
  iv. Force to local control.
  v. Inhibit all protection.
  vi. Reset motor thermal fault.
  vii. Activation of cascade function.
  viii. Reset of faults (that can be reset).
  ix. Activation of second set of motor parameters.
- 1 analogue output for motor current and motor torque, motor thermal state, power factor configurable and the like.
- 1 PTC/PT input for motor PTC/PT thermal protection.
- 4 additional digital/analogue inputs and outputs respectively for additional other on-board motor protection.

xiii. Serial Communication and Interface

The soft starter shall be fitted with removable, “hot swappable” “smart slot” communications protocol(s) interface cards, to allow for the following:

- Profibus DP protocol communications.
- The connections/ports shall be as follows:
  i. RS-232 and RS-485 ports for the Profibus DP protocol communications.
- The unit shall be configured so that it can communicate with and be monitored and controlled (if applicable) via a PLC/RIO, SCADA or other control system.
- The software must also be operable with a handheld personal computer with Windows operating system.
- The soft starter unit shall be programmable with an optional PC based software package via a serial/USB port located on the unit. The software shall operate on any standard, compatible personal computer or laptop installed with Windows operating system.
- The configuration software shall allow and enable interrogation and modification of all parameters accessible within the unit.
- A facility shall be provided to store files and print records of the operating parameters.
- The configuration software shall allow control of the soft starter unit following a set of verification procedures.

The programming settings shall be done on Site in conjunction with the *Employer* and specialist subcontractor/OEM, appointed by the *Contractor*. The *Contractor* shall make adequate allowances for these interactions in his tendered rates.

6.14.3 Testing

Testing and commissioning of the units shall be in accordance with the relevant SANS, IEC and other applicable standards. The *Employer* may at his discretion instruct the *Contractor* to perform additional tests and/or provide additional information as required to prove the functionality and compliance of the units. The costs of such tests are deemed to be included in the tendered rates.

6.14.4 Labelling

All soft starters, associated equipment, circuits and cabling/wiring shall be labelled and numbered. Labelling of the soft starter and equipment, such as circuit breakers, contactors, fuse holders (if applicable) and the like, shall be by means of suitably sized Traffolyte labels, which shall be permanently fastened.

All cables and wiring shall be labelled/numbered in accordance with the requirements stated under the sections of these specifications titled ‘LV Cables’ and ‘LV Conductors’, as well as per Doc No 1924701-2-300-E-SP-0010 for communications cables and the like, as applicable. The schematic drawings shall be updated accordingly to include the labelling/numbering of the circuits.

6.15 Variable Speed Drives

6.15.1 General

This part of the specifications covers the minimum requirements for fully-integrated, low voltage (230/400 VAC) variable speed drives (VSD) and shall be applicable to all types of AC motor application. The VSD's shall be suitable for heavy duty operating applications, defined as 'severe', and shall be supplied and installed as a complete system.

All power devices shall be inaccessible during routine maintenance or set-up. The units must be suitable for mounting in defined pollution degree 3 environments.

Each VSD system shall include all system components that are required to meet the performance, protection, safety, testing, and certification criteria of this specification. These components may include, but are not be limited to, VSD converter/DC link/inverter, output filters and the like.

The VSD's shall be controlled by a microprocessor that continuously monitors and protects the motor and the VSD. All units, regardless of power rating, shall utilize the same type of control module.

The VSD's shall be provided with a HMI display and adjustment interface/keypad for setting and monitoring. All settable parameters shall be accessible, without a need for an additional connection to a computer. The VSD's shall however also be supplied with a USB port for programming purposes and retrieval of data.

The VSD systems shall, as a minimum, comprise of the following:

- A fully integrated and serviceable package.
- Include all material necessary to interconnect any VSD system elements, even if shipped separately.
- Low voltage VSD's shall be designed for panel/enclosure installation, appropriately de-rated.

Any modifications to a standard product that is provided in accordance with this specification shall be performed by the VSD OEM only. Before dispatch the VSD systems shall be completely factory pre-wired, assembled and tested by the VSD OEM as a complete package, to ensure that a properly coordinated, fully integrated drive system is delivered to Site.

The VSD shall be supplied with all critical and recommended spare parts. All VSD's shall be of the fully integrated "plug and play" type. All 3rd party certification, safety or protection requirements shall comprehensively cover the entire VSD system. Certification or protection of individual system elements or components will not be accepted.

The VSD manufacturer shall have at least 20 years' experience in manufacturing VSD's for low and medium voltage applications and shall provide evidence of their ability to provide parts and service support after hand-over and commissioning. A user's list of similar design equipment previously supplied and installed by the OEM, including contact names and telephone numbers, shall be furnished upon request.

The *Contractor* shall also provide evidence that the equipment is dependable and includes proven, high-performance technology. Evidence shall be provided to verify that the same type of equipment has been successfully used in similar environments and applications for 20 years or more. The *Employer* reserves the right to disqualify and reject technologies with an operating track record of less than 20 years.

Where VSD's require capacitors for harmonic/PFC reduction, oil filled capacitors will not be permitted.

Full factory acceptance tests shall be performed at the VSD's OEM's facility, certifying the complete product before shipment to Site.

The procedures for the design approval, manufacturing, inspection, testing, commissioning and minimum requirements of the equipment/systems are covered in further sections of these specifications.

6.15.2 Technical Requirements

i Minimum Requirements

The VSD's shall be designed and be capable of operating under the conditions as listed below:

- Rated operational voltage for LV VSD's (continuously): 230/400 VAC -15%, +10%.
- Rated control voltage: 24 V AC/DC, +10%/-15%.
- Adapt automatically the main frequency of 50Hz.
- Total efficiency no less than 96.0% at full load and 95% at 50% load. Guaranteed minimum total VSD system efficiency (ηsys) shall be above 96% at 100% load and above 95% in the 100% to 50% load range. The efficiency of the VSD converter must be at least 99%. Efficiency evaluation shall include input transformer (if applicable), harmonic filters (if applicable), and power factor correction (if applicable), VSD converter and output filter, as indicated below.
- Maintain minimum 0.95 power factor, from between 30% to 100% of rated speed.
- Total harmonic distortion (THD): Less than 5% on linear and non-linear loads.
- Degree of protection for LV VSD's: Minimum IP20.
- Full Type 2 co-ordination, with in-line contactor and with thermal overload where applicable.
- At ambient temperature from 0^{o} C to 40^{o} C without derating. Operation up to 60^{o} C should be possible with a maximum derating of 0.8% for every ^{o}C. Capability to be in an environment with a relative humidity of up to 93% without condensation.
- In altitudes of up to 1000 m. For higher altitudes, derating shall not be more than 2.2% for each additional 100 m.
- The system shall have standard load starting capabilities, i.e. 10 start times per hour at ambient temperature of 40^{o} C without the need of an auxiliary fan.
- Starting current limitation, adjustable from 150% up to 700%, depending on the load requirement.
- All VSD units are to be full duty cycle rated with internal bypass.
- All VSD's shall be provided with a common choke, if so required by the OEM, to provide common mode voltage protection.
- The VSD's shall be pre-set at the factory to have the capability to start, operate and protect the motor and unit without any adjustment for standard motor ratings.
- The VSD shall have the necessary functionalities to allow modification of the required parameters to be made on Site.
- Built-in facility to drive both variable and constant torque motors, without the need for any changes to the unit.

ii. Minimum Main Settings

- Setting current.
- Ramp time during start.
- Ramp time during stop.
- Initial/end voltage.
- Current limit.
- Torque control for start.
- Torque control for stop.
- Kick start.

iii. Minimum Interface/Data Display Requirements

The VSD unit shall be provided with the minimum features for the operator interface as listed below. Data shall be provided in a 4-digit, 7-segment LCD HMI display (English) with 2 selection keys and 2 navigation keys and with a resolution of at least ±0.01% and an accuracy of 1%. The minimum data to be displayed is:

- Input current in Amperes.
- Output current in Amperes.
- Input voltage in Volts.
- Output voltage in Volts.
- Input frequency in Hertz.
- Output frequency in Hertz.
- Motor power factor.

- Motor active power.
- Total 3 phase kW output.
- Motor torque/load.
- Motor thermal status.
- Motor operating time.
- Phase rotation direction.
- Last fault detected.

The HMI display for LV VSD's shall be face-plate mounted.

iv. Minimum Warning Provisions

- Current underload warning.
- Current imbalance warning.
- Voltage imbalance warning.
- Thyristor, IGBT, IGCT, SCR overload warning.
- Electronic overload time-to-trip.
- Short circuit warning (for limp mode).
- Over voltage warning.
- Under voltage warning.
- Power factor underload warning.
- Locked rotor warning.
- Faulty fan/VSD temperature warning.
- THD (U) - total harmonic distortion warning.
- Motor runtime limit warning.
- Phase loss warning (for standby).
- EOL warning.

v. Minimum External Fault Detection

- Power supply failure.
- Low control supply voltage.
- Phase loss.
- Current underload warning.
- Overload current.
- Lock rotor fault.
- Prolong starting fault.
- Motor thermal fault detected by PTC.
- Starter overheated.
- Line frequency out of tolerance.
- Control line failure.
- Faulty usage (e.g. using limp mode inside-delta).
- Faulty connection/serial link fault.
- Bad network quality.

vi. Minimum Internal Faults Detection

- Thyristor, SCR, IGBT, IGCT and the like overload.
- Short circuit.
- Open circuit thyristor or gate.
- Heat sink over temperature.
- Shunt fault.

vii. Minimum PTC Inputs

- Switch-off resistance: 2825 ohm ± 20% (unless otherwise required by OEM).
- Switch-on resistance.

viii. Power Quality Metering

Power quality metering shall be incorporated in the VSD system to continuously monitor and display input and output power quality. This shall allow easy customer-verification of power quality and efficiency of the VSD system. The power quality data shall include the following:

- Input and output voltage (average rms value).
- Input and output current (individual phase rms values and average rms value).
- Input and output frequency.
- Power factor.
- kW, kVAr.
- kWHr.
- THD (average of 3 phases).
- Calculation of total input current or voltage harmonic demand distortion.
- Drive efficiency.
- Motor voltage (rms).
- Motor current (rms).
- Motor speed (in RPM or %).
- Motor flux (%).
- Motor torque current (%).

ix. Operating Envelope

VSD's shall meet the following minimum speed and torque requirements:

- The VSD's shall be capable of producing a variable AC voltage/frequency output to provide continuous operation over the normal system 30-100% speed range.
- The VSD's shall be capable of operation at 1/10 speed, to facilitate checkout and maintenance of the driven equipment.
- The VSD power circuit shall be capable of operating without a motor connected to the VSD output.
- All VSD systems shall be of the 2 quadrant type.
- No regenerative power absorption/braking facilities are required. The VSD's shall have built-in protection for the aforementioned.
- The VSD's shall be capable of operating any standard AC motor of equivalent rating (horsepower and speed) over the specified speed range.
- The VSD shall be able to produce any specified torque at any speed within the operating range (variable and constant torque capability).
- If high breakaway/starting torque is required, the VSD shall provide full-rated torque at breakaway.

The VSD shall have overload provision capabilities and protection, including in particular transient over torque/breakaway torque. The setting limit shall be up to 200% of nominal torque rating, unless otherwise specified.

x. Harmonics

VSD's shall comply with IEEE 519 and further applicable regulatory standards for total harmonic (including current and voltage) distortion, calculation and measurement. Distortion limits shall be met without causing the VSD to operate at a leading input power factor of 30% to 100% of rated speed.

Voltage harmonics for individual or simultaneous operation of the VSDs shall not add more than 3% total harmonic voltage distortion while operating from the utility source, or more than 5% while operating from standby generator (if applicable).

Total harmonic current distortion limits for each individual VSD shall not exceed 5%, as calculated and measured at the point of common coupling, defined as the input connection of each VSD.

Total harmonic distortion (THD) for low voltage VSD's shall be < 5% for linear and non-linear loads.

The VSD converter section shall be 18 or more pulse to eliminate the need for harmonic filters. Where a standard VSD cannot achieve this requirement, built in automatic harmonic and power factor correction shall be included.

Compliance shall be verified by the VSD OEM, which shall include measurements without the VSD's operating. The VSD OEM shall be responsible for any additional equipment that is needed to attain compliance.

xi. Motor Compatibility

The VSD systems shall provide an output wave form that will allow utilization of standard motors, without the need of any special insulation or de-rating. Motor life expectancy may not be compromised in any way by the operation of the VSD system. The system shall comply with all elements of the harmonics requirements of this specification. The VSD shall provide motor overload-protection under all operating conditions.

The VSD output wave form shall be suitable for operating a squirrel cage induction motor without de-rating or requiring additional service factor.

To ensure that there are no problems due to motors overheating, the VSD output current wave form, as measured at the motor, shall be inherently sinusoidal at all speeds with a total harmonic current distortion of less than 3% when referenced to the full load output current fundamental between 10% and 100% speed. VSD's utilizing output transformers are not acceptable.

The system design shall not have any inherent output harmonic resonance within the operating speed range. The VSD output shall produce no electrically-induced pulsating torques, which could cause a resonance in the mechanical system.

Should individual torque pulsation frequencies for VSD other systems be in excess of 1%, the VSD manufacturer shall perform a torsional analysis.

All VSD's shall inherently protect motors from high-voltage $\delta v/\delta t$ stress, independent of the cable length to the motor. The VSD's shall not require non-standard insulation systems or insulation ratings above the VSD output voltage rating.

The VSD system shall be designed to produce no standing waves or over-voltage conditions for cable lengths shorter than 2 200m. If the VSD requires an output filter to meet this requirement, it shall be an integral part of the VSD system.

No integral input transformers will be required for the VSD, unless specified otherwise.

xii. System Input Power Factor

All VSD systems shall maintain a 0.95 minimum power factor from between 30% to 100% of rated speed. VSD systems that include power factor correction and/or harmonic filter (if applicable) shall under no circumstances have a leading power factor under utility or generator operation (if applicable). The VSD's OEM shall supply a power factor correction system, if required, to meet this requirement.

Any power factor correction units shall include a separate input isolating contactors with fuses, power factor correction grade capacitors (voltage class shall be consistent with the VSD system input voltage) and series harmonic de-coupling reactors, all integrated into the VSD system.

For VSD systems employing a capacitive input filter, an electrical system analysis shall be performed by the VSD OEM to ensure that the VSD does not create a leading power factor or a resonant condition while operating on utility or back-up generator (if applicable) power. This analysis shall be submitted to, and be subject to approval by the *Employer* prior to the placement of orders for these units.

xiii. Speed Regulation

VSD control system speed regulation shall be ±0.5% without encoder or tachometer feedback.

xiv. Design Calculations

If torsional rotational analysis is required, the total rotating system shall be analysed to determine its natural resonant frequencies. Stresses shall be calculated for elements of the rotating system, utilizing torsional excitation data from the drive and driven system, taking into account potential fault conditions and appropriate amplification and damping factors of the rotating system.

A written report shall be compiled on the analysis, which shall detail the procedures used and the assumptions that were considered. The results of the analysis shall be presented in both detailed and summary form. Specific data to be presented shall include the following:

- A diagram of the frequencies of the torque pulsations and the mechanical resonant frequencies, showing their coincident points.
- A plot of total shaft stress versus operating speed for the most highly stressed areas of the rotating system.
- A diagram of the rotating system model and mode shapes for resonance(s) of interest.
- Tables summarizing total calculated stresses for each element of the rotating system at operating speeds where interference(s) exist between torsional excitations and torsional resonance.
- Details of the rotating system used in the analysis, including the specified or a recommended alternate coupling.

6.15.3 Availability

i. Firing Signals

All internal firing signals and other communications with power components, such as the status and diagnostic signals, must meet noise immunity and safety requirements as defined in these specifications and applicable regulatory standards.

ii. Failed Power Electronic Ride-Through Capability

If power-electronic bypass features are included, the failure of any power switching device (SCR, diode, IGBT, IGCT, etc.) in both the converter and inverter sections and/or switching device control circuitry shall not result in a process trip and shall allow for continued operation of the VSD system.

In the event of a device or device control failure, the VSD shall annunciate and identify the specific location of the failed device and allow for continued operation until such time as repairs can be scheduled. The feature shall be demonstrated and documented during the factory acceptance testing of the VSD system.

iii. Power Interrupt Ride-Through:

The VSD's shall meet the following minimum requirements:

- The VSD system must be capable of continuous operation in the event of a power loss of a minimum of 5 cycles.
- The VSD system must be capable of automatically restarting in the event of a momentary loss of power.
- The VSD system shall provide the user with the choice of automatically restarting or not. A safety device (hard key and password) must be available to allow enabling, disabling, and setting changes to this feature only by authorized personnel.
- The user shall be able to selectively apply this feature and have the ability to set the allowable restart time applicable to some (but not necessarily all) conditions as determined by the *Employer*, to be appropriate for the specific application.

iv. Power Sag Ride-Through:

The VSD's shall be capable of maintaining continuous operation with 35% voltage sag on the input power line. If the input voltage sags below 65% of its rated value, the VSD shall absorb the minimum required power from the (rotating) motor in order to maintain the DC link bus (if incorporated) voltage at nominal value.

Such operation shall be maintained as long as the voltage is absent (or below 65%). If enabled, the control shall monitor the motor flux (both magnitude and phase) as it decays, based on the motor open circuit time constant. If the drive is restarted and the motor flux is still above 4% of rated value, the drive shall re-magnetize (if applicable) the motor and follow the speed ramp without any delay.

v. "Catch-A-Spinning-Load" Capability:

The VSD system must be able to catch and take control of a spinning load at any speed if started while rotating equipment is already spinning in a forward direction. Appropriate safeguards must be included in this operation to prevent damaging torque(s), voltages or currents from impacting any of the equipment.

When power is restored after a complete power outage, the VSD shall also be capable of catching the motor while it is still spinning in a forward direction and restoring it to proper operating speed without the use of an encoder.

The *Employer* shall have the option of employing this feature or disabling it. This option shall be hard-key and password protected to avoid unwanted changes by unauthorized personnel.

vi. Auto-Restart Capability:

The VSD system must be capable of automatically restarting in the event of a process or drive trip. The VSD system shall provide the *Employer* with the choice of automatically restarting or not. The user shall be able to selectively apply this feature to all conditions.

This option shall be hard-key and password protected to avoid unwanted changes by unauthorized personnel.

vii. Ground Faults:

In the event of an input or output ground fault, the VSD shall be capable of annunciating the ground fault condition and continue to safely operate until such time that the protection system comes into effect and clears the fault.

6.15.4 Serviceability and Maintainability

i. Front Access

VSD systems shall preferably be designed for front access only. The VSD manufacturer shall state in their proposal whether rear or side access is required. An explanation of the reasons and specified distance for any required rear or side access shall be given.

ii. Power Component Accessibility

All power components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime. Alternate access options may be proposed for review and approval by the *Employer*.

Systems that employ a single integrated power conversion module that is not repairable on Site, or systems that are not readily accessible by Site maintenance personnel, are not acceptable.

iii. Voltage Isolation

VSD's shall be constructed so that different voltage level components, circuits, wiring, cabling and the like are completely isolated from each other and shall include, where applicable, physical barriers.

iv. Mean Time To Repair (MTTR)

In the event of a power electronic failure, removal and replacement should take an average of 20 minutes, after capacitors (if applicable) have discharged and safe working conditions have been established.

6.15.5 Physical Requirements

i. Heat Dissipation/Cooling System

Low voltage VSD's shall not be air-forced cooled, but shall be designed with suitable heatsinks to provide proper and adequate heat dissipation, as the low voltage VSD's will be located inside panels/enclosures.

The VSD OEM shall provide heat dissipation data, including information necessary for the design of any HVAC systems (if applicable), which is to be installed by Others, if so required.

ii. Enclosure

Any ventilated panels/enclosures shall have cleanable filter media covering all air inlets. Inlet air filters shall be 100% washable with a corrosion-free media. Filters shall be front replaceable (for cleaning) while the VSD is in operation, without exposing maintenance personnel to any of the power components.

Where VSD's are in panels/enclosures, the aforementioned shall be constructed so that different voltage level components, circuits, wiring, cabling and the like are completely isolated from each other and shall include, where applicable, physical barriers. Microprocessor and control logic boards and their power supplies shall preferably be safely accessible without exposure to possible high voltages and without drive shutdown.

iii. Installation/Cabling

All VSD systems wiring (power, control, and protection) shall be located internally within the enclosures they are installed in. All external power and communications cabling and conductors shall be as per the drawings, bill of quantities and all other associated contract documentation.

iv. Interlocks

Where the VSD OEM or *Employer* deems it necessary to have appropriate mechanical key interlocks, these shall be provided as a minimum on all doors/front panels/face plates. Interlocking shall be fully coordinated to prevent access to all danger voltage level compartments including transformers (if applicable), filters or any switchgear that is part of the supply when line power is applied to the VSD system. Interlocks must be mechanical to provide positive lock-out prevention and safety.

If the above is incorporated, electrical interlocks shall also be provided and shall be integrally connected to the mechanical interlock for lock-out procedures and maintenance purposes. The entire interlocking system shall be designed so as to allow maintenance personnel to locally override the plant operator/authorised person (if applicable) at the CCR and/or Engineering Control Station, once the electrical command has been issued by the plant operator/authorised person to do so, during maintenance duties. These systems shall not void any other mandatory interlocking systems.

The VSD's shall be provided with hard-wired and programmable facilities for manual operations to be completely locked out and put into function only by the plant operator/authorised person (if so required), with fail-safe measures to ensure that total control vests solely with the operator/authorised person (if applicable) at the CCR and/or Engineering Control Station. Remote/local switches to facilitate this operation in a safe manner shall also be provided.

All interlocking systems shall be 'fool proof'/'fail safe', and in strict accordance with relevant statutory regulations and standards, industry best practices and guidelines.

6.15.6 Protective Devices/Diagnostics

i. Drive Input Protection

VSD system software shall include protective functions, which shall detect abnormal conditions due to an internal sub-component failure(s). Protective functions shall as a minimum include:

- Excessive input reactive current detection (one cycle protection).
- Excessive drive losses protection.

ii. Power Component Protection

VSD's shall include Distribution Class 2 surge arrestors to protect the unit against voltage surges. Where applicable, the VSD system shall include power fuses on the input to the converter devices. The VSD shall preferably have a fuseless design.

iii. Minimum Motor/Main Protection

- Starting Protection: Programmable tripping curves, equivalent to IEC 60947-4-1 thermal protection Class 2, 10A, 10, 15, 20, 25 or 30 for different type of operation duty, shall be provided.
- Electronic overload and thermal protection.
- Dual overload (separate overload for start and run).
- PTC connection.
- PT-100 connection.
- Locked rotor/motor stall protection: The monitoring limits for stall frequency (speed) and stall time shall be settable by the user. The user shall also be able to select whether the stall function is enabled and whether the converter responds with an alarm or a trip when a stall is detected. If the motor reaches 5 times the rated current or higher, the VSD shall shut down within the time specified by the *Employer*.
- Current underload protection.
- Overspeed.
- Current imbalance protection.
- Power factor underload protection.
- Under voltage protection (input and output of VSD).
- Over voltage protection (input and output of VSD).
- Voltage imbalance protection.
- Earth fault protection / ground fault protection.
- Phase reversal and single phasing protection (input and output of VSD).
- 24 V output protection.
- Frequency range protection.
- Bypass open protection.
- User defined protection.
- Too long current limit protection.
- HMI failure protection.
- Fieldbus/communications failure protection.
- Extension I/O failure protection.
- Max number of starts/hour.
- Too long start time protection.
- Thermal memory: Shall be capable of memorising the thermal status of the motor at the events of the loss of power at the incoming or control supply. Thermal condition of motor shall be modelled according to time event during loss of control supply.
- Time between starts: Shall be capable to recognise that a previous stop command was activated and will only restart the motor after a pre-set delay. This delay shall be adjustable between 0 to 999 minutes.

iv. Minimum VSD Protection

- Withstand minimum up to 13 times of rated current for 20 ms.
- Built-in thermal protection.
- Protection against micro interrupt < 200 ms to minimise tripping due to voltage dips.
- FAN failure where applicable.
- Preheating capability (where applicable) when motor not running.
- Short circuit of the inverter and other internal circuitry.

v. Minimum Mechanical Protection

- The system shall detect and provide for possible low load torque, to include an alarm or shut down of the VSD in such an event. Current detection is not acceptable.
- The system shall provide linear deceleration in order to eliminate water hammer in the case that a water pump is used.
- Shall provide self-adapt long staring time in case of high inertia fan loading.
- On load and off load starting.
- The system shall provide detection of phase rotation, to avoid operation in wrong direction in case of supply sequence change, especially in the case of a generator supply.

vi. I/O Control Points

The VSD's shall be designed to provide, as a minimum, the following I/O's for surveillance and protection purposes:

- Relay outputs for safety interlock.
- Relay output for end start-up.
- Relay outputs for hard-wire protection functions to other protection equipment, i.e. circuit breakers, contactors and the like.

- Digital and analogue inputs/outputs for:
  i. Motor thermal/winding temperature alarm/protection.
  ii. Motor powered.
  iii. Motor current alarm/protection.
  iv. Motor underload alarm/protection.
  v. Motor PTC alarm/protection.
  vi. Second motor parameter selected.
  vii. Bearing temperature alarm/protection.
  viii. Oil temperature alarm/protection (if applicable).
  ix. Low oil alarm/protection (if applicable).
  x. Motor vibration alarm/protection.
  xi. Input shaft speed monitoring/alarm/protection.
  xii. Output shaft speed monitoring/alarm/protection.
- 2 logic input for start/stop control.
- 2 additional logic inputs for:
  i. Forced freewheel.
  ii. External fault.
  iii. Motor preheating.
  iv. Force to local control.
  v. Inhibit all protection.
  vi. Reset motor thermal fault.
  vii. Activation of cascade function.
  viii. Reset of faults (that can be reset).
  ix. Activation of second set of motor parameters.
- Analogue outputs for motor current and motor torque, motor thermal state, power factor and the like.
- 1 PTC/PT input for motor PTC/PT thermal protection.
- 4 additional digital/analogue inputs and outputs respectively for additional other on-board motor protection.

Responsive action to motor winding temperature detectors or thermostatic switches is required for motor protection.

The VSD system shall be protected from damage arising from the following, without requiring an output contactor:

- Single-phase fault or 3-phase short circuit on VSD system output terminals.
- Power device failure to commutate/switch due to severe overload or other conditions.
- Loss of input power due to opening of VSD input disconnecting device or utility power failure during VSD operation.
- Loss of one phase of input power.
- Induction motor regeneration due to backspin or loss of VSD input power.

The VSD shall be able to withstand the following fault conditions without damage to the power circuit components:

- Failure to connect a motor to the VSD output.
- VSD output open circuit that may occur during operation.
- VSD input or output ground fault.
- VSD input or output single-phase.

The VSD's shall be provided with integrated controls to operate or trip an incoming power disconnect device.

vii. Additional external protection functions

The following additional external protection functions shall be provided:

- Process stop: It shall be possible to connect a process stop button or relay to a predefined input of the VSD.
- External emergency off: It shall be possible to wire the normally closed (NC) contacts of external emergency off switches into the tripping loop of the VSD.
- Alarm and trip levels values shall be settable on the VSD.
- VSD on-board emergency stop button.

viii. Other Functions

Other functions shall include:

- Real time clock.
- Event log and fault history.
- Emergency mode.
- Secure settings.
- Keypad password.
- Electronic overload time-to-cool.
- Runtime measurements for thyristor, SCR, IGBT, IGCT and the like.
- Auto phase sequence detection.
- Motor heating.
- Stand still brake.
- Voltage sag detection.
- Limp mode with two-phase motor control if one set of thyristors, SCR's, IGBT's, IGCT and the like are shorted.

ix. Diagnostics and Fault Recording

The control logic section shall be fully digital and shall not require analogue adjustment pods or fixed selector resistors. Fault log data storage memory shall be stored in non-volatile memory, which shall be configured so that it does not require a UPS supply to keep the data stored.

Each VSD shall, for the 50 most recent events, store all information as highlighted under the 'Minimum Warning Provisions', 'External Faults Detection', 'Internal Faults Detection' and 'Power Quality Metering' sections.

A Windows-based graphical tool suite shall be provided with the VSD. This graphical PC tool shall be able to plot and display the different VSD parameters and have the ability to freeze plotting and print hard-copy versions of the plots.

6.15.7 Component Requirements

i. Printed Circuit Boards

All printed circuit boards shall be new and shall be uniformly coated for moisture and chemical resistance, in addition to any dielectric coating properties.

ii. Power Bus and Wiring

The main power bus shall have high-conductivity and be plated for chemical and corrosion resistance and low losses. The bus shall be appropriately sized for the VSD continuous current rating and braced to withstand the mechanical forces caused by a momentary short circuit current.

All connections shall be bolted or continuously welded. Main grounding of the VSD system shall be via 600/1000V UV stabilised, insulated green/yellow copper earth wire (SANS 1507) of size suitable to the maximum electrical fault level rating that can occur at the VSD, unless otherwise specified. The earth wire shall terminate onto the main VSD, which shall be of the tinned type. Lugs for the wire shall also be of the tinned type.

iii. DC Link Inductors

DC link inductors, if required, shall be air core types to prevent saturation. Where applicable, separate inductors (split dual winding type) shall be provided in the positive and negative leg of the DC link to minimize stray magnetic fields. Inductors shall be Class H insulation (220° C insulation, 150° C rise) with over-temperature protection.

If inductors are used, the inductors shall be integral to the VSD system line-up, to minimize cabling costs. If it is not possible to integrate the inductors into the VSD system and enclosure, the cabling and connectors shall be supplied and installed on Site by the *Contractor*, subject to approval by the *Employer*.

Inductors shall be designed to prevent saturation under maximum fault current conditions.

iv. DC Link Capacitors:

If capacitors are used in the converter DC link, they shall be integral to the VSD system line-up to minimize cabling costs.

Capacitors used in the converter DC link shall contain discharge resistors and shall be capable of reducing the residual charge to 50 volts or less within 10 minutes after the capacitor is disconnected from the source of supply.

v. Input Harmonic Filters:

If harmonic filters are required to meet power factor requirements, they shall not adversely affect any associated data and communications cabling/wiring. The VSD OEM shall provide the filter, upstream filter isolation, protection and protection coordination.

The harmonic filter components shall be integral to the VSD system line up to minimize cabling costs, but shall be isolated from other components, so that they can be disconnected from the power source and accessed for maintenance/repair while the VSD is in operation.

Harmonic filters shall be located on the primary side of the VSD and be switchable with the VSD, to prevent the filter being operational in the event of a VSD trip, which could create a damaging leading power factor condition. The complete filter must have independent protection for over-current, phase differential and ground fault.

Capacitors used in harmonic filter banks shall in all cases be provided with a method of shorting the phases to ground once power has been removed and the capacitors have been discharged to a safe voltage level.

Any reactors shall, as a minimum, be iron-core with Class H (220° C insulation, 150° C rise) insulation and over-temperature protection. Reactors shall be designed to prevent saturation under maximum fault current conditions.

vi. Output Filters

If output filters are required to meet the output harmonics requirements of this specification or to meet any special requirements of the application, they must be fully incorporated into the VSD system design and added to the overall VSD line-up.

Where a potential exists for self-excitation between the output filter and the motor system, suitable, full protection measures (voltage and current) shall be incorporated into the VSD to prevent such an occurrence.

All reactors shall be iron-core with Class H (220°C insulation, 150°C rise) insulation and over-temperature protection. Reactors shall be designed to prevent saturation under maximum fault current conditions.

vii. VSD Integration

The *Contractor* shall be responsible for the final integration of the VSD's.

6.15.8 Programming and Communications

i. Serial Communication and Interface

The VSD shall be fitted with removable, “hot swappable” “smart slot” communications protocol(s) interface cards, to allow for the following:

- Profibus DP protocol communications.
- The connections/ports shall be as follows:
  i. RS-232 and RS-485 ports for the Profibus DP protocol communications.
- The unit shall be configured so that it can communicate with and be monitored and controlled (if applicable) via a PLC/RIO, SCADA or other control system.
- The software must also be operable with a handheld personal computer with Windows operating system.
- The VSD unit shall be programmable with an optional PC based software package via a serial/USB port located on the unit. The software shall operate on any standard, compatible personal computer or laptop installed with Windows operating system.
- The configuration software shall allow and enable interrogation and modification of all parameters accessible within the unit.
- A facility shall be provided to store files and print records of the operating parameters.
- The configuration software shall allow control of the VSD unit following a set of verification procedure(s).

The programming settings shall also be capable of being entered via the HMI interface keypad. The keypad shall allow the operator to enter exact numerical settings in standard engineering units. The programming settings shall be done by the *Contractor* on Site in conjunction with the *Employer*, motor manufacturer and specialist subcontractor/OEM, to be appointed by the *Contractor*, and shall incorporate the input requirements as specified by the *Employer*. The *Contractor* shall make suitable allowances for these interactions in order to obtain the correct settings for the specified application and associated motor.

6.15.9 Testing

The testing and commissioning of the units shall be in accordance with all applicable IEEE, IEC and further applicable standards. The *Employer* may at his discretion instruct the *Contractor* to perform additional tests and/or provide additional information as required to prove the functionality and compliance of the units. Allowances shall be made by the *Contractor* in the scheduled rates included in the bill of quantities for such tests.

6.15.10 Labelling

All VSD’s, associated equipment, circuits and cabling/wiring shall be labelled and numbered. Labelling of the VSD’s and equipment, such as circuit breakers, contactors, fuse holders (if applicable) and the like, shall be by means of suitably sized Traffolyte labels, which shall be permanently fastened.

All cables and wiring shall be labelled/numbered in accordance with the requirements stated under the sections of these specifications titled ‘LV Cables’ and ‘LV Conductors’, as well as per Doc No 1924701-2-300-E-SP-0010 for communications cables and the like, as applicable. The schematic drawings shall be updated accordingly to include the labelling/numbering of the circuits.

6.16 UPS and Batteries

6.16.1 General

This section describes the requirements for three-phase, on-line double conversion technology, continuous operation, solid-state uninterruptible power supply (UPS) units. The UPS shall operate as an active power control system, working in conjunction with the main electrical system (i.e. inverter section incorporated), to provide continuous and online power to critical loads. The ratings of the UPS' are shown on the drawings and in the bill of quantities.

These specifications do not cover paralleling of UPS's and include only single stand-alone supply source units. The units are not to be paralleled.

The UPS system shall be a fully integrated unit, except for the additional backup batteries, which shall also be supplied and installed as a completely assembled and wired unit. The *Contractor* shall appoint a specialist subcontractor/OEM as applicable to undertake the complete design, supply, installation and commissioning of the new UPS and associated battery equipment/systems.

The aforementioned shall also include, but not be limited to, any programming (where applicable) of the units and complete integration of the equipment/systems with the respective main electronic monitoring and control infrastructure (data network), and any other local systems as required. The procedures governing the design approval, manufacturing, inspections, testing and commissioning of the equipment/ systems are covered in further sections of these specifications.

It will be the responsibility of the *Contractor* to ensure that the specialist subcontractor/OEM fully co-operates, co-ordinates and furnishes any technical support plus associated technical information to Others as required, to ensure that the UPS systems are fully and correctly electrically and electronically integrated.

All UPS's shall comply with the minimum requirements as set out below:

6.16.2 Operational Requirements

The UPS shall be designed to provide regulated and conditional sinusoidal (AC) power as well as direct current (DC) power to both linear and nonlinear protected type loads, using online double conversion technology as per IEC standards. The UPS shall provide uninterruptible power during all modes of operation.

The UPS shall incorporate the following modes of operation:

i. *Normal*

The inverter and the rectifier shall operate in an on-line manner to continuously regulate the power to the critical loads. The rectifier shall derive power from the AC input source and supply DC power to DC loads and float charge the batteries etc.

ii. *Battery*

Upon failure of the AC input source, the critical loads shall continue to be supplied by the main inverter without any switching. The inverter shall obtain its power from the batteries. There shall be no interruption in power to the critical load upon failure or restoration of the AC input source.

iii. *Recharge*

Upon restoration of the AC input source, the UPS shall simultaneously recharge the batteries and regulate the power to the critical loads.

iv. *Static Bypass*

The static bypass switch shall be used for transferring the critical loads to input supply without interruption. Automatic re-transfer to normal operation shall also be accomplished with no interruption in power to the critical loads. The static bypass switch shall be fully rated and shall be capable of manual operation as well. The UPS shall be able to recharge the batteries while supplying the full power to the loads via the static bypass switch.

v. Internal maintenance bypass switch

The UPS shall be provided with internal bypass switches for supplying the loads directly from the mains supply, while safely isolating the UPS for maintenance purposes. These switches shall also completely and safely remove any externally or internally connected batteries during maintenance activities. The switches shall be removable and lockable.

6.16.3 Technical Requirements

The UPS shall have an integrated protective 3-phase circuit breaker on the output, of the correct amperage and fault level rating, which shall be correctly coordinated with the main circuit breaker supply from the main low voltage DB board, as well as the main circuit breaker in the UPS. This circuit breaker shall also be of the cascading type, as for the rest of the low voltage switchgear.

Additional circuit breakers shall be provided for other outputs as and if required, and shall also be of the cascading type. For DC supplies, the circuit breakers shall be of the double pole type.

The UPS nominal input ranges shall be:

- Voltage : 304-477 VAC 3 phase (adjustable).
- Frequency : 40-70 Hz (auto sensing).
- Input power factor : 0.98 for load > 50%.
- Earthing principle : [TN-S].
- Total Harmonic Distortion (THD) : < 5% at 100% load.

The UPS nominal output ranges shall be:

- AC output voltage rating : 400 VAC 3 phase / 3 x 231VAC 1 phase (adjustable).
- Direct Current Output voltage rating : 24 VDC and 110 VDC (adjustable)
- Earthing principle : [TN-S].
- Output voltage regulation for steady state and transient variations (at default parameter settings):

  i. ± 1% steady state for a static 100% balanced load.
  ii. ± 1% steady state for a static 100% unbalanced load.
  iii. ± 5% for a 0 to 100% load step.

- Max. Voltage transient recovery time: 100 ms milliseconds to nominal.
- Output frequency regulation synchronized to mains over the range of:

  i. 47-53 Hz in normal operation.
  ii. 50 Hz ± 0.1 Hz in battery operation.

- Output voltage harmonic distortion:

  i. <2% THD maximum and 1% single harmonic for a 100% linear load.
  ii. <5% THD maximum for a 100% non-linear load.

- Overload capability:

  i. 150% for 1 minute in normal operation.
  ii. 125% for 10 minutes in normal operation.
  iii. 110% continuous in bypass operation.
  iv. 800% for 500 milliseconds in bypass operation.

- Phase displacement:

  i. 20 degrees ± 1 degree for balanced load.
  ii. 20 degrees ± 1 degree for 50% unbalanced load.
  iii. 20 degrees ± 3 degrees for 100% unbalanced load.

- Output power factor rating: For loads exhibiting a power factor of 0.5 leading to 0.5 lagging, no de-rating of the UPS shall be required.
- Short circuit withstand: The UPS must withstand a full 3 phase bolted short circuit fault on the output without damage to the UPS unit.

- System AC-to-AC efficiency >95.3% for loads greater than 100% of system load.
- System AC-to-AC efficiency >94% for loads greater than 50% of system load.
- Acoustic noise: dB(A) of noise, typically, measured at 1 meter from the operator surface shall be less than 52 dBA.

The UPS shall be fully integrated, to comprise of the power section, bypass static switch, any internal batteries, interface LCD display unit and all other accessories. The UPS and battery enclosures/cabinets shall be equipped with removable lifting eyes, rated to adequately handle the load of the units. All service and installation accesses shall be as per the manufacturer's design and relevant statutory regulations and standards.

The entire UPS system, including the batteries with associated cabinet(s), shall be designed to effectively operate in the Site conditions and environment as described in these specifications, without any deficiencies. Dedicated service to one specific environment shall not be acceptable.

The UPS shall permit user-installable and removable battery units.The batteries and the associated circuitry requirements shall be as follows:

- The batteries shall be rated to a supply capacity of 2 hours, as per the drawings and bill of quantities, on 100% load.
- Batteries shall be of the fully sealed, low maintenance, deep discharge cycle gel type, with minimum rated lifespan of 15 - 20 years standby mode and 3000 full operating cycles. The maximum allowable discharge of the battery shall be to 80% capacity rating of each respective battery, unless otherwise required or specified by the OEM.
- The battery cabinet/enclosure shall be of modular construction design, to consist of removable battery modules for ease of battery replacement.
- Each battery module shall be monitored to determine the highest battery unit temperature for use by the UPS battery diagnostic and temperature compensated charger circuitry.
- Battery charge current limit: The UPS shall be capable of limiting the energy sourced from the mains for purposes of battery charging. As a default setting, the battery charge energy shall be set to 100% of its nominal value. When signalled by a dry contact, such as from an emergency generator, the UPS shall be capable of limiting the battery charge energy taken from the mains. This shall take place in user-selectable increments of 75%, 50%, 25%, 10% and 0% of the nominal charge power. The selection shall be made from the UPS front panel display/control unit.
- The battery charging circuit shall remain active when in static bypass and in normal operation.

The external battery cabinet(s) shall also be provided with removable and lockable switches for safely isolating the batteries from the UPS and mains supply during maintenance.

A microprocessor LCD controlled display unit, including all controls, alarms and the like, shall be located on the front of the system. The display shall consist of an alphanumeric display with backlight, an alarm LED and a keypad, consisting of pushbutton switches.

The following minimum metered data shall be available on the alphanumeric display:

- Year, month, day, hour, minute, second of occurring events.
- Input AC voltage.
- Output AC voltage.
- Output AC current.
- Output DC voltages.
- Output DC currents.
- Power factor.
- Input frequency.
- Battery voltage.
- Highest internal battery temperature.

The display unit shall allow the user to display an event log of all active alarms and of the 64 most recent status and alarm events.

The following minimum set of alarm conditions shall be available:

- Static bypass switch on.
- EPO Active.
- Mechanical bypass activated.

- External bypass switch(es) activated.
- Battery discharged.
- Return from low battery.
- Low battery.
- Load not powered from UPS.
- UPS in bypass.
- Runtime calibration aborted.
- Runtime calibration started.
- Runtime calibration complete.
- Battery self-test aborted.
- Battery self-test started.
- Battery self-test completed.
- Number of battery modules decreased.
- Number of battery modules increased.
- Fan fault.
- SBS fault.
- System not in sync.
- Bypass not available, frequency/voltage out of range.
- Mains voltage/frequency out of range.
- Site wiring fault.
- Low battery voltage shut down.
- XR battery breaker or fuse open.
- Defective battery detected.
- Runtime is below alarm threshold.
- Load is above alarm threshold.
- Battery over-voltage warning.
- Battery over-temperature warning.
- Emergency power supply fault.
- Output overloaded.

The following minimum controls or programming functions shall be accomplished by use of the display unit.

- Pushbutton membrane switches shall facilitate these operations.
- Silence audible alarm.
- Set the alphanumeric display language.
- Display or set the date and time.
- Enable or disable the automatic restart feature.
- Transfer critical load to and from static bypass.
- Test battery condition on demand.
- Set intervals for automatic battery tests.
- Adjust set points for different alarms.
- Program the parameters for remote shutdown.

The UPS front panel user interface shall, as a minimum, include the following:

- UPS outputs.
- On Battery: When yellow, this LED indicates the UPS is running from battery power.
- Bypass: When yellow, this LED indicates the load is being supported by static bypass/mechanical bypass.
- Fault: When red, this LED indicates there is a fault condition present in the UPS.
- Push button user controls.
- Up Arrow.
- Down Arrow.
- Help Key.
- Escape Key.
- Enter Key.
- Potential free (dry) contacts.

The following minimum potential free contacts shall be available on a relay interface board:

- Normal operation.
- Battery operation.
- Bypass operation.
- Common fault.
- Low battery.
- UPS off.

For the purposes of remote communications and associated monitoring (and control where applicable) via PLC/RIO, SCADA and the like, the UPS shall be able to provide all information electronically, via communications protocol(s) as specified on:

- Metered data.
- All active alarm statuses, including event logs and recent.

The UPS shall be fitted with removable, “hot swappable” “smart slot” communications protocol(s) interface cards, to allow for the following:

- Profibus DP protocol communications.
- The connections/ports shall be as follows:
  i. RS-232 and RS-485 ports for the Profibus protocol communications.

The programming settings shall be done on Site in conjunction with the *Employer* and specialist subcontractor/OEM. A USB port for PC download shall also be provided. The *Contractor* shall make adequate allowances for these interactions.

6.16.4 Labelling

All UPS, associated equipment, circuits and cabling/wiring shall be labelled and numbered. Labelling of the UPS and equipment, such as circuit breakers, contactors, fuse holders (if applicable) and the like, shall be by means of suitably sized Traffolyte labels, which shall be permanently fastened.

All cables and wiring shall be labelled/numbered in accordance with the requirements stated under the sections of these specifications titled ‘LV Cables’ and ‘LV Conductors’, as well as per Doc No 1924701-2-300-E-SP-0010 for communications cables and the like, as applicable. The schematic drawings shall be updated accordingly to include the labelling/numbering of the circuits.

6.16.5 UPS Loads

The *Contractor* shall confirm the respective UPS loads to ensure that the selected UPS sizes are adequate for the application before ordering and building of the units.

6.17 Fire Detection System

6.17.1 General

This section describes the requirements for the new fire detection systems that are to be installed at the new substations buildings. The *Contractor* shall appoint a specialist subcontractor/OEM as applicable, to undertake the complete design, supply, installation and commissioning of the new fire detection systems.

This shall also include, but not be limited to, any programming (where applicable) of the units and complete integration of the equipment/systems with the respective main electronic monitoring and control infrastructure (data network), access control and any other local systems as required. The procedures governing the design approval, manufacturing, inspections, testing and commissioning of the equipment/systems are covered in further sections of the specifications.

The *Contractor* shall ensure that the appointed specialist subcontractor/OEM fully co-operates, co-ordinates and furnishes any technical support and associated technical information to any Others as required, to ensure that the new fire detection systems are fully and correctly integrated, both electrically and electronically.

The fire detection system shall be designed to comply with a Category L1, P1 system, unless required otherwise by statutory regulations and standards and/or *Employer* requirements. Throughout this specification, where reference is made to a fire detection system, it shall imply a complete system, which shall include, but not be limited to, a central control panel and its associated local control panels, field devices, wiring and the like. Further reference shall be made to the drawings, bill of quantities and other associated contract documentation for any additional requirements.

The fire detection system shall consist of a central control panel, connected to field devices typically comprising local control panels, addressable and non-addressable units such as fire/smoke detection units, fire suppression panels, monitoring and control devices and annunciation devices located throughout the protected area.

The central control panels shall continuously monitor the statuses of all sensing and monitoring/control devices and initiate action when a fire or smoke condition is present. The central control panel shall make all decisions regarding the state of the system from the information received from each field device. The operation of the systems shall be field configurable from the central control panel via a keypad or Windows-based software, to suit the specific application and to permit future changes. This configuration shall be maintained under power failure conditions.

Local control addressable fire panels shall monitor and control the individual fire suppression rooms, detecting the room conditions and initiate the suppression procedure as well as communicating with the main panel to initiate further alarms and notifications.

The central control panel shall have a front panel, comprising of indicating LED'S, control keypad and backlit graphical LCD display. The LCD display shall indicate and detail each and every event which occurs in the system. The control panel shall be modular in design and operate as a stand-alone unit.

The local control addressable fire panels shall have a front panel, comprising of indicating LED'S, control keypad, backlit graphical LCD display, manual override and emergency stop buttons. The LCD display shall indicate and detail each and every event which occurs in the system. The control panel shall be modular in design and operate as a stand-alone unit.

The system shall correctly interface with at least the following:

- Main electronic monitoring and control (if applicable) infrastructure (data network), via PLC/RIO’s, for remote viewing (and where applicable control) on SCADA and the like.
- Access control system, and where required intruder alarm system.

For the purposes of remote communications and associated monitoring (and control where applicable) via PLC/RIO's, SCADA and the like, the fire detection system shall be capable of providing all information electronically, via communications protocol(s), with the following minimum details:

- "PANEL ON/OFF" details.
- "SYSTEM HEALTHY" details.
- "FIRE/FAULT" indication details.
- Self-monitoring details.
- Device status.

The above shall include event logs (history details) and recent/current statuses.

The fire detection systems shall be fitted with removable, "hot swappable" "smart slot" communications protocol(s) interface cards, to allow for the following:

- Profibus protocol communications.
- The connections/ports shall be as follows:
  i. RS-232 and RS-485 ports for the Profibus protocol communications.

The programming settings shall be done on Site in conjunction with the *Employer* and specialist subcontractor/OEM. The *Contractor* shall make adequate allowances for these interactions.

6.17.2 Standards

The fire detection system shall conform fully to South African standard SANS 10139 and European standard EN 54 (all applicable parts) and other relevant standards and specifications as applicable.

The panels shall be designed, manufactured and supplied in accordance with relevant IS0 9001 standards and further statutory regulations, standards and specifications, as applicable.

6.17.3 Fire Control Panels System Operation

The system shall be designed so that only minimal operator training is required. Basic fire alarm functions shall be completely self-explanatory. The occurrence of a fire or fault alarm shall indicate all relevant test and zone information without operator intervention.

In a quiescent state the panel shall have the "SUPPLY ON" indicator illuminated and the "PROCESSOR RUNNING" indicator flashing. The LCD display shall show time and date as well as the loop alarm status.

The occurrence of a fire or fault signal, or a keyboard operation carried out by an operator, shall not inhibit or delay the receipt of additional alarms. Should any part of the system be isolated or placed in a test mode, an LED on the front of the panel shall illuminate to indicate an abnormal status. This condition shall be simultaneously indicated on the LCD display. The normal operation of all other devices shall not be affected in this state.

6.17.4 Access Protection

Access to the system shall be protected as follows:

i. Control Key

The control key shall enable or disable the keyboard and control keys of the panel.

ii. Access Codes

Access codes shall prevent unauthorised entry to the programming menus of the panel. Each menu shall have two different levels of access.

iii. Door Lock

The panel door lock shall prevent unauthorised access into the cabinet.

iv. Non-Volatile Memory Switch

The non-volatile memory switch shall prevent unauthorised or accidental changes being made to the system configuration data.

6.17.5 Self-Monitoring

The central and local control panels shall be designed and programmed to perform extensive automatic self-monitoring. If the control panels detect a fault, it shall result in a fault indication being given by means of a common fault LED.

The following minimum conditions shall be continuously monitored by the central control panel:

- 24 V Power supply fault (internal supply).
- Mains power failure.
- Low battery.
- Battery over-voltage.
- No battery connected.
- Alarm siren/strobe open circuit.
- Alarm siren/strobe short circuit.
- Extinguishing agent release actuator open circuit.
- Extinguishing agent release actuator short circuit.
- Watchdog time-out.
- Tamper switch.
- Memory lock/unlock.
- Event buffer full.
- No communication.
- RAM memory check.
- EPROM memory check.

6.17.6 Fire Alarm Display

Any fire or fault alarm shall initiate a display on the LCD showing the following minimum information:

- Type of alarm or fault.
- Loop number.
- Zone number.
- Sensor address.
- Type of sensor.
- Event number.
- Status.
- Number of alarms.
- Time and date.

6.17.7 Fire Alarm Operation

Any fire alarm shall initiate the following minimum operations:

- The common fire indicator and appropriate zone fire indicator (LED) shall illuminate.
- The LED on the alarmed detector(s) shall light.
- The event shall be logged in the system memory.
- Communicate with access control system to release automatic door closers and/or release magnetic door locks and the like, as applicable.
- The fire alarm shall override any fault condition displayed at the time of the alarm.
- Visual and audible alarms and extinguisher (if applicable) actuator outputs shall become active according to the immediate or delay parameters.
- Sirens/strobes will continue to operate (continuous tone) until silenced by inserting the control key and pushing the silence alarm button.
- In the event that visual/audible alarms and extinguisher actuator outputs have been deactivated by the silence alarm button, they shall automatically re-activate in the event of a subsequent fire alarm, unless specified or required otherwise for compliancy purposes.
- Coincidence, area and adjacent area devices shall operate as programmed.
- Communications to send a “FIRE/FAULT” signal, with associated details, to the SCADA system via the local PLC/RIO.

6.17.8 Fault Alarm Operation

Any fault alarm will initiate the following minimum actions:

- The system fault and appropriate zone fault indicator (LED) shall illuminate.
- The event shall be logged in the system memory.
- Visual and audible alarm and outputs shall become active according to the immediate or delay parameters and sound intermittently.
- Sirens/strobes will continue to operate (intermittent tone) until silenced by inserting the control key and pushing the silence fault button.
- Communications to send a “FIRE/FAULT” signal, with associated details, to the SCADA system via the local PLC/RIO.

6.17.9 System Extensibility

The system shall be modular in design and supported by appropriate software to enable the fire system to be configured exactly to the needs of each location.

System extension shall be by means of plug-in modules, automatically configured by the system.

6.17.10 System Capacity

The main control panel shall be capable of operating at least 4 fire zones and local control panels shall be capable of operating at least 3 zones. Each zone shall be capable of handling a minimum of 32 addressable devices, where applicable. These devices may be detectors, controllers, monitors and input/output units and the like.

6.17.11 Device Types And Cable

The central control panel shall support at least the following types of sensors and monitors:

i. Fire/Smoke Sensors

- Multi-sensor smoke/heat detectors (allows for different unit to be used).
- Optical smoke detectors (units for harsh, dusty environments to be used).
- Heat detectors (fixed and rate of rise, allows for different unit to be used).

ii. Monitoring Controllers

- Manual call points monitor incorporating an interrupt facility for fast response.
- Zone monitoring units.
- Loop isolators (for short circuit protection).
- Siren/strobe circuit controller.
- Switch monitor unit for monitoring normally open or normally closed contacts.

iii. Input/Output Devices

- Manual call point (break-glass unit).
- Manual gas release inhibit key switch.
- Relay interface unit for air-conditioning shut-down.
- Relay interface unit for fire damper closer.
- Relay interface unit for automatic door closer magnetic release.
- Relay interface for magnetic door lock.

iv. Device Identification

The central control panel and, where applicable, local control panels, shall automatically identify each device on the address line during initial start-up and record this information in memory. Thereafter the control panel shall poll the device types on every scan, and indicate a "Wrong Device" fault should a device be changed to an incorrect type.

v. Device Status

The central control panel shall poll all devices of the system within five (5) seconds. The analogue value shall be read and stored in memory on every scan. The status of a device, once polled, shall be assessed by the control panel, which will indicate the following minimum conditions:

- Fire.
- Pre-condition.
- Fault.
- Communication problem.
- Wrong device type.
- Device removed.
- Earth fault.
- Maintenance and device statistics as detailed.

vi. Alarm Threshold

The alarm threshold level of each analogue device shall be individually adjustable from the control panel. Four levels shall be available, each having a fixed, pre and fire alarm threshold.

vii. Automatic Compensation

The system shall automatically raise the alarm threshold of all devices as their quiescent analogue value increases as a result of environmental contamination.

When the maximum level of compensation is reached for a device, the panel shall indicate a "MAINTENANCE" condition for that specific sensor.

viii. Maintenance Conditions

Maintenance conditions shall be generated either by means of self-test, at pre-programmed times, or once maximum level of compensation has been reached.

ix. Alarm Verification

The control panels shall employ methods to eliminate false alarms from occurring. Alarm verification of automatic devices must be programmable on a zone by zone basis. Alarm verification shall be selectable as normal, one detector confirmed or two devices simultaneously in alarm.

Fire alarm response times shall be within the parameters indicated in EN 54 Part 2 and other applicable specifications and standards. The reporting of manual call points to the control panel shall be done on an interrupt basis. Once devices are in a precondition state, the scan rate shall be increased in order to decrease the reaction time.

x. Line Monitoring

The control panel shall monitor any loops for short-circuit, open circuit and physical removal of devices from the system. Faults of this nature shall be indicated visibly and audibly within the time period specified in EN54 Part 2 and other applicable specifications and standards.

xi. Memory Allocation

The control panel shall allow for the allocation of system memory to suit this specific application. The system memory shall be allocated to the following functions:

- Input/output programming, including Boolean logic.
- Text.
- Event buffer.

xii. Cabling

All devices shall be connected via the appropriate cabling/conductors, which shall include, but not be limited to, a combination of PH120 copper cable with a temperature rating of 830°C and flame and shock resistance for 120 minutes, hardwired I/O link cabling, Profibus DB cables and the like. All cabling/conductors shall be of the fire retardant, self-extinguishing, zero toxic emissions type.

Should normal LV conductors also be incorporated, they shall comply with the requirements as set out under the section 'LV Conductors' as set out in these specifications.

6.17.12 Signalling And Annunciation

Fire alarms and fault warnings shall be indicated visibly and audibly on the control unit. All visible indicators shall be LED's. The following colours shall be used for visible indicators:

- Red shall indicate:

  i. Fire alarms.
  ii. Transmission of signals to fire alarm routing equipment.
  iii. Transmission of signals to controls for automatic fire protection equipment.

- Yellow shall indicate:

  i. Fault warnings.
  ii. Disable conditions.
  iii. Zones in the test state.
  iv. The transmission of signals to fault warning routing equipment.

- Green shall indicate:

  i. Correct operation of power supply and microprocessor.

- Audible Alarms

  Audibly fire and fault signals shall be differentiated as follows:

  i. Fire - Continuous tone.
  ii. Fault - Intermittent tone.

External visual and audible alarms shall be activated as per the drawings and bill of quantities.

6.17.13 Panel Indicators

The central control panel shall, as a minimum, have the following LED's:

i. General Indicators

- Dual common fire.
- Common fault.
- Disable.
- Supply fault.
- System fault.
- Processor running.
- Supply ON.

ii. Control Indicators

- Silence buzzer.
- Disable.
- Test.

iii. Sounder Indicators:

iv. Sound ON

- Delay ON.
- Delay OFF.
- Fault/disable.
- Silence.

6.17.14 Panel Display

The central control panel shall, as a minimum, contain a backlit 128 x 64 graphical LCD display.

6.17.15 Panel Controls

The central and local control panel shall, as a minimum, have the following control keys:

i. General

- Alphanumeric keypad with navigation keys.

ii. Sounder

- Sound Alarms.
- Silence/Resound Alarms.
- Mute.
- Reset.

6.17.16 Outputs

i. General Outputs

The central and local control panels shall as a minimum provide the following general outputs. All relays shall be rated 1 A at 24 VDC.

- Common fire relay.
- Common fault relay.
- 2 x Programmable relay.

ii. Programmable Outputs

A minimum of 8 additional programmable output relays shall be supported by the panel.

iii. Data Outputs

The following data outputs shall be provided in the central and local control panels:

- RS-232 and RS-485 ports for Profibus DP communications.
- USB port for PC download.

iv. Programmable Inputs/Outputs

It shall be possible to program inputs and outputs from any of the following minimum sources:

- Panel inputs.
- Panel relays.
- Field I/O devices.
- System I/O devices.
- Inter-panel I/O by means of networking.

6.17.17 Programming

Programming shall be possible from the keypad at the front of the central control panel or by downloading data from the PC. All programming shall be menu-driven and protected by access codes and memory lock. The programming shall allow for at least the following functions:

- Programming of output relays.
- Programming of detectors.
- Programming of inputs/outputs.
- Uploading/downloading of configuration data.

One way of programming shall not exclude the other.

It shall be possible at all times to upload the stored programme to a PC in order to maintain updates.

6.17.18 Maintenance Functions

The central control panel shall incorporate facilities to help monitor the general use and maintenance of the system. The following minimum maintenance facilities shall be available:

i. Automatic Monitoring

Each addressable device shall be continuously monitored by the control panel, to include, as a minimum, the following:

- Removal of device.
- Quiescent value of device.
- Contamination.
- Circuit failure.
- Device type.
- Communication quality.
- Short circuit.
- Open circuit.

Should any devices not meet the required parameters, an audible and visual alarm shall be activated. The location, nature of the fault and location of the faulty device shall be displayed. The central control panel shall also monitor any loops for earth faults which shall be reported as described above. The fault shall also be displayed on the SCADA system(s).

ii. Archive Facility

The central control panel shall have an archive facility capable of storing the last 1 000 events. The events shall be stored on a first-in, first-out basis. It shall be possible to print these events selectively as follows:

- All events.
- Fire events only.
- Fault events only.
- Conditions/maintenance events only.
- Soak test results.
- Actions (i.e. reset/sounders, bells, etc.).
- Events from a given date/time.

iii. Statistics

The system shall be able to supply the following minimum statistics for each device:

- Maximum and minimum value with data.
- Average value.
- Number of alarms.
- Communication quality.

iv. System Maintenance Reports

The following minimum system maintenance reports shall be available on demand:

- Event buffer data.
- Soak test results.
- Test reports.
- Exception reports.

v. Service/Commission Mode

A service/commission mode switch shall be provided to facilitate the commissioning and servicing of the system. In the service/commission mode all panel outputs shall be disabled to prevent false alarms from being initiated during the servicing/commissioning of the system.

vi. Zone Test Mode

The central/local control panels shall be able to enter a test mode, which will allow a one-person walk test. In test mode, the central/local control panels shall not operate any relays or alarms based on the data received from the zones in test. However the panel will log all alarms occurring in these zones in order to generate a report at the end of the test period.

Should an alarm occur in any zone other than those being tested, the panel is to respond to the alarm in the normal manner.

The panel shall automatically return to the normal monitoring mode if the walk-test is not completed within a specified time.

6.17.19 Detectors and Loop Devices

All automatic detectors shall be formally approved by at least two (2) of the internationally recognised testing laboratories listed below:

- Underwriters Laboratories, USA (UL).
- Verband der Sachversicherer, Germany (VdS).
- British Standards, Great Britain (BS).
- Loss Prevention Certificate Board, Great Britain (LPC)
- Underwriters Laboratories, Canada (ULC).

The detectors shall be suitable for connecting to a two-wire (or 4-wire of applicable) central system and operate satisfactorily within a supply voltage range of 17-28Vdc and shall be polarity insensitive. Where required, the central control panel shall provide any additional/separate 17-28Vdc supplies which may be required for the detectors.

i. Indicators

A red indicator LED shall be provided on the detector, which illuminates when the detector has reached a pre-set alarm level. The indicator shall be operated independently of the detector from the central control panel.

Detectors mounted in ceiling voids shall be provided with indicators mounted on the underside of the ceiling in the vicinity of the detector. Detectors mounted within floor trenches shall be provided with indicators mounted on the wall in close proximity to the detector. The remote indicator shall operate in tandem with the devise indicator.

ii. General Detector Requirements

Data transmission to and from the central control/local panels from the detector shall be via communications circuitry as applicable, which is factory fitted to the detector by the original detector OEM and forms a complete and integral part of the detector.

The detector shall be supplied complete, fully tested and calibrated. All detectors shall come standard with a locking mechanism.

Separate mounting bases shall be provided, which enable ready removal of the detectors for maintenance. The fitting of a detector into a base shall be a simple one-hand operation without risk of damage to the base or detector. The detector shall click home clearly, which shall be an indication that the detector is fitted correctly. The address of a base shall remain undisturbed and unchanged by the removal or replacement of a detector. The base shall not contain electronic circuitry.

Each base shall be provided with a durable tag on which a number or mark is displayed, which shall identify the address of the monitor. The bases shall be fitted with dual finger, steel receptacles.

The unique address of the detector shall be set by the installer by means of a coded plastic card fitted to the detector base.

The detector shall be capable of being remotely tested from the central control panel by the transmission of a 3-bit code. The control panel shall initiate a maintenance alarm should this test fail.

The installation and siting of the detectors must conform to SANS 10139 and other relevant standards and specifications, as applicable.

iii. Multi-sensor Smoke/Heat Detector

Multi-sensor smoke/heat detectors shall be suitable for detecting visible smoke and shall be enhanced by the use of a heat sensing element. The smoke-sensing part shall be of the light scattering type, using a pulsed internal LED light source and a photo-diode sensor. The heat-sensing part shall monitor ambient temperature by means of an NTC thermistor.

The detector shall be capable of operating within the following environmental limits:

- Temperature operating range : -20°C to +60°C.
- Humidity operating range : 0% to 95% RH (no condensation).

All circuitry shall be protected against moisture and fungus. The detectors shall be unobtrusive when installed.

Smoke entry points shall be protected against dust and insect ingress by corrosion resistant gauze. The detector shall be capable of protecting an area of up to 50 m^2 at a height of up to 7.5 m.

iv. Optical Smoke Detector

Photoelectric (optical) smoke detectors shall be suitable for detecting visible smoke, as produced by slow smouldering fires, including burning PVC.

They shall be of the light scattering type, using a pulsed internal LED light source and a photo-diode sensor.

The detector shall be capable of operating within the following environmental limits:

- Temperature operating range : -20°C to +60°C.
- Humidity operating range : 0% to 95% RH (no condensation).

All circuitry must be protected against moisture and fungus. The detectors must be unobtrusive when installed.

The detector shall be capable of protecting an area of up to 50 m^2 at a height of up to 7.5 m.

Where required, specialised optical detectors will be required and shall be rated for use in harsh, high dust environments. The detectors shall make allowance for an air delivery system, complete with replaceable filters for removal of particles down to a size of 25 microns. Where the detectors require an additional 24Vdc auxiliary power supply, it shall be provided from the central control panel. The specialised optical detectors shall consist of the same minimum additional features stipulated for conventional optical detectors.

v. Heat Detectors (Fixed and Rate of Rise)

The device shall monitor ambient temperature by means of an NTC thermistor.

The detector shall be capable of operating within the following environmental limits:

- Temperature operating range : -20°C to + 60°C.
- Humidity operating range : 0% to 95% RH (no condensation).

Full circuitry must be protected against moisture and fungus. The detectors must be unobtrusive when installed.

Each detector shall be suitable for protecting an area of up to 50 m^2 at a height of up to 7.5 m.

vi. Manual Call Point (Break-glass Unit)

The call point shall be manufactured from red polycarbonate plastic. The overall size of the call point shall not exceed 90 mm x 90 mm x 55 mm.

A communications module shall be installed within the call point for communication with the central and local control panels as applicable. No external alterations to the call point shall be made other than the fixing of a flush mounted LED to be located to the right of the word "FIRE", which shall appear in letters across the top of the call point on the vertical face. The LED shall be red in colour.

The LED shall illuminate when the call point is activated. Illumination of the LED shall however be by command from the control panel.

Manual call point units shall be protected against ingress of dust and water to IP67. Units mounted outside the building shall be provided with a hood-mounted cover over the unit.

Each call point shall be addressable and/or non-addressable/conventional, as per the drawings and bill of quantities and be compatible with the control panels. The units shall be provided with means of testing. The call point shall be capable of responding when polled by the fire panels, by transmitting its address and status code. The call point shall be capable of handling the control panels' poll rate.

Addressable call points shall be polarity insensitive and shall be capable of operating by means of a 2-wire looped system.

The communication module shall incorporate an interrupt facility, which shall override any other data transmissions taking place in order to inform the central panel that the manual call point has been activated.

vii. Relay Interface Unit

The relay interface unit for air-conditioning shut-down, fire damper closing, automatic door closer magnetic release, magnetic door locks and the like, as applicable, shall provide two voltage-free change-over relay contacts for the high current operating power switching of these peripheral devices. The contacts shall be rated for 5A at 220 VAC or 24 VDC as applicable.

The relay interface unit will feature the automatic activation of the relay contacts upon receiving of an alarm signal and will also allow the manual activation of the relay by pressing a manual test button.

viii. Loop Isolator

Loop isolators shall be designed to connect into the loop circuit and monitor the loop for short circuit. In the event of a short circuit occurring, the loop isolators on each side of the short circuit shall disconnect and isolate that portion of loop from the system, enabling the remainder of the system to function normally.

A light emitting diode (LED) shall illuminate when an isolator is in an open condition.

ix. Input/Output Unit

The input/output unit shall provide a programmable voltage-free, single pole, change-over relay output, a single monitored switch input and an unmonitored non-polarised opto-coupled input. The unit shall be loop-powered and operate at between 14-28Vdc. The output relay rating shall be 1A at 30Vac or 30Vdc maximum.

x. Output Unit

The output unit shall provide a voltage-free, single pole, change-over relay output rated at 30Vac or 30Vdc maximum.

The unit shall be loop powered and operate between 14-28 VDC.

xi. Switch Monitor Unit

The switch monitor unit shall be designed to monitor the state of one or more single pole, volt free contacts connected on a single pair of cables and shall report the status to the analogue control panel. The unit shall provide four input states to the control panel, i.e. "Normal", "Fault", "Pre-alarm" and "Alarm".

The switch monitor unit shall be loop powered and shall operate between 14-28 VAC.

xii. Powered Sirens/Strobes (External Visual and Audible Alarms)

The sirens and LED red strobe lights shall connect directly to the addressable loop with its own unique address. The siren/strobe shall be capable of operating in a continuous or pulsed mode. It shall be possible to connect a maximum of 32 sounders to an analogue addressable loop. The same applies to the strobe lights.

Internal and external sounders shall have an output of 75 dB (A) at 1 metre with a current consumption of 4-45 mA at 17-60 VDC, unless otherwise specified in the drawings and/or bill of quantities. Suitable circuitry shall be included, if required, where internal and/or external visual and audible alarms are to be supplied by 230Vac.

The units shall be supplied to be operable as a sounder base, or a sounder base with cap, for use as a standalone sounder.

The sirens and LED red strobe lights may be connected to the main, and, where applicable, to the local control panels via hardwired I/O's.

All units shall, as a minimum, be IP65 rated, irrespective of their location.

Note: Where different type internal and/or external visual and audible alarms have been shown in the drawings and/or bills of quantities, these units shall still be fully compatible with the system.

6.17.20 Software Control

In order to ensure the reliability of the system, the following software design requirements shall apply:

i. General

- The software shall have a modular structure.
- Measures shall be included in the program to prevent the occurrence of a deadlock in the system.
- The execution of the program shall be monitored.
- The memory contents containing program and configuration data shall be checked automatically at intervals not exceeding 1 hour.

ii. Operating Programmes

- All executable code and data shall be held in memory, which is capable of continuous, reliable, maintenance free operation, for a period of at least 10 years.
- The program shall be held in non-volatile memory, which can only be written to at access level 4.

iii. Configuration Data

- The Site-specific data shall be protected against power loss by a back-up energy source, which can only be separated from the memory at access level 4.
- The back-up battery shall be capable of maintaining the memory contents for at least 5 years.

6.17.21 Power Supply And Charger Unit

The power supply and charger unit shall form an integral part of the control unit and shall operate from mains power of 230 VAC ±10%. The output shall be rated for 10 A at 24 VDC as a minimum.

The power supply and charger unit shall contain over-voltage protection to prevent any malfunction or damage due to power line surges.

In the event of a failure of the mains supply to the central and local control panels, as applicable, there shall be an automatic switchover to the standby internal battery supply without disturbing the sound operation of the fire detection system. This action will not cause any false or fire alarms.

The control panels shall be able to house the standby batteries of 24Vdc, rated to maintain operation for a minimum of 24 hours, of which at least 2 hour is at alarm status. The batteries shall have a minimum expected life span of 10 years, in the environment they which they are to operated.

6.17.22 Labelling

All cabling for the fire detection systems, associated equipment and circuits shall be labelled and numbered. Labelling of systems and equipment shall be by means of suitably sized Traffolyte labels, which shall be permanently fastened.

All cables and wiring shall be labelled/numbered in accordance with the requirements stated under the sections of these specifications titled ‘LV Cables’ and ‘LV Conductors’, as well as per Doc No 1924701-2-300-E-SP-0010 for communications cables and the like, as applicable. The schematic drawings shall be updated accordingly to include the labelling/numbering of the circuits.

6.18 Building Access Control

6.18.1 General

The *Contractor* shall appoint a specialist subcontractor/OEM, as applicable, to undertake the complete design, supply, installation and commissioning of the new building access control equipment/systems as specified.

The equipment and systems shall include all programming of the system and complete integration of the equipment/systems with the respective main electronic monitoring and control (if applicable) infrastructure (data network), and any other local systems as applicable and as required. The procedures governing the design approval, manufacturing, inspections, testing and commissioning of the equipment/systems are covered in further sections of these specifications.

The *Contractor* shall ensure that the specialist subcontractor/OEM fully cooperates, coordinates, supports and supplies any technical and associated information to Others as required, to ensure that the building access control and intruder alarm systems are fully integrated, both electrically and electronically.

Throughout this specification, where reference is made to an access control system, it shall imply a complete system, which shall include, but not be limited to, a central control panel and its associated field devices, wiring and the like.

The system shall comply with the following minimum requirements, as well as the further details indicated on the drawings or included in the bill of quantities and any other associated contract documentation:

6.18.2 System Operation

The building access control shall consist of a central control panel connected to field devices, typically comprising of biometric finger print scanners and door controllers, allowing access control via magnetically locked doors.

The system control panels, door locks, controllers and readers shall be installed as shown on the drawings. Final positions of the equipment shall be determined on Site in conjunction with the *Employer.*

The system shall keep records of the system operations and events, which will be remotely accessible by the *Employer* via the fibre optic network, should this be required. Under intruder detection conditions the systems shall send an alarm signal to the security room via the fibre optic network.

6.18.3 Access Control Door Principle Operation

i. Entering

Access control doors shall allow entering access to users under the following conditions:

- The user's biometric print has been preprogramed into, and is recognised by the system, via the external biometric reader.
- If a user does not have biometric access a door buzzer is used to draw the attention of staff within the building. The door can then be opened from the inside, by using the door release button.
- Additional conditions may be required by the *Employer*. This shall be finalised during the final design stage of the systems.

ii. Exiting

Access control doors shall allow exiting access to users using the door release button located within the building.

iii. Unauthorised Entering

The door controller shall be able to detect, using the door open/close sensor, if the door is forced open without the deactivation (by using an authorised biometric reading) of the door magnet. The system shall provide a signal to the intruder alarm system to sound the intruder alarm forward the signal accordingly.

6.18.4 Fire Alarm Conditions

The scope of the *works* includes the supply and installation of a fire detection system, as described in a separate section of these specifications. Under fire alarm conditions (double knock if applicable) the fire panel shall provide a signal to the access control system, which shall in turn signal all access control door magnets to be released to allow for fire escape, should it be required.

6.18.5 Access Control Door Equipment

The access control door equipment shall consist of and include the following minimum equipment:

Table 13 : Door Equipment

Equipment
External biometric readers (complete with IP65 openable enclosure).
Internal door release buttons.
500 kg door lock magnets (installed by door manufacturer) per door leave.
Door position (open or closed) indication magnets.
External door buzzers.
Green break glass unit.

6.18.6 System Equipment

The table below indicates the minimum equipment required for the access control system.

Table 14 : Complete System Equipment

Item	Description
Main System Infrastructure	
Access Control System	Centralised access control interface units : Impro Technologies IXP220 system or approved equivalent, complete with enclosure, power supply, battery backup and registration reader etc. The system shall have Profibus communication capabilities and shall be able linked to remote I/O modules and/or PLC's. Any connection or communication converters and associated cabling as required shall be included in the scope of *works*, to establish the communication link. The system shall be installed in the substation areas as indicated on the drawings.
Setup and Monitor station and software	New laptop PC, complete with the selected system software and associated licencing. Licencing shall be a once-off cost and shall be included in the scheduled rates. PC minimum specification: i7 Processor, 8GB memory, 2TB hard drive, graphics accelerator and operation system as required by IXP220 system or approved equivalent.
Access Control Portion of System	
Door Controller	Door controller shall be Impro Technologies 2nd Generation Twin Terminal (ITT) RS485 or approved equivalent for the control of all inputs and outputs at the respective access points. Door controller shall be supplied complete with enclosure, power supply and battery backup. The power supply shall be adequately sized to provide power to the door controller, magnetic lock and all associated equipment at the respective doors.

Table 14 : Complete System Equipment

Item	Description
External and Internal Biometric readers	Wall mounted biometric reader compatible with the selected access control system shall be Sagem Reader type or approved equivalent, complete with LED and tone indication. The reader shall be installed within an IP65 openable enclosure, to serve as dust and moisture protection when not used.
Door lock magnet	500 kg magnetic door lock with LED indication and bracket installed into door frame by door manufacturer.
Green break glass unit	Wall-mounted, green, resettable. Glass replaceable version will not be accepted. Green break glass unit shall be compatible with the selected system. Unit shall have incorporated LED indication.
Doorbell	Wall mounted, heavy-duty metal push button tone generator. (Doorbell for user enter request). Minimum IP65 rated. Shall also be powder coated.
General	
Programming	The *Contractor* shall allow for all programming of the system, including 3 additional reiterations, to ensure that the *Employer* is satisfied with the setup, operation of the system and commissioning.
Wiring	The *Contractor* shall allow for all wiring to make this system fully functional.
Others	Provision and installation of any additional items deemed necessary by the specialist subcontractor to render this installation complete and working as required.

All cabling/wiring for the access control systems, including associated equipment and circuits, shall be labelled and numbered. Labelling of system and equipment shall be by means of suitably sized Traffolyte labels, which shall be permanently fastened.

All cables and wiring shall be labelled/numbered in accordance with the requirements stated under the sections of these specifications titled ‘LV Cables’ and ‘LV Conductors’, as well as per Doc No 1924701-2-300-E-SP-0010 for communications cables and the like, as applicable. The schematic drawings shall be updated accordingly to include the labelling/numbering of the circuits.

6.19 Earthing and Lightning Protection

6.19.1 General

The *Contractor* shall appoint a SANS accredited/certified specialist subcontractor to undertake the complete final design, supply, installation and commissioning of the entire new earthing and lightning protection systems required for the new substations. The subcontractor shall be registered with SABS (ISO 9001 - latest amendment applies) as a designer, fabricator, installer, tester and maintainer of lightning protection systems. The *Employer* shall approve the *Contractor's* subcontractor whom he intends to use for the *works*.

As part of the *works* by the specialist subcontractor, a comprehensive lightning risk assessment report for the new substations shall be compiled and furnished to the *Employer* for approval. The report shall form the basis for the selection and design of the required earthing and lightning protection systems.

The specialist subcontractor shall also be required to undertake soil resistivity tests at the new substations locations, in accordance with SANS 10199 and other applicable standards and specifications, for design purposes. These tests shall be undertaken once the soil platforms for the substations have been finalised, in order to obtain the final soil resistivity values from which the final designs shall be based upon.

The *Contractor* shall furnish a comprehensive report on the findings to the *Employer* for review and approval. All installations shall fully comply and be certified in accordance with the requirements of SANS 10142-1, 10199, 10313, 62305 and other applicable standards and specifications.

The scope and format for the soil resistivity test report shall be based on Doc No 1924701-E004-RPT-0002 'Bulk Power Upgrade - Soil Resistivity Report'. Account shall also be taken of relevant Eskom standards, specifications, guidelines and further Eskom requirements.

The earthing and lightning protection systems shall furthermore include the complete integration of the new earthing and lightning protection systems with the structures to be protected and the electrical and electronic installations, including those to be provided by Others. The procedures for the design approval, manufacturing, inspection, testing and commissioning of the equipment/systems are covered in further parts of these specifications.

The *Contractor* shall ensure that the specialist subcontractor fully cooperates, coordinates and furnishes any technical support and associated information to Others as required, to ensure that the new earthing and lightning protection systems are fully and correctly integrated.

For tender purposes, provision has been made for a Class IV lightning protection system.

6.19.2 Earthing and Lightning Protection Systems Design and Installation

The specialist subcontractor shall undertake resistivity tests at the substations locations, in order to complete the final designs and installations, including the extent and type of installations. The tests results shall be compiled and provided in a comprehensive report, to include all information as per SANS 10199, such as sounding arrays, Sunde's graphical method, two layer soil models, appraisal of soil for corrosiveness and the like.

The tests results shall be incorporated in an earthing and lightning protection design report, which shall be submitted by the *Contractor* to the *Employer* for review and approval. The documents submitted to the *Employer* shall also include the associated electronics files for any software programmes used for the design purposes. The approved software programme to be used for earthing purposes shall be CDEGS. The *Contractor* shall notify the *Employer* of which software programme will be used for the LPS systems, if applicable, for approval.

The specialist subcontractor shall perform the soil resistivity tests in strict accordance with SANS 725 (IEEE 80), 10199, Eskom requirements and all other relevant standards and specifications, as applicable. The Wenner four pin method shall be used to obtain the results. Final soil resistivity values shall be between 10 and 100 Ωm. Reference shall be made to the civil specifications (Doc No 1924701-2-300-C-SP-0001) covering the further requirements for the imported soil for the building and substation platforms.

Unless otherwise specified or instructed, the specialist subcontractor shall measure the resistivity at 1m probe spacings (as per SANS 10199) up to a maximum distance of 16m. The probe depth shall be as per the OEM test equipment specifications. The specialist subcontractor shall certify and take full responsibility

for the accuracy of the results. Allowance shall be made for a minimum of 10 test points for Substation M and N each and 20 test points for the new Main Intake Substation.

The suitability of copper for the earthing and lightning protection systems will be re-assessed, based on the corrosiveness of the soil and taking account also of the harsh corrosive environment at the Site. Provisional allowances have been made for the use of copper. This may be amended to stainless steel if required and where so instructed by the *Employer.*

All earthing, including associated bonding conductors, lightning protection systems and the like, shall have a final measured resistance of no more than 1 Ohm. All earthing and lighting protection systems shall take due cognisance of the extensive electronic systems included in the scope of the *works*. The main earthing principle to be employed shall be the TN-S type.

Typical main earthing and lightning protection equipment will include, but not be limited to:

- Earth mats/grids.
- Earth spikes.
- Earthing straps and tails.
- Insulated copper earth wires for LPS down conductors and general earthing/bonding purposes.
- Main/raw and electronic earth bars.
- Earth line equalisers.
- Lightning masts.

The entire earthing systems for Substations M and N and the Tippler 3 building shall be based on a combined MV/LV earth system. The earth installations shall also be in accordance with the TN-S earthing principle. The final earth resistance value shall not be more than 1 Ohm. The *Contractor* shall also provide the main transformer earth bar at the Tippler 3 building for, amongst others, earthing interconnections between the Tippler 3 building and Substation M.

For the Main Intake Substation, the earthing system shall be designed to ensure that aspects such as step and touch potential, grid potential rise and the like are within statutory and Eskom required safe limits, taking account of the specific requirements of the 11 kV Switch House and 132 kV Control Building, as well as applicable Eskom standards and specifications. Eskom's TNC-S and/or TN-S earthing principles shall apply, as per their requirements.

Final testing of all earthing and lightning protections system installations shall include, but not be limited to, the following, unless any statutory regulations, standards or Eskom requirements dictate differently:

- Testing of each final installed earth mat/grid.
- Testing of the entire earthing and lighting protection systems for each substation building.
- Testing the entire earthing and lighting protection systems at each substation building when connected to the final earth mat.
- Testing the above once substations, including Tippler 3 building, are interconnected to one another.
- Testing the above when all other earthing infrastructure, such as for the conveyors, etc., is interconnected with each other.
- Testing of any other ancillary elements such fences, gates, outdoor equipment and the like.

No earthing and lightning protection equipment and connections shall be covered up before the *Employer* has inspected and approved them.

Labelling of all earthing and lightning protection systems shall be as per the drawings, these specifications, *Employer* standards and, where applicable, Eskom's requirements.

6.20 Corrosion Protection

6.20.1 General Corrosion Protection

Corrosion protection of steel materials shall be as per the requirements of these specifications, the *Employer's* and Eskom (where applicable) standards and associated minimum SANS and other requirements. The protection of the specified steel materials shall make allowance for the harsh, coastal environment at the Site.

Any equipment not strictly complying with the above requirements shall be rejected. The *Contractor* shall furnish written confirmation that all equipment complies with the specifications. Should the *Contractor* fail to furnish such confirmation, the *Employer* reserves the right to reject the equipment.

6.20.2 Galvanic Corrosion Protection

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer*.

The table below provides a general indication/guide only, of which metals can be connected to each other without the need of special measures to ovoid interaction, and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The responsibility will remain with the *Contractor* to avoid bimetal/galvanic corrosion between different metal equipment.

Table 15 : Combinations Of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	StSt	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Copper	Not Permissible	Not Permissible	Permissible	Permissible	Not Permissible	Permissible
StSt	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

Where equipment has been exothermically welded together, 3 thick layers of bitumen shall be applied afterwards, unless otherwise specified or instructed.

6.21 Fire Stopping

The *Contractor* shall employ suitable fire stopping methods wherever necessary and/or as stipulated in these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer*'s specifications or any other applicable standards and documents related to the *works*.

All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and approved standards. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localised and contained and not propagate via any electrical and/or electronic infrastructure. The *Contractor* shall fully comply with these requirements.

6.22 Labelling

All LV installations shall be labelled in accordance with these specifications, drawings, *Employer* standards and, where applicable, Eskom requirements, unless otherwise specified or instructed.

The *Contractor* shall submit label samples and schedules to the *Employer* for approval prior to manufacture. The necessary allowances shall be made in the tender rates.

6.23 Notices and Signage

Apart from general notices and signage required in accordance with statutory regulations and standards, or other contract documentation and drawings, further notices and signage for which allowances shall be made by the *Contractor* shall also include, but not be limited to, the following:

- Declaring and showing purpose of UPS 'Live' external visual and audible alarm indications.
- Declaring and showing purpose of fire alarm external visual and audible alarm indications.
- Declaring and showing purpose of fire suppression external visual and audible alarm indications.
- Declaring and showing purpose of building pressure loss external visual and audible alarm indications.
- Declaring and showing purpose of intruder alarm external visual and audible alarm indications.
- External notice/signage indicating danger and staying clear of pressure relief devices.
- Internal signage showing danger, unauthorised entry prohibited at all rooms inside the building.
- Internal signage showing danger, unauthorised entry prohibited, live equipment do not entry at VSD, transformer, switchgear rooms and the like.
- MV and LV warning signs.
- Internal/external treatment and full first aid notice/signage.

All notices and signage shall be CHROMADEK type, with suitable colouring and fixing materials, unless otherwise specified or instructed. Where applicable, the colouring and wording on the notices/signs shall be as per statutory regulations and standards. For non-standard notices/signs the *Contractor* shall, in conjunction with the OEM and *Employer*, develop the correct wording and colouring as required.

All CHROMODEK notices/signs shall be of the long life, heat reflective, UV stabilised type. This shall include all fixing materials, which shall have excellent protection against corrosion resistance, to take account of the harsh, coastal environment at the Site. Where notices/signage is to be fastened via screws or bolts/nots, the aforementioned shall be of the 316L stainless type. Where they are to be glued on, the glue shall be of the long lasting, heat resisting type. The *Contractor* may propose alternative fixing methods and/or materials for the *Employer's* approval.

General wording on notices and signs shall be English, Afrikaans and IsiXhosa, unless instructed otherwise by the *Employer*. All notices/signage for Eskom shall be as per the requirement.

The *Contractor* shall submit samples and schedules to the *Employer* for approval prior to manufacture. These shall all be included in the tender rates.

7.0 PACKAGING, TRANSPORTATION AND HANDLING

The following general requirements are applicable to all equipment forming part of the *works:*

- If any equipment requires special maintenance or attention during storage, this shall be clearly stated prior to placement of orders and the *Employer's* attention shall be drawn to this fact.
- Crates supplied for transport shall be suitable for Site storage for a period up to 6 months to allow for delays in the installation of equipment.
- The *Contractor* shall be responsible for loading all materials and equipment at the OEM premises, transportation, handling and off-loading thereof on Site, including also any further handling of equipment until it is placed in the final, permanent position.
- Under no circumstances shall any equipment be stored outside or exposed to the weather. All secondary equipment shall be brought to Site once it can be installed in the relevant rooms where it is to be permanently installed.

8.0 SPARES, TOOLS AND CONSUMABLES

8.1 General

The *Contractor* shall provide critical and recommended spares, as prescribed by the OEMs, which shall include, but not be limited to, the following systems, instrumentation and associated installations.

- Earthing system.
- Lightning protection system.
- Distribution boards, junction boxes, termination boards.
- Uninterruptable power supplies.
- Luminaires and light switches.
- Socket outlets and isolators.
- Cable trays, ladders, racks, ducts, power skirting/trunking and conduits.
- Fire detection system.
- Access control system.
- Intruder alarm system.

8.2 Spares, Tools and Consumables required prior to Final Handover

The *Contractor* shall supply all spares that are required for start-up and commissioning purposes and for the 12-month period after commissioning, as recommended by the specialist subcontractors/OEM's.

The *Contractor* shall also supply all consumables required within 12 months after commissioning and any special maintenance tools, defined as tools that are not readily available from commercial tool suppliers.

Prior to placement of orders, the *Contractor* shall submit his proposed list of spares, consumables and tools to the *Employer* for his review and approval.

Each spare part shall be properly tagged with a weatherproof label, showing the manufacturer's unique part number, description of the part and expiry date for parts having a limited shelf life. Small items with the same part numbers shall be tagged and packed together in a plastic bag or box. The tag shall also be shown on the outside of the bag or box.

The cost of the above spares, consumables and tools shall be included in the rates tendered by the *Contractor*.

8.3 Spares required after Final Handover

The *Contractor* shall also provide to the *Employer* a list of all critical and recommended spares as prescribed by the specialist subcontractor/OEMs, which shall cover the operational requirements after final handover of the *works*. These lists shall include, but not be limited to, the following:

- Description of spare part.
- Spare part number, as applicable.
- Supplier contact details.
- Suggested stock levels.
- Prices.
- Lead-times for ordering and delivery of such spares.

The *Employer* may issue an instruction to the *Contractor* to supply and deliver spares for operation and maintenance of the equipment after final handover. Separate payments will be made by the *Employer* for the provision of such spares.

9.0 O&M MANUALS, TRAINING AND BACK-UP SUPPORT

9.1 O&M Manuals

Technical, training, maintenance and operating manuals shall be provided for each type and model of equipment. Technical manuals shall include all technical data, construction information and leaflets for each individual component used in the equipment as provided. Where generic manuals are provided, an addendum is to be included, indicating the applicable project specific components.

Manuals shall be of a good quality and shall. as a minimum, cover the following:

- Technical descriptions of the equipment and component parts.
- General arrangement drawings.
- Installation instructions with drawings or pictures.
- Operating and maintenance instructions for all components.
- Detailed parts lists, accompanied by exploded view type drawings clearly detailing the part and uniquely identifying each part.
- Spare part ordering instructions.

Any special instructions pertaining to storage of spare parts or their shelf life shall be included in the maintenance manual. All drawings required for component location, dismantling and re-assembly for maintenance purposes shall be included in the maintenance manual. All special tools required for operating and maintenance of the equipment shall be presented in the form of a schedule in the operating and maintenance manual.

The content of the training manuals shall be based on the content of the technical, operating and maintenance manuals.

9.2 Training

The *Contractor* shall arrange certified/accredited training for the *Employer*'s operating personnel, to be provided by the *Contractor* in conjunction with knowledgeable representatives of the equipment suppliers/OEM's. The scope, content, venue and duration for training shall be approved by the *Employer*.

Training shall be directly applicable to the actual equipment supplied for the *works*. Generalised training based on similar equipment shall not be acceptable. The training shall also include practical hands-on training for each individual trainee.

The training to be provided shall demonstrate the operation, function, trouble-shooting and maintenance requirements of the services, including, but not limited to, the following:

- Earthing system.
- Lightning protection system.
- Distribution boards.
- Uninterruptable power supplies.
- Lighting installation and switches.
- Socket outlets and isolator installations.
- Fire detection system.
- Access control system.
- Intruder alarm system.
- Any other aspects of the LV installations as deemed necessary by the *Employer*.

9.3 Training of Maintenance Personnel

Maintenance personnel shall be trained to operate all components and understand the function of the equipment, i.e. methods of maintenance, fault finding, correction, routine maintenance (frequency and methods of testing).

Training shall include familiarisation with documentation (maintenance plan, procedures and the like), hardware familiarisation and maintenance and maintenance of the LV installation. Maintenance training shall be provided prior to the installation of the equipment.

9.4 Training of Operators

Operators shall be trained and declared competent to operate the new systems prior to the equipment being dispatched from the factory. This will include familiarisation with the relevant documentation, including drawing configuration logic, as well as operator interface familiarisation, e.g. operational functions, alarms and the like. The *Contractor* shall make provision for training of all the operators.

9.5 Engineering Training

Formal, upfront engineering training shall be provided on the LV installations as described in these specifications prior to design freeze.

Thereafter on-the-job training shall be provided, extending through the design stage up to final commissioning and handover. The design and control/interface functions shall be covered during this training, to enable the *Employer's* engineering team to fully understand the operation and maintenance of the LV equipment prior to FAT.

The *Employer's* engineering team will be in attendance throughout the installation and commissioning stages of the *works*. The *Contractor* shall accord the *Employer's* engineering team full access to the *works* and shall provide formal training and ad-hoc mentoring to ensure a seamless handover upon completion of the *works*.

9.6 Back-Up Support

Back-up support services, including the provision of on-Site technical support by the specialist subcontractors/OEMs for all the LV installations and equipment, shall be available 24 hours a day, 7 days a week. Contact details for the companies and persons providing these support services shall be provided to the *Employer*. Payment for such back-up support will be subject to the relevant provisions of the contract.

10.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

11.0 INSPECTIONS, TESTING AND COMMISSIONING

11.1 General

The *Contractor* shall develop quality control procedures, test plans and the like and shall provide all necessary resources for the management and implementation of these procedures and plans, in accordance with the general requirements as set forth in the accompanying Works Information. The further requirements as detailed below shall form an integral part of these quality management procedures.

All testing and commissioning shall be in accordance with these specifications, all relevant regulatory standards, industry best practices, *Employer* and Eskom (as applicable) requirements and the like.

The *Contractor* shall supply, operate and maintain all equipment and instruments required to perform all tests, inspections and commissioning, which shall only be undertaken by suitably qualified, experienced and competent persons to be appointed by the *Contractor*, using only fit-for-purpose, correctly calibrated equipment.

The *Employer* may at his discretion instruct the *Contractor* to perform additional testing and/or commissioning activities, as well as provide any additional information as required to prove the functionality, operability and compliance of the units. Allowances shall be made by the *Contractor* in the scheduled rates included in the bill of quantities for such tests.

Should the *Contractor* fail to perform any test or properly commission equipment supplied and installed by the *Contractor*, or should any item of equipment or part of the installations fail any test or commissioning inspection, the *Employer* reserves the right to recover from the *Contractor* any reasonable cost to himself to witness the repeat of such test or commissioning.

The notice period and date(s) to be provided by the *Contractor* to the *Employer* for witnessing any testing or commissioning activities shall be as stipulated in the Contractor Document Schedule, unless otherwise instructed or specified.

The *Contractor* shall at all times provide unimpeded access to the *Employer* to inspect the *works* and to attend or witness any test or event as may be required by the *Employer*. All equipment and instruments required to perform all tests and inspections shall be supplied, operated and maintained by the *Contractor*.

The *Contractor* shall rectify any defects noted during the final inspection prior to final hand-over.

11.2 Factory Inspections and Tests

All project specific, factory built equipment and any other *Employer* selected equipment, shall be tested and inspected at the manufacturing premises prior to delivery to Site. The *Contractor* shall notify the *Employer* in advance of the tests and inspections, as indicated in the *Contractor* Documentation Schedule. The *Employer* may, at his discretion, wish to witness these tests and inspections.

11.3 Site Inspections and Tests

The *Contractor* shall notify the *Employer* at least seven (7) working days prior to the dates of key inspections and tests, including, but not limited to, the following:

- Earthing system commissioning and testing.
- Lightning protection system commissioning and testing.
- Distribution boards, junction boxes, termination boards commissioning and testing.
- Uninterruptable power supplies commissioning and testing.
- Luminaires and light switches commissioning and testing.
- Socket outlets and isolators commissioning and testing.
- Fire detection system commissioning and testing.
- Access control system commissioning and testing.
- Intruder alarm system commissioning and testing.

Typical Site acceptance testing and inspections shall include, but not be limited to the following:

- Inspection and testing of delivered equipment/systems in accordance with the specifications, Works Information, drawings and applicable statutory regulations, standards and associated requirements.
- Verification of the functionality, operability and compliance of equipment/systems.
- Inspection of cable trenches after excavation and prior to the installation of bedding material.
- Inspection of cable trenches after installation of bedding material and the installation of cables.
- Inspection of cable trenches after installation of padding material and backfill.
- Compaction tests on backfilled trenches.
- Soil resistivity tests.
- Earth resistance and continuity tests.
- Lightning protection systems testing and measurements.
- All UPS operations under simulated power provision and failures.
- Monitoring and control systems testing.
- Access control systems testing.
- Fire detection systems testing.
- Intruder alarm systems testing.
- VOIP systems testing.

The *Contractor* shall at all times provide unimpeded access to the *Employer* to monitor the *works* and to attend or witness any test or event as may be required by the *Employer*.

11.4 Test Equipment and Certificates

The *Contractor* shall supply, operate and maintain all equipment and instruments required to perform all tests and inspections.

Test reports and/or certificates shall be issued for all tests that are conducted. These certificates shall be signed by the *Contractor* and the manufacturer/test laboratory (as applicable). The number of copies to be issued to the *Employer* shall be as per the *Contractor* Document Schedule.

Unless separately scheduled, the cost of all equipment, instruments and tests shall be included in the scheduled rates for the relevant items.

Test reports and certificates that will be required include, but are not limited to, the following:

- Earthing system test reports and certificates.
- Lightning protection test reports and certificates.
- Distribution boards, junction boxes, termination boards test reports and certificates.
- Uninterruptable power supplies test reports and certificates.
- Luminaires and light switches test reports and certificates.
- Socket outlets and isolators test reports and certificates.
- Fire detection system test reports and certificates.
- Access control system test reports and certificates.
- Certificates of Compliance.
- All further test reports and certificates for tests undertaken in accordance with SANS and applicable other standards and specifications.
- Certificates for integration tests.

11.5 Repetition of Tests and Inspections

Should the *Contractor* fail to perform any test, or should any item of equipment or part of the installations fail any test, the *Employer* reserves the right to recover from the *Contractor* any reasonable cost to himself to witness the repeat of such test.

11.6 Final Inspection and Handover

Prior to practical completion and handover of the *works*, the *Contractor* shall arrange a final inspection with the *Employer*.

The *Contractor* shall give at least fourteen (14) working days' notice of the date of the final inspection, unless otherwise instructed or specified. Documentation to be submitted by the *Contractor* to the *Employer* at the final inspection shall include, but not be limited to, the following:

- O&M manual.
- Test reports and certificates.
- As-built documentation and drawings.
- Certificate of Compliance(s).

The *Contractor* shall rectify any defects noted during the inspection prior to the hand-over inspection.

The *Contractor* shall provide signed off documentation by the equipment supplier/OEM, certifying that the installation of all equipment supplied by them conforms to their own standards and specifications.

12.0 DESIGN APPROVAL, MANUFACTURING, INSPECTIONS, TESTING AND COMMISSIONING PROCEDURES

The following procedures shall apply to the design approval, manufacture, inspections, testing, installation and commissioning of the equipment/systems.

- *Contractor* appoints the specialist subcontractor/OEM.
- *The Contractor* provides the project and technical requirements to the specialist subcontractor/ OEM.
- The specialist subcontractor/OEM undertakes the design of the equipment/systems and submits drawings plus any other associated technical information for approval to the *Contractor*.
- *Contractor* checks the drawings and associated technical information as provided, for compliance with all the requirements of the specifications, Works Information, drawings and the like and submits three copies, signed off as checked, to the *Employer* for approval.
- *Employer* returns copies as approved, or for resubmission, to the *Contractor*.
- Manufacture of the equipment/systems commences after approval of the drawings and associated technical information, by the *Employer*.
- *Contractor* checks and inspects the manufactured equipment/systems at the specialist subcontractor/OEM's premises during all stages.
- *Contractor* presents the *Employer* with written confirmation that the equipment/systems are in full compliance with the project requirements and have been checked, inspected and fully tested. This confirmation, signed and dated by both the *Contractor* and the specialist subcontractor/OEM, is to accompany a written request for the *Employer* to witness factory acceptance tests (FAT), i.e. re-inspection and retesting of the equipment/systems.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list and approval by the *Employer*, the equipment/systems may be dispatched to Site.
- On arrival of the equipment/systems on Site, the *Contractor* shall request in writing that the *Employer* witness the associated Site acceptance tests (SAT) as applicable. After the tests, written confirmation shall be provided by the *Contractor* to the *Employer* that the equipment/systems are in full compliance. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval by the *Employer*, the equipment/systems may be installed.
- Once the equipment has been installed, tested for complete functionality, operability and compliance as per the contract, the *Contractor* shall request the *Employer* in writing to witness the installed equipment/systems.
- The installed equipment/systems shall be re-tested on Site so that the *Employer* may verify the functionality, operability and compliance requirements. Upon approval of the *Employer*, after the installation and tests, written confirmation shall be provided by the *Contractor* to the *Employer* that the equipment/systems are in full compliance and have been commissioned correctly. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/ OEM.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor.*
- Should the *Employer* determine that the final product does not fully meet the project requirements, functionality, operability and/or compliance requirements, the *Contractor* shall undertake the necessary repairs and re-testing, all at his own expense.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval received from the *Employer*, the equipment/systems shall be formally handed over to the *Employer*.
- Under no circumstances will the *Employer* enter into any discussions regarding conformance to the project requirements with the specialist subcontractor/OEM. All communications shall be between the *Employer* and *Contractor* only.
- The *Contractor* shall ensure that full copies of the project requirements, specifications, approved signed copies of the drawings and any other associated technical information, are at hand during all inspections.
- All relevant statutory testing, commissioning and certification of the equipment/systems shall be performed by the specialist subcontractor/OEM.
- The *Contractor* shall notify the *Employer* in advance of the tests and inspections, as indicated in the *Contractor* Documentation Schedule.

13.0 HANDOVER DOCUMENTATION

13.1 As-Built Documents

The *Contractor* shall maintain records and prepare as-built documentation for all design documents, drawings, quality control records, tests, pre-commissioning reports, commissioning reports, operation and maintenance manuals and the like. The as-built documents shall be comprehensive and shall demonstrate compliance with the project specifications and drawings. Reference shall also be made to the further requirements as detailed in the accompanying Works Information. The following details shall apply:

- The scope and format, including the required indexing, of the as-built information shall be discussed and agreed with the *Employer* prior to compilation and submission of the final documentation.
- All as-built documents shall be signed off by the *Contractor* and submitted to the *Employer* for approval, as these are developed and at completion of the *works*.
- All as-built documents shall be furnished to the *Employer* in both hard and soft copy formats.
- As-built documents shall be submitted as per the requirements as set out in the CDS, unless otherwise instructed by the *Employer*, and the further requirements as detailed below.

13.2 As-Built Drawings

The *Contractor* shall keep a separate set of project drawings for marking up changes to the original design as the *works* progress. Marked-up red lined hard copies of drawings shall be maintained by the *Contractor* during installation of the equipment and shall be included in the handover documentation.

As-built drawings shall include the drawings issued by the *Employer* as well as any drawings compiled by the *Contractor*.

Software copies of the “as-constructed” drawings shall be provided in ‘rvt’, ‘dgn’, ‘dwg’, ‘dxf’ and ‘PDF’ formats.

The final, as-constructed drawings shall be signed off by the *Contractor* and submitted to the *Employer* for approval at completion of the *works*.

13.3 Data Packs

Data packs for all equipment and materials shall be provided by the *Contractor* in electronic and hard-copy format and shall be neatly indexed and referenced to facilitate easy navigation by the *Employer* between documents. This shall include, but not be limited to, the following:

- Final design calculations, including native software files if applicable.
- Equipment specification sheets.
- Data sheets for instrumentation and equipment, including physical dimensions.
- Wiring diagrams.
- Any other information as required by the *Employer*.

13.4 Quality Control Records

The *Contractor* shall, as part of the handover documentation, provide the *Employer* with all quality control records, including, but not limited to:

- Equipment and material installation standards applicable to the relevant equipment or material supply.
- All calibration certificates.
- Material certificates.
- SABS certificates, where appropriate.
- All test and calibration certificates.
- Certificates of Compliance.

13.5 Further Handover Documentation

Further handover documentation shall include:

- Comprehensive operation and maintenance manuals.
- All equipment guarantees, which shall be ceded to the *Employer* upon completion of the *works*.
- Copies of final configured software programmes of equipment/systems.
- All software licences and programming of software, which shall be ceded to the *Employer* upon completion of the *works*.
- List of recommended critical and recommended spare parts lists, including suggested stock levels.
- Further information as advised by the *Employer*, as required for the hand-over, commissioning, operation and maintenance of the installed systems and equipment.

14.0 MEASUREMENT AND PAYMENT

14.1 General

The tendered rates shall be deemed to include all and every cost item required for the completion, handover and commissioning of the *works,* in full compliance with these specifications, the Works Information and the drawings, including, but not limited to, the following:

- Design (including shop drawings), supply and installation of the *works* that are required to deliver a complete, fully functional and fully compliant system.
- Supply of installation and commissioning spares and operational (critical and recommended) spares required for normal wear and tear during plant operation for the period of one year after commissioning.
- Supply of special tools required for maintenance purposes.
- All testing and commissioning activities that are required to get the installed equipment ready for operations.
- Compilation and submission of all handover documentation as described in these specifications.
- Training of *Employer's* operational staff, as detailed in these specifications.

Allowances to be made in the tendered rates are as described below.

14.2 Payment Items

14.2.1 LV Cables

The tendered rates for cables shall cover all costs for the supply and installation of cables, including, but not limited to, procurement, transport, handling, inspection, laying in trenches, pulling through ducts, installing on cable tray, bedding in, cutting, temporary sealing and testing of cables, including suitable fire stopping material where required.

The scheduled rates shall include for the supply and installation of danger tape, including, but not limited to, procurement, transport, storage, handling, installation and cutting of the tape.

14.2.2 LV Conductors

The tendered rates for conductors shall cover all costs for the supply and installation of conductors, including, but not limited to, procurement, transport, handling, inspection, installation at any height and within specified cable management systems, cutting and termination of conductors, suitable fire stopping material, where required, and commissioning.

14.2.3 Cable Trays, Wire Meshes, Ladders, Racks, Ducts and Associated Fixing Materials

The tendered rates shall cover all costs for the supply and installation of all cable trays, wire meshes, ladders, racks and ducts, mounting materials and accessories required to perform the *works,* including, but not limited to, procurement, transport, handling, storage, inspections, installation at any height of all necessary fixings, joints, terminations, bends, elbows, expansion joints, earthing, all necessary scaffolding, hoisting and the like and suitable associated fire stopping material where required.

14.2.4 Conduit

The tendered rates shall cover all costs for the supply and installation of conduit, including, but not limited to, procurement, transport, storage, inspections, installation of conduit, which may be cast in concrete, chased in walls or surface mounted. The rates shall also allow for installations at any height and shall provide for all fixings, glue, joints, terminations, bends, elbows, expansion joints, saddles and the like, including suitable associated fire stopping material where required.

14.2.5 Distribution Boards, Cabinets, Junction/Plugs Boxes and Termination Boards

The tendered rates shall cover all costs for the supply and installation of distribution boards, cabinets, junction/plug boxes and termination boards, including, but not limited to, procurement, transport, handling, storage, testing, provision of designs and drawings for approval (multiple reiteration), inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets and the like.

14.2.6 UPS and Batteries

The tendered rates shall cover all costs for the provision of a complete functional, operable and compliant system and shall include, but not be limited to, procurement, transport, storage, handling, designs, drawings for approval (multiple reiteration) inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets and the like.

14.2.7 Variable Speed Drives and Soft Starters

The tendered rates shall cover all costs for the provision of a complete functional, operable and compliant system, and shall include, but not be limited to, procurement, transport, storage, handling, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

14.2.8 Power Skirting and Trunking

The tendered rates shall cover all costs for the supply and installation of power skirting and trunking, including, but not limited to, procurement, transport, storage, testing and inspections, all necessary fixings, joints, terminations, bends, elbows, covers and the like, including suitable associated fire stopping material where required.

14.2.9 Power, Data/Telephone Outlets, Switches, Isolators and Accessories

The tendered rates shall cover all costs for the supply and installation of power, data and telephone outlets, switches, isolators and accessories, including, but not limited to, procurement, transport, storage, testing and inspections, installation at any height and in specified equipment, commissioning, including all fixings, screws, mounting brackets and the like, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

14.2.10 Lighting and Luminaires

The tendered rates shall cover all costs for the supply and installation of luminaires and accessories, including, but not limited to, procurement, transport, handling, storing on Site, inspection and installation at any height and in specified equipment, commissioning, including all fixings, screws, mounting brackets and the like, as required to ensure that the luminaires that are installed are complete and fit for purpose.

14.2.11 Fire Detection Systems

The tendered rates shall include all costs for the supply and installation of the fire detection system, including, but not limited to, procurement, transport, storage, testing and inspections, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets and the like.

14.2.12 Building Access Control Systems

The tendered rates shall cover all costs for the supply and installation of the building access control systems, including, but not limited to, procurement, transport, storage, inspections and testing, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets and the like.

14.2.13 Earthing and Lightning Protection Systems

The tendered rates shall cover all costs for the supply and installation of the earthing and lightning protection systems, including, but not limited to, procurement, transport, storage, testing and inspections, designs and drawings for approval (multiple reiteration), commissioning of the equipment at the required location and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all accessories, fixings, screws, mounting brackets and the like.

14.2.14 Visual and Audible Alarm Indicators

The tendered rates shall cover all costs for the supply and installation of the visual and audible alarm indicator systems, including, but not limited to, procurement, transport, storage, inspections and testing, drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all accessories, fixings, screws, mounting brackets and the like.

15.0 MATERIAL SPECIFICATIONS

Table 16 : Material/Equipment

Component / Material	Make Type or Equivalent Approved
Cable and Wiring	
LV Cables and Conductors	Aberdare, CBi
Earth and Safety Earth Cables	Aberdare, CBi
Wiring in Conduit / Trunking	Aberdare, CBi
Lugs, Joints, Terminations	Not specified
Control and Network Cabling	Not specified
Control and Network Termination	Not specified
Glands and Junction Boxes	
Glands	CCG, Pratley
Junction Box	CCG, Pratley
Cable Support Infrastructure	
Cable Tray, Ladders, Racks	Cabstrut, O-Line, Schneider Electric
Cable Wiring Channels, Ducts	Cabstrut, O-Line, Schneider Electric
Conduiting and Power Skirting	
Conduit chased or installed into Walls	Not specified
Conduit exposed (surface mount)	Not specified - 316L stainless steel
Power Skirting	ABB
Wall boxes chased into Walls	Not specified
Wall boxes exposed (surface mount)	Not specified - 316L stainless steel
Labels, Cable Identification and Cable Ties	
Equipment Labelling/Numbering	Traffolyte and CAB 3
Power and Data Outlets and Accessories	
Socket Outlets	LESCO, Crabtree, Clipsal, Legrand
Isolators	LESCO, Crabtree, Clipsal, Legrand
Industrial Welding Socket	Crabtree, Clipsal, Legrand, WACO
Telephone and Data Outlets	Crabtree, Clipsal, Legrand
Luminaires and Light Switches	
Luminaire Type A	2 x 10W (4000 Kelvin), LED, up/down, diecast marine grade aluminium body, high-impact clear glass protector, wall mounted, IP65 luminaire, colour pearl light grey type Beka LED Duo.
Luminaire Type B	65W (4000 Kelvin), LED, vapour proof, polycarbonate body, opaque polycarbonate diffuser, surface/bracket mounted, IP65 luminaire, colour light grey type Venture Lighting 65W Non-Corrosive 1500mm Twin 840.
Luminaire Type C	5W/meter (4000 Kelvin), 230Vac (incl. power supply if needed), LED flexible strip light, silicon body, opaque silicon diffuser, surface mounted, IP65 luminaire, colour light grey type Luminance LED Neon Flex.

Table 16 : Material/Equipment

Component / Material	Make Type or Equivalent Approved
Luminaire Type D	60W (4000 Kelvin), LED, 1200mm x 600mm panel, aluminium body, opaque polycarbonate diffuser, drop-in ceiling mounted, IP20 luminaire, colour white luminaire type Venture Lighting 60W LED Panel 600mm x 1200mm Edge Lit 840.
Luminaire Type E	18W (3000 Kelvin), LED, Bulkhead, high-pressure die-cast aluminium body, surface mounted, IP66, luminaire, colour black type Beka Bulkhead Series 52 LED 18W Opaque.
Luminaire Type F1	210W (3000 Kelvin), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium type Philips Tango G2 HP LED Floodlight 315LEDs 210W.
Luminaire Type F2	120W (3000 Kelvin), LED, floodlight, high-pressure die-cast aluminium body, tempered glass protector, surface stirrup mounted, IP65, luminaire, colour grey aluminium type Philips Tango G2 LED Floodlight 120LEDs 120W.
Light Switches	Clipsal S2000 Range
Distribution Boards and Enclosures	
Distribution Boards	ABB ArTu range
UPS Panel and Battery Cabinet	ABB ArTu range
LV Switchgear	ABB
Electronic Equipment	
Access Control System	Impro IXP220
Fire Detection System	Ziton / Aritech
Fire Detection Cable	PH120 1.5mm²
UPS	Riello Multi Sentry, Eaton, Tescom
Variable Speed Drives	ABB
Soft Starters	ABB
Visual and Audible Alarm Indicators	
Visual Alarm Indicators	ACDC IP65 L-shape wall mounted 24V Signal Tower LED Light (One LED Light only per Indicator), or equal approved. LED colours as specified in bills of quantities or instructed otherwise.
Audible Alarm Indicators	ACDC IP65 32 Tone 75dB Eagle Audible Alarm Colour Red, or equal approved.

Technical Specification Tippler 3 Bulk Power Supply -

Protection and Metering Installations

Document Number 1924701-2-300-E-SP-0009

Document Details

Ref (SA)	1924701-2-300-E-SP-0009
Date	27 May 2016
Prepared by	Lize-Mari Botha
Reviewed by	Brett Sansom
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	13 April 2018	Issued for Construction	Colin Pym	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

This specification covers the requirements for the MV (and LV where applicable) protection and metering *works* at the three new Substations M, N and New Main Intake Substation, Tippler 3 building transformer (no metering required at this point) as well as other associated *works* at Eskom's existing Blouwater and Iscor Substations.

1.2 Purpose

The purpose of this specification is to set out the minimum technical requirements for quality and workmanship for the design (where required), fabrication, supply, installation, construction, testing and commissioning of equipment and associated infrastructure for the MV (and LV where applicable) protection and metering installations, which include, but are not limited to, the following:

i. Various Eskom Substations (Blouwater, Iscor and Ystervark)

- High-voltage feeder protection schemes (4FZD3920).
- Buszone protection scheme (4BZ5700).
- AC/DC panels.
- Battery panels and accessories.
- Metering panels.
- Junction boxes (current, voltage, isolator, interface).
- Telecontrol equipment.
- Substation automation equipment.

ii. Main Intake Substation:

- 132-66/11 kV transformer and 11 kV reactor (if applicable) protection schemes.
- 11 kV busbar (arc) protection for all air-insulated compartments.
- 11 kV cable feeder protection with overcurrent, earth-fault, over-/under Voltage, over-/under frequency and including differential and Solkor protection.
- 11 kV cable feeder protection with overcurrent, earth-fault, over-/under voltage, over-/under frequency and differential protection.
- Bus section protection with overcurrent, earth-fault and synchronism check.
- Metering panels.

iii. Substations M and N:

- 11 kV and 3.3 kV busbar (arc) protection for all air-insulated compartments.
- 11 kV cable feeder protection with overcurrent, earth-fault, over-/under voltage, over-/under frequency and differential protection.
- 11/3.3 kV transformer protection with unit protection, overcurrent and earth-fault protection.
- 11/0.4 kV transformer protection with overcurrent and earth-fault protection.
- Bus section protection with overcurrent and earth-fault protection.
- Metering panels.

iv. Substations A, H, J and K:

- Decommission and remove existing Solkor-R/Rf relays and connecting to Main Intake Substation as applicable.
- Cut the face-plate (if necessary) of the panel to fit the new Solkor-N relay.
- Install, test and re-commission affected bays.

v. Tippler 3 Building:

- 11/0.4 kV transformer protection with unit protection, overcurrent and earth-fault protection.

This specification shall be read in conjunction with the following documents, drawings and further details and specifications as referenced therein:

- Works Information.
- Bill of quantities.
- Site Information.
- Drawings.
- Technical schedules.
- Further applicable requirements included in other parts of the contract documentation.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton Seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
A	Ampère
AC	Alternating Current
Amsl	Above Mean Sea Level
BoQ	Bill of Quantities
CB	Circuit Breaker
CBNH	Circuit Breaker Not Healthy
COMTRADE	Common format for Transient Data Exchange
CT	Current Transformer
dB	Decibel
DC	Direct Current
DCI	Direct Current Isolate Switch
DP MCB's	Double Pole Miniature Circuit Breakers
DTF	Distance to Fault
DT	Definite Time
GPRS	General Packet Radio Service
GSM	Global System for Mobile communication
HMI	Human-machine Interface
HV	High Voltage (44 kV and above)

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
Hz	Hertz
I/O	Input-/Output
IDMT	Inverse Definite Minimum Time
IEC	Independent Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronic Engineers
In	Nominal Current Rating
IP	Ingress Protection
IRIG	Inter-range instrumentation group time codes
JB	Junction Box
kPa	kilo-Pascal
LAN	Local Area Network
LAP	List of Accepted Products (Eskom)
LC	Lucent Connector
LCD	Liquid Crystal Display
LDC	Line Drop Compensation
LED	Light Emitting Diode
LHMI	Local Human-machine Interface
LOR	Local/Off/Remote Switch
LV	Low Voltage (1000 V and below)
mm	Millimetre
MCB	Miniature Circuit Breaker
MIB	Marshalling Interface Box
MRT	Motor Running Timer
ms	Millisecond
MV	Medium Voltage (between 1000 and 44 kV)
MVA	Mega-volt Ampère
NRS	National Rationalised Specifications
OEM	Original Equipment Manufacturer
OLTC	On-load Tap Changer
PCBs	Poly-chlorinated biphenyls
PMRTU	Pole-mounted Remote Terminal Unit
PPS	Pulse Per Second
PTP	Precision Timing Protocol
p.u.	Per Unit
PVC	Poly-vinyl Chloride
REF	Restricted Earth Fault

Table 2 : Abbreviations

Abbreviation	Meaning Given to the Abbreviation
RMS	Root mean square
RTU	Remote Terminal Unit
s	Seconds
SABS	South African Bureau of Standards
SANS	South African National Standards
SCADA	Supervisory Control And Data Acquisition
SEF	Sensitive Earth Fault
SNTP	Simple Network Timing Protocol
SoE	Sequence of Events
ST	Straight Tip
V	Volt
VA	Volt-Ampère
VAr	Volt-Ampère Reactive
VT	Voltage Transformer
VTJB	Voltage Transformer Junction Box
W	Watt

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of any inconsistency, conflict or discrepancy between the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer, unless with written approval from the manufacturer.

For the Eskom portion of the *works*, only Eskom approved equipment, schemes, materials and the like shall be used. Reference shall be made to the latest LAP list available on Eskom's technical document website.

The C*ontractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer's premises, or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 *Employer's* Standards

The *Contractor* shall be responsible for compliance of all *works* with the following *Employer* standards and specifications and other standards and specifications as referenced therein.

Table 3 : *Employer's* Standards and Specifications

Standard	Description
EEM-Q-008	Corrosion Protection Specification
EEM-Q-012	General Electrical Equipment
EEM-Q-013	Commissioning and Handover
EEM-Q-017	Medium Voltage Switchgear and Control Gear for Substation
EEM-Q-018	Lighting on Equipment
EEM-Q-019	Cable Reel Systems
EEM-Q-020	Test on Electrical Equipment
EEM-Q-021	Electronic Equipment
EEM-Q-023	Medium Voltage Equipment for Port Equipment
SYS-P-0001	Business Codification
H500100-2-000-J-STD-0008	Instrumentation Identifications Standard
H500100-2-000-J-STD-0009	Tag Naming Standard

It is the responsibility of the *Contractor* to ensure that he obtains all of the *Employer's* standards (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the *works* by the *Contractor* to the standards.

3.4 South African and International Standards

The *Contractor* shall also ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include the following and all other standards and specifications as referenced therein.

Table 4 : South African Standards

Code	Standard Title
SANS 474	Code of practice for electricity metering
SANS 556	Low-voltage switchgear
SANS 60044-7	Instrument Transformer Part 7: Electronic Voltage Transformers
SANS 60044-8	Instrument Transformer Part 8: Electronic Current Transformers
SANS 60050-441	International electrotechnical vocabulary Chapter 441: Switchgear, control gear and fuses
SANS 60439	Low-voltage switchgear and control gear assemblies
SANS 60623	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Vented nickel-cadmium prismatic rechargeable single cells
SANS 60670	Boxes and enclosures for electrical accessories for household and similar fixed electrical installations

Table 4 : South African Standards

Code	Standard Title
SANS 60947	Low-voltage switchgear and control gear
SANS 60998	Connecting devices for low-voltage circuits for household and similar purposes
SANS 61000	Electromagnetic compatibility (EMC)
SANS 61058	Switches for appliances
SANS 61084	Cable trunking and ducting systems for electrical installations
SANS 61439	Low-voltage switchgear and control gear assemblies
SANS 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
SANS 61850	Communication networks and systems for power utility automation
SANS 61869	Instrument transformers
SANS 62051	Electricity metering
SANS 62052	Electricity metering equipment (a.c.) - General requirements, tests and test conditions
SANS 62053	Electricity metering equipment (a.c.) - Particular requirements
SANS 62054	Electricity metering (a.c.) - Tariff and load control
SANS 62055	Electricity metering - Payment systems
SANS 62056	Electricity metering data exchange
SANS 62058	Electricity metering equipment (AC) - Acceptance inspection
SANS 62059	Electricity metering equipment - Dependability
SANS 62208	Empty enclosures for low-voltage switchgear and control gear assemblies
SANS 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
NRS 029	Current transformers
NRS 030	Inductive voltage transformers
NRS 047	Electricity supply - Quality of service
NRS 048	Electricity supply - Quality of supply
NRS 083	Code of practice for the application of electromagnetic compatibility (EMC) standards and guidelines in electricity utility networks
NRS 096	Electricity metering - Ancillary specifications

International standards shall include the following and all other standards and specifications as referenced therein.

Table 5 : International Standards

Code	Standard Title
IEC 60068	Environmental Testing
IEC 60870	Telecontrol equipment and systems

3.5 Eskom Standards

Eskom standards shall include the following and all other standards and specifications as referenced therein.

Table 6 : Eskom Standards

Code	Standard Title
Protection	
240-42066934	IEC 61850 Protocol Implementation Document For The Purposes Of Substation Automation
240-49994219	Technical Requirements For The Sourcing Of Protection, Control And Automation Equipment
240-56362060	Protection Philosophy Line Differential Protection For Underground And Overhead Feeders From 11 kV Up To 132 kV
240-56364503	Standard For The Application Of Buszone Protection
240-61224248	Protection, Telecontrol And Substation Automation Technology Direction For The Wires Business
240-62629353	Specification For Panel Labelling Standard
240-62773019	Specification For Low Voltage Auxiliary Electrical Components Standard
240-64100247	Standard For Earthing Of Secondary Plant Equipment In Substations
240-64636794	Generic Equipment Specification For Wiring, Wire Marking, Cable Numbering, Fibre Optic Cable Installation And Labelling Standard
240-64685228	Generic Specification For Protective Intelligent Electronic Devices (IED's)
240-65216698	Test Procedure For Inductive And Capacitive Voltage Transformers
240-65216748	Test Procedure For Power Transformers
240-68980568	Standard For The Application Of Transmission And Distribution Protection Schemes
240-70413291	Specification For Electrical Terminal Blocks
240-72263631	PTM&C IP Address Allocation Guideline
240-74771178	Substation Automatic Voltage Regulation Philosophy
240-75424170	Substation Automation - Substation Computing Platform Standard
240-75425259	Specification For Screened Armoured Cable For EIA-485 Data Communication
240-75712557	Standard For Back-Up Protection On 11 kV Up To and Including 132 kV Networks
240-75763120	Specification For A Digital Temperature Instrument For Power Transformers
240-81321219	Substation Automation Network Architecture Standard For Distribution Substations
240-84854886	Protection Philosophy: Transformers And Shunt Reactors For Wires Business On The Eskom Network
240-89338526	Protection Settings Process Flow Within The Distribution Group
DST_34-195	Standard Drawing Practice For Cad Users In The Power Plant And Control Plant Environments And For Electrification Networks
DSP_34-233	Specification For A Distribution Under Frequency Load Shedding Protection Scheme
DSP_34-543	Specification For A Distribution Transformer On-Load Tap Changer Protection And Control Scheme
DPC_34-1034	Distribution Test Procedure For High Voltage Isolators

Table 6 : Eskom Standards

Code	Standard Title
DPC_34-1035	Current Transformer Test PC
DPC_34-1395	Distribution Test Procedure For Over Current And Earth Fault Protection Relays
DPC_34-2244	Distribution Bus Bar Protection Testing And Commissioning PC
PVAAZ9	Procedure For Collecting Information For Forecasting Requirements For Protection And DC Equipment
Metering	
240-57648999	Standard Regarding Access To Meters, Metering Circuits And Metering Data
240-61227528	Requirements For Revenue Protection Audits On Conventional Metering Guideline
240-61266818	Specification For GSM / GPRS Modems For Remote Metering
240-65292589	Standard For Substation Meter Panels - HV/MV Indoor
240-69164883	Live Method Non-Intrusive Current Transformer (CT) Ratio Verification
240-69387766	Standard For Programmable Meter Configuration
240-69387776	Standard For Configuring GPRS Cellular Modems
240-70732858	Standard For The Configuration Of The Landis And Gyr FBC Encoder
240-70732868	Standard For Test Block Connections For Metering Circuits
240-71469670	Terminology Relating To The Direction Of Power Flow
240-76613301	Field And Laboratory Evaluation Of Programmable Meters
240-76619529	Standard For Using The Metal In Determining Phasor Diagrams
240-76624509	Control Of New Metering Product And Version Changes In Technical, Software, Firmware And Hardware
240-76624511	Standard For Instrument Transformer Burdening
240-76624513	Standard For The Calibration Of Test Instruments Used By Field Staff
240-76625405	Standard For Analogue Transducer Based Measurement System For Electrical Quantities
240-76628285	Standard For Three Phase Energy Metering For Use With Metering And Verification Projects
240-76628289	Standard For Single- And Three Phase Energy Meters: Whole Current Single Rate
240-76628605	The Treatment Of Active Power And Lagging And Leading Reactive Power In Metering Systems
240-76628621	Standard For Pulsing And Timing On Metering Circuits
240-76628623	Standard For Phase Failure Relays
240-76628631	Standard For Sealing Metering Equipment
240-77224535	Standard For The Estimation Of Large Power Users Metering Data On MV90
240-77224537	Standard For Calibration And Limits Of Errors For Single And Three Phase Energy Meters
240-77224539	Standard For The Calibrating Single And Three Phase (3 Element) Induction Type Active Energy Meters - Class 2 Whole Current And Transformer Operated
240-77224541	Standard For The Operation Of The Metering Data Acquisition (DAS)
240-77296994	Standard For The Configuration Of The Elster Meters Using Power Master Unit

Table 6 : Eskom Standards

Code	Standard Title
240-78943470	Standard For The Configuration Of The Schneider ION 8800 Meter
240-79669677	Demilitarised Zone (DMZ) Designs For Operational Technology
240-80176775	Safe Disposal Of Redundant Batteries
240-80176791	Secondary Plant Commissioning Of DC Power Equipment
240-80309303	Standard For Substation Meter Panels: Outdoor Single And Dual Feeder
240-82534274	Definition Of The Eskom Power Quality Data Import Format (EPQDIF)
240-85106861	Standard For Adopted Open Protocols For Eskom Advanced Meters
240-91415576	Standard For Digital Multimeters
240-99523661	Standard For The Configuration Of The Landis+GYR ZMD & ZMG Meters
240-99523663	Standard For Using The Landis And Gyr Phantom Load Set (TVT4 And TVE102/3) To Inject Metering Circuits
DC & Auxiliary Supply	
240-53114248	Thyristor And Switch Mode Chargers, AC/DC To DC/AC Converters And Inverter/Uninterruptible Power Supplies Standard
240-55151946	Ac Reticulation Philosophy For Substations
240-56227711	Maintenance Of Vantage Nickel Cadmium Cells
240-56362221	Standard For Safety Signs Used In DC Applications
240-60725641	Specification For Standard (19 Inch) Equipment Cabinets
240-75658628	Distribution Group's Specific Requirements For AC/DC Distribution Units
240-76619545	Cordex Battery Charger Settings Work Instruction
240-76627823	Lead Acid and Nickel Cadmium Battery Logbooks Standard
240-76628619	Application Of Emergency Lighting In Distribution Substation Buildings
240-89797258	The Safe Handling, Transportation And Disposal Of Cells, Batteries And Electrolyte
240-91177496	Provision Of Auxiliary Supplies At Switching Substations
240-91190294	Dc & Auxiliary Supplies Philosophy
240-91190310	Sizing Of DC Systems For Substation Applications
240-94937573	Standard For Feeder Bypassing
240-108614750	Acceptance And Commissioning Of DC Supply Equipment
DST_34-999	Design Standard For DC & Auxiliary Supplies
Telecontrol	
240-53902530	Substation Automation - Data Concentrator Specification For Data Retrieval And Remote Access
240-54615374	Distribution Substation Gateway Specification
240-57855742	Secure Remote Access System Standard Specification For Field IED Access
240-59089329	Dnp3 Implementation Standard
240-64038621	Remote Device Communication Standard For Operational And Engineering Data Retrieval And Remote Access
240-68107841	Eskom Iec61850 Standard Requirements For Pics, Pixit And Tics

Table 6 : Eskom Standards

Code	Standard Title
240-68235024	Eskom Iec61850 Station Bus Interoperability Test Standard
240-70412755	Substation Control And Automation HMI Standard Specification For Distribution And Transmission Substations
240-71083018	Telecontrol Protocol Standard
240-71085748	DNP3 Addressing Standard
240-71086056	DNP3 Class Allocation Standard
240-71555552	Specification For 1u 19Rack Mount Fibre Optic Patch Panels
240-76619483	IST PMRTU DNP3 Configuration And Commissioning Standard
240-86457202	DNP3 Device Acceptance Test Procedure
240-103792430	Telecoms Cable And Materials Specification
Substation Commissioning and Handover	
240-54615413	Standard For Commissioning Protection Assets
240-87605434	Quality Checklist For Distribution Substation Primary Plant Prior To Handing Over For Commercial Operation

It is the responsibility of the *Contractor* to ensure that he obtains all Eskom standards, specifications and associated requirements (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the *works* by the *Contractor* to the afore - and abovementioned.

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 7 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details are included in the Site Information document forming part of the accompanying Works Information.

5.0 SCOPE OF *WORKS*

5.1 *Works* Included

5.1.1 Main Intake Substation, Substation M, Substation N and Tippler 3 Building Transformer

The *works* included in the scope of the *Contractor* includes the design (where required), fabrication, supply, installation, construction, testing and commissioning of all protection, automatic voltage control panels and metering panels, testing and commissioning of all IED's installed on MV switchgear, including but not limited to:

- All detailed designs, drawings and documentation as required in terms of this specification. The *Contractor* shall engage the services of approved specialist subcontractors and OEM's, to be approved by the *Employer*, as necessary.
- All management, personnel, labour and other resources that are required to execute the *Contractor's* scope of *works*, in accordance with the requirements of this specification.
- Coordination between other services to be maintained to ensure correct and proper integration of the electrical systems.
- Quality management, as described in the Works Information and these specifications.
- Supply of commissioning and operational spares, required for normal wear and tear during plant operation for the period of one year after commissioning, and special tools required for maintenance purposes, as described in Section 10.0.
- Operating and maintenance manuals, training and back-up support, as described under Section 11.0.
- Pre-commissioning and commissioning of protection and metering installations, including supporting documentation, as described under Sections 13.0.
- All as-constructed documentation, as described under Section 14.0.

The scope of *works* to be provided by the *Contractor* shall include the detailed designs, supply, installation, configuration and commissioning of all new protection, metering and automatic voltage control infrastructure, as referenced in the detailed specifications including, but not be limited to, the items as listed below:

- Measurement instrumentation equipment.
- Enclosures and cabinets.
- All panel wiring inside enclosures with protection, metering or automatic voltage control infrastructure installed, unless factory/OEM warranties apply, in which case the OEM shall be responsible for wiring and modifications.
- Interface and commissioning of communication links between IED's and monitoring and control (where applicable) systems and port main SCADA network.
- Calculation of settings.
- IED software and internal logic programming, including any interlocking required on IED's and the like.
- Factory acceptance testing.
- Site acceptance testing.
- Staged acceptance testing.
- Pre-commissioning testing.
- Commissioning testing.

As part of the *works,* the *Contractor* shall also be required to match protection at existing Substations A, H, J and K as set out below:

- Decommission and remove existing Solkor-R/Rf relays of existing bays and connecting to New Main Intake Substation as applicable.
- Cut the faceplate (if necessary) of the panel to fit the new Solkor-N relay.
- Install, test and re-commission bays.

The system shall be designed, installed and commissioned by the *Contractor* to provide a fully functional, operable and compliant system for the required protection, metering and automatic voltage control systems to all new substation HV, MV, LV and monitoring and control (where applicable) equipment, in accordance with these specifications, Works Information, drawings, bill of quantities and all other related contract documentation.

It will be the responsibility of the *Contractor* to ensure that the specialist subcontractor/OEM fully cooperates, coordinates and furnishes all technical support and associated technical information to the *Employer* and Others as required, to ensure that the new infrastructure and systems are fully and correctly integrated.

Should there be any discrepancies or misunderstandings regarding the *works* to be undertaken by the *Contractor*, the *Contractor* shall immediately notify the *Employer*.

5.1.2 Eskom's 'Ystervark' (Section of New Main Intake Substation), Blouwater and Iscor Substations

The *works* included in the scope of the *Contractor* includes the procurement of Eskom National Contract schemes and equipment, installation, construction, testing and commissioning of all new protection, communication, telecontrol, metering, control, DC and auxiliary equipment including, but not limited to, the following:

- All shop drawings, drawings and documentation as required in terms of this specification. The *Contractor* shall engage the services of approved specialist subcontractors and OEM's, to be approved by Eskom and the *Employer*, as necessary.
- All management, personnel, labour and other resources that are required to execute the *Contractor's* scope of *works*, in accordance with the requirements of this specification.
- Co-ordination between other services to be maintained to ensure correct and proper integration of the electrical systems.
- Quality management, as described in the Works Information and these specifications.
- Operating and maintenance manuals, training and back-up support, as described under Section 11.0.
- Pre-commissioning and commissioning of all protection, communication, telecontrol, metering, control, DC and auxiliary equipment, including supporting documentation, as described under Sections 13.0.
- All as-constructed documentation, as described under Section 14.0.

The scope of *works* to be provided by the *Contractor* shall include the supply, installation, configuration and commissioning of all new protection, communication, telecontrol, metering, control, DC and auxiliary equipment, including, but not be limited to, the items as listed below:

- High-voltage feeder protection schemes (4FZD3920).
- Buszone protection scheme (4BZ5700).
- AC/DC panels.
- Battery panels and accessories.
- Metering panels.
- Junction boxes (current, voltage, isolator, interface).
- Telecontrol equipment.
- Substation automation equipment.
- Factory acceptance testing.
- Site acceptance testing.
- Staged acceptance testing.
- Pre-commissioning testing.
- Commissioning testing.

All *work* shall be done according to Eskom's standards and requirements. The *Contractor* shall ensure that all subcontractors/OEMs conform to all Eskom requirements and requests.

It will be the responsibility of the *Contractor* to ensure that the specialist subcontractor/OEM fully cooperates, coordinates and furnishes all technical support and associated technical information to the *Employer* and Others as required, to ensure that the new infrastructure and systems are fully and correctly integrated.

Should there be any discrepancies or misunderstandings regarding the *works* to be undertaken by the *Contractor*, the *Contractor* shall immediately notify the *Employer*.

5.2 *Works* Excluded

5.2.1 Main Intake Substation, Substation M, Substation N and Tippler 3 Building

The following items are excluded from *Contractor's* scope of *works:*

- The Port's centralised SCADA.
- The *Contractor* is however required to fully cooperate, coordinate and furnish any technical support and information required by the *Employer* and Others responsible for the SCADA remote monitoring and control (where applicable), to enable the required integration of the electrical equipment with the centralized port monitoring and control (where applicable) systems.
- VSDs and any other equipment relating to Tippler 3/Conveyors.

5.2.2 Ystervark, Blouwater and Iscor Substations

The following items are excluded from *Contractor's* scope of *works:*

- Calculation of settings for protection equipment.
- Configuration and testing of RTU and telecontrol functionality to Eskom Control Centre.
- Commissioning of protection and metering installations, however the *Contractor* will assist Eskom and provide any information to them if so requested.

5.3 Designs, Calculations and Drawings by the *Contractor*

5.3.1 General

The *Contractor* shall provide as a minimum the following calculations, designs, drawings and design and construction reports, to be approved by the *Employer*:

- Protection scheme manufacturer's drawings.
- Protection scheme IED internal logic diagrams (masking) in printed and the IED/OEM proprietary software format.
- Protection scheme setting calculation sheets and setting sheets (where applicable).
- Protection scheme settings as applied to the IEDs in printed and the IED/OEM proprietary software format.
- Interlocking and lockouts.
- All associated protection infrastructure.
- Commissioning results of all protection schemes clearly indicating scheme response to fault conditions.

Documentation to be produced by the *Contractor* shall be compiled and submitted in accordance with the procedures included in the Works Information as well as the further requirements as detailed below. All documents, for which prior approvals are required, shall be timeously submitted to the *Employer* for review and approval, prior to placement of orders, fabrication or manufacture.

The *Contractor* shall, as necessary, appoint specialist subcontractors and OEMs to undertake the designs, calculations and drawings, which shall be prepared and checked by suitably qualified and experienced professional engineers, registered with the Engineering Council of South Africa (ECSA) or an equivalent institution recognised by ECSA.

The design engineers shall be appointed by the *Contractor,* subject to approval by the *Employer*. Designs, calculations and drawings shall not be prepared and checked by the same person and shall be reviewed by the *Employer* before the commencement of fabrication.

The *Employer* will provide the *Contractor* with the necessary formats for documents that are to be submitted for approval.

The *Employer* may, at his sole discretion, request additional design calculations, design and construction drawings and associated information, as deemed necessary for verification of the correctness and compliance of the designs. The cost of providing such additional information shall be deemed to be included in the tendered rates, i.e. further payments for such information will not be made.

5.3.2 Designs and Calculations by the *Contractor*

The *Contractor* shall submit all required calculations in a neat and legible manner. Where calculations are performed using specialised software programs, the *Contractor* shall also furnish copies of the final native software files, without any exclusions. The calculations shall be provided in a professional, neat format, to include, but not be limited to, the following, in the order as stated below:

- Summary of assumptions and conclusions.
- Table of contents.
- List of all associated drawings.
- List of compliancy standards.
- List of all text and references used.
- Nomenclature.
- Calculations

5.3.3 Drawings by the *Contractor*

All design and construction drawings shall be submitted in hard and soft copies. Soft copies shall be in 'rvt', 'dgn', 'dwg', 'dxf' and 'pdf' formats as requested by the *Employer*. Three hard copies are to be provided, which shall be fully signed off, unless specified otherwise.

The *Contractor* shall be solely responsible for the submission of any drawings that are to be provided by his appointed specialist subcontractors or OEM.

5.4 Safety

Reference is made to the environmental and safety requirements as detailed in the Works Information and the particular requirements as described below.

The *Contractor* shall take all necessary safety precautions to prevent static electricity discharge, sparking and any other unsafe condition, which could pose a safety risk to personnel, property and/or equipment.

The location and extent of potentially explosive atmospheres are to be identified and indicated on hazardous area classification drawings. All electrical equipment and instruments for use in hazardous classified areas shall be supplied with a hazardous area certificate issued by a certifying authority approved by SABS/SANS/IEC. Certificates shall be indexed and filed in a certification register.

All *works* shall be performed under strict lockout/disconnection conditions and a register shall be kept of all isolated circuits. The *Employer's* requirements shall also be incorporated in all safety procedures. Provision shall be made for the following:

- The switching and lockout procedures shall form part of the *Contractor's* HSE documentation.
- Whenever a live circuit must be isolated, the *Employer* shall be notified.
- The *Contractor* shall maintain a full key lockout system, with appropriate registers and signatures.
- Under no circumstances shall the *Contractor* do any switching. All switching shall be undertaken by the *Employer*/Eskom's authorised personnel.

5.5 South African Electrical Compliance

Any equipment designed and fabricated/manufactured overseas shall have an electrical certificate of compliance to South African Regulations before it is delivered (and operated) in South Africa. The compliance certificate(s) shall fully cover high voltage, medium voltage and low voltage equipment. These certificates shall be issued by an accredited South African professional engineer.

5.6 *Employer* QA Representative

The *Contractor*'s QA requirements shall be as set out in the accompanying Works Information.

The *Employer* may choose to appoint a QA/QC representative to monitor and report on some or all aspects of the production and fabrication processes. Full cooperation shall be extended to the appointed QA/QC representative. Associated costs for such services will be borne by the *Employer*.

5.7 *Contractor*'s Subcontractor Declaration

Where *works* are to be performed by a subcontractor, the *Contractor* shall provide notices and obtain the *Employer's* approval prior to the appointment of the subcontractor. This shall include all subcontractors providing design, fabrication, assembly, installation and related services.

6.0 SPECIFICATIONS

6.1 General

The *Contractor* shall be required to appoint a specialist subcontractor/OEM, as applicable, to undertake the complete design (where applicable), supply, installation and commissioning of the new protection, metering and automatic load management systems respectively for the new Main Intake Substation, Substations M and N, A, H, J and K, as well as the Tippler 3 building transformer (no metering at the Tippler 3 building required), as specified.

The installation of the systems shall include any programming required, and complete integration of the equipment/systems with the respective main electronic monitoring and control (where applicable) infrastructure (data network), and any other local systems as applicable and required. The procedures governing the design (where specified) approval, manufacturing, inspections, testing and commissioning of the equipment/systems, are covered in further sections of these specifications.

It will be the responsibility of the *Contractor* to ensure that the respective specialist subcontractor/OEM fully cooperates, coordinates, support and supply any technical and associated information to Others as required, to ensure that the protection and metering systems are fully integrated, both electrically and electronically.

The *Contractor* shall provide his own computer hardware for programming, testing and commissioning of the protection and metering devices.

6.2 Protection and Control

6.2.1 General

This specification provides the general requirements for all anticipated protection and control functions. The applicability of functions for each bay shall be checked against the bills of quantities and the drawings to ensure correct implementation.

6.2.2 Scheme Requirements

i. *Tripping and Spring Rewind DC Supplies*

Four double-pole miniature circuit-breakers (DP MCB's) shall be provided for the protection and isolation of the DC supplies. The DP MCB's shall be installed in the main tripping (M), back-up tripping (BU), closing (C), and spring rewind (SR) circuits.

Separate DP MCB's (curve C) shall be applied to the main tripping circuit and the back-up tripping circuit as more than 80% of secondary wiring faults are located within the circuit-breaker. The 10A rating provides co-ordination with upstream 16A devices and provides adequate protection for 1.5 mm^2 and 2.5 mm^2 panel wiring. This MCB and wiring refers to the internal scheme.

A 10 A DP MCB (curve C) shall be applied to the spring rewind circuit. The DP MCB is provided to clear faults on the supply cable to the spring rewind motor. The rating shall provide co-ordination with upstream devices and must provide protection to the outgoing 2.5 mm^2 or 4 mm^2 cores, unless otherwise specified.

The "indication" and "network switch supply" circuits shall be supplied from the back-up DC DP MCB via separate MCB's.

The incoming DC supply shall be routed via the back plate to the DP MCB's and thereafter into the system circuitry.

The protection IED internal fuses (where available) shall co-ordinate with the DP MCB.

DP MCB's shall be of the cascading type, approved for use on nominal 110 V DC, and shall be rated to break 5 kA (L/R = 4 ms). The DP MCB's shall be suitable for isolation. The DP MCB's will be designated as follows:

- Main DC supply – DCI MCB (M)
- Back-up DC supply – DCI MCB (BU)
- Close DC supply – CCI MCB (C)
- Spring rewind DC supply – MCB (SR)

The protection shall include terminals on the main or back-up DC circuit to accommodate the provision of an auxiliary DC supply to each circuit-breaker for SF_6 gas pressure monitoring and the like. Where both main and back-up DC circuits are available, the circuit-breaker auxiliary supply shall be provided from a different supply to that feeding the circuit-breaker fail relay.

Loss of the circuit-breaker auxiliary supply renders the circuit-breaker unable to trip or close. A fault occurring whilst the circuit-breaker DC supply is unavailable will be cleared by a back-trip of the upstream circuit-breakers, via the circuit-breaker fail function (provided this relay is itself not affected by the DC supply failure).

ii. *Separate Indication DC Supply*

Where the practice of providing a separate DC supply for indication purposes is followed, the supply shall normally be routed through a mechanical indication cut-off timer located on the DC distribution panel and supplied from a dedicated DP MCB.

Additional terminals shall be provided in the scheme to facilitate connection of this supply.

All DC indication lamps shall be connected into this circuit.

iii. *AC Supply*

AC supply shall be provided for each scheme for the “Protection not healthy” indication circuit, for transducers and for mechanism box heaters.

The incoming AC supply shall be routed through a double pole (DP) MCB (curve C) for isolation and protection purposes. The rating shall provide co-ordination with upstream devices and provide adequate protection for 2.5 mm^2 and 4.0 mm^2 panel wiring.

The AC supply to the heaters in associated primary equipment interface enclosures shall be supplied from the same AC supply. Each heater supply shall be provided with a DP MCB (curve C) for protection and isolation purposes. The MCB shall provide adequate grading with the MCB on the incoming supply.

AC MCB’s shall have rated breaking capacities of 6 kA, cascading type.

The PNH indication lamp shall be supplied directly from the MCB. Transducers (where required) shall be supplied via sliding link isolation terminals on the AC supply (i.e. from the AC MCB).

iv. *Auxiliary Voltage Supplies*

The DC MCB’s shall be collectively labelled “DC Isolate” in addition to their individual functions and will replace the traditional DC Isolate switch.

The master trip relay and associated trip inputs will be wired to the main DC supply, whilst the main IED, including all current and voltage based protection, as well as the winding temperature trip inputs, shall be wired to the back-up DC supply. Auxiliary DC supplies to the circuit-breaker mechanism boxes and MIB and circuit-breaker closing circuits shall be fed from the back-up DC circuit.

It shall be possible for the indication circuit to be supplied with power via the back-up DC circuit, or from an independent DC source.

v. *Local Alarm and Indication Circuits*

The operation of all alarm and tripping functions, such as differential, REF, over current protection and the like, shall be clearly indicated locally to an operator via the main IED. Clear distinctions shall be made between each function, namely “HV Hi-set OC”; “HV IDMT OC” and the like. The indication shall be displayed on an LCD alpha-numeric display, using user-defined text messages, or via a target LED and a user defined text label. All trip and alarm indications shall remain displayed until reset by a push button.

The main IED should have sufficient target LED’s and a hand reset function, such that annunciation may be done on the IED. All LED-type alarms that are latched shall be reset with one push button.

Local indication of the alarms and trips of IED’s not situated on MV switchgear shall be as depicted on the layout drawings.

Panel mounted semaphores shall be included, providing the following DC operated indications:

- Circuit-breaker Open (Green).
- Circuit-breaker Closed (Red).
- Disconnector Open (Green).
- Disconnector Closed (Red).
- MV Incomer Cable Earthed (Red).

Panel mounted cluster LED’s shall be provided for the following indications:

- Circuit-breaker Not Healthy (Amber)

Any master, customer master or trip repeat relay not visible with an acceptable flagging mechanism and hand reset push button shall have an LED integrated in the relay reset push button, indicating its operation. The integrated push button/LED shall be suitably labelled.

6.2.3 Protection Relays: Intelligent Electronic Devices (IED)

6.2.3.1 *Applicable Standards*

Relays shall conform to the following and any other standards (as applicable):

- IEC 60068 – Environmental Testing
- IEC 60255 – Measuring Relays and Protection Equipment
- IEC 60870-5-103 – Transmission Protocols – Companion Standard for the Informative Interface of Protection Equipment
- IEC 61000 / SANS 61000 – Electromagnetic Compatibility (EMC)
- IEC 61850 / SANS 61850 – Communication Networks and Systems for Power Utility Automation

6.2.3.2 *Hardware*

i. Operating Conditions:

The IED's shall be capable of operating within the limits as indicated in Table 8 below.

Table 8 : Operating Conditions for Protection and Metering Equipment

Condition	Description
Operating Altitude	≤ 2000 amsl
Operating Temperature	45°C Maximum; -5°C Minimum
Maximum Humidity	< 93 %, non-condensing

ii. Safety

Protective IED's shall be designed in accordance with the product safety requirements of IEC 60255-27.

iii. Frequency

The power frequency shall be 50 Hz nominal. Relays shall operate as per specification within the range of 47 Hz to 52 Hz. Total harmonic distortion, including all harmonics up to the order of 40, shall not exceed 8 %.

iv. DC Supply Inputs

Auxiliary supplies shall be provided at 110 V DC The supply voltage tolerance shall be ± 20% of nominal.

v. AC Supply Inputs

AC supplies shall be 230 V phase-to-neutral and 400 V phase-to-phase.

vi. Output Contacts

Output contacts shall be rated as indicated in Table 9 below.

Table 9 : Output Contact Ratings

Condition	Description
Make and carry for 500 ms	30A @ 250 V DC
Carry for 3s	15A
Carry continuously	8A
Break (inductive L/R = 40 ms)	0.15A @ 250 V DC

The break current rating may be reduced if a current operated seal-in (compatible with the proposed design) is provided.

Contacts used to directly operate circuit-breaker tripping or closing coils shall be rated to break 10A (L/R = 20ms) at 250 V DC.

Suitable contact protection (i.e. a snubber circuit) may be provided in tripping circuits, so as to achieve this.

Where the contact is not capable of breaking 10A (L/R = 20ms) at 250V DC without external contact protection, operation of a circuit breaker closing coil shall be done via a “sacrificial” auxiliary relay rather than directly by the numerical IED’s output contacts.

vii. Self-Monitoring (Watchdog Contact)

Relays shall have a self-monitoring function of both hardware and software that is done on a continuous basis. Any fault or irregularity shall immediately be alarmed via a watchdog output contact. Each relay shall be equipped with one normally-open and one normally-closed watchdog contact. Alternatively, a single change-over contact may be provided.

viii. AC Current Inputs

Unless specified otherwise or in the design drawings, current transformer inputs shall be rated at 1A nominal (In) with the following overload capabilities:

- 50 x In for 3 s or 100 x In for 1 s
- 2 x In continuously

The total burden of the current transformer circuits comprising a single complete protection system shall not exceed 0.2 VA per phase at In.

The burden imposed by each CT input shall be less than 0.5 VA in this case.

The neutral and, where provided, Sensitive Earth Fault (SEF) current inputs shall include filtering to prevent operation when harmonics are present in the primary residual earth currents. A low-pass filter with the following characteristics shall be supplied:

- 2^{nd} harmonic rejection > 6:1; and
- 3^{rd} harmonic rejection > 50:1

ix. Mechanical Design

The IED shall be of the plug-in type, where the plug-in unit can be withdrawn or inserted into a fixed mounted base unit. All I/O and analogue circuits etc. shall be terminated on the fixed mounted base. The withdrawal of the plug-in unit shall result in immediate shorting of all current circuits. Safe withdrawal of the IED from the base unit shall be possible without having to install or modify any circuit connecting to the IED or the mounted base unit. Means shall be included to seal the plug-in unit into the base unit, to prevent accidental removal.

IP rating of the IED shall be IP 54.

x. Current Connections

For the current transformer secondary circuit lead connections, both ring lug and compression type terminations shall be supported. Each of the current terminals shall be capable of accepting at least two 2.5 mm^2 size wires, either solid or fine stranded.

6.2.3.3 *User Authorisation*

The IED shall have a minimum of four user groups for the various required functions of the personnel on Site. Each group shall have a unique username and password that can only be changed by the administrator. The minimum available user groups with rights shall be as indicated in **Table 10** below:

Table 10 : User Rights

Condition	Description
Viewer	Read only access
Operator	Selecting “Local” or “Remote” state Read records and alarms Clear alarms and indications Operate equipment
Engineer	Operator rights plus: Change settings Clearing records and events
Administrator	Engineering rights plus: Changing passwords Factory reset of IED View auditing log

The *Employer* may, at his discretion, require a change to the user rights, which will, if applicable, be communicated as an instruction to the *Contractor*.

6.2.3.4 *Auditing*

It shall be possible to log, in a chronological order, at least the following events:

- Configuration file changes.
- Firmware changes.
- Settings/setting group changes.
- Test mode on/off.
- Latched trip resets.
- Password changes.

Only the administrator shall have rights to access the log. It shall not be possible to clear the log under any circumstances.

6.2.3.5 *Local Communications Requirements (Station)*

The use of the IEC 61850 protocol is preferred for communication between the IED’s, for local communication, operation and control.

Communication shall be possible via fibre, copper or serial ports, or a combination of the three. Wherever possible, LC fibre connectors shall be used. If LC fibre connectors are not available, the *Contractor* shall indicate which connectors are available.

6.2.3.6 *Inter-tripping*

The protection shall provide an inter-trip facility capable of the following, selectable on the relay:

- A trip at the local end directly trips the circuit breaker at the remote end; or,
- A trip at the local end removes the need for a guard operation at the remote end, allowing tripping with a weak infeed.

Two additional inter-trip channels shall be provided, which will allow external devices to directly trip the remote end.

6.2.3.7 *Access*

It shall be possible to access the IED from the IED front-port, from the local substation PC/ substation LAN, or remotely via a web-interface. Access and rights shall be as per the user rights defined in **Table 10** above.

6.2.3.8 *Time Synchronisation*

Time synchronisation shall be possible by receiving a pulse from an external clock via SNTP or PTPv2/IEEE 1588-2008. It shall have a time stamping resolution of 1 ms.

6.2.3.9 *Bay Control*

It shall be possible to control a circuit breaker, motor-operated disconnectors or circuit breaker truck and motor-operated earth-switch from designated control buttons on the local HMI (LHMI) of the IED. Additionally, primary devices shall easily be controlled and statuses clearly indicated via a single-line diagram view on the IED LHMI.

It shall be possible to interlock the circuit breaker open/close command directly by a binary input, protection relay internal interlocking logic, thermal protection operation, or by a protection relay trip command output operating in lock-out mode. Operation of the equipment from the LHMI shall only be possible if the bay is completely isolated from the power system.

6.2.3.10 *Indications and LED's*

All protection start and trip alarms must be clearly indicated and logged internally. The resetting of indications and alarm LED's shall be easy, preferably by pressing one button only. User rights shall be such that the clearing of indications and alarms can only be done by suitably authorised personnel.

The LHMI shall include at least eleven (11) freely programmable alarm LED's for status indication. It shall be possible to insert a written clarification on a paper strip beside each of the LED's to indicate the assigned function of the LED.

6.2.3.11 *Local/Off/Remote Switch*

The LHMI shall be equipped with a Local/Off/Remote (LOR) switch/button, and shall include local and remote status indication. It shall be possible to alarm to the SCADA system the status of this LOR switch.

The operation rights of the LOR switch shall be covered with the user authorisation procedures of the relay. When in "Local" mode, remote control commands to the bay shall be ignored, and vice versa in "Remote" mode.

6.2.3.12 *Disturbance, Fault and Event Recording*

The relay shall be capable of recording and storing at least the 1000 latest time-tagged events in a non-volatile memory.

The sample frequency shall be selectable, maximum sample frequency being no less than 1.6 kHz (32 samples per cycle at 50 Hz). The recording time shall be selectable, including the pre-trigger time. All analogue and binary input channels must be capable of triggering the function.

There shall be a settable delay time for triggering channels, in order to prevent successive recordings triggered by the same source. Analogue channels must have an adjustable triggering level. For binary channels it shall be possible to choose triggering either from the rising or falling edge of the signal, or both. It shall be possible to record either wave-forms or trends of the analogue channels. When the maximum number of channels is connected, utilising the highest sampling frequency, at least two recordings, each with a length of 10 seconds, shall be supported.

Support for a suitable software tool shall be included for uploading the recorded disturbance records. The uploaded recording shall be of a well-recognized format, preferably the COMTRADE format.

i. Event Registration

The SoE (Sequence of Events) information must be accessible locally via the user interface on the relay front panel or remotely via the communication interface of the relay. This information should furthermore be accessible, either locally or remotely, using the web-browser based user interface.

To collect sequence-of-events (SoE) information, the relay must incorporate a non-volatile memory with a capacity of storing at least 1000 event codes with associated time stamps. The non-volatile memory must retain its data also in case the relay temporarily loses its auxiliary supply. The event log should facilitate detailed pre - and post-fault analyses of feeder faults and disturbances.

ii. Fault Records

The relay should have the capacity to store the records of at least 100 fault events. The records must enable the user to analyse the four most recent power system events. Each record must include the current and voltage values (if applicable), the start times of the protection blocks, time stamp and the like.

It must be possible to trigger the fault recording by the start signal or the trip signal of a protection block, or by both. The available measurement modes include DFT, RMS and peak-to-peak. In addition, the maximum demand current with time stamp should be separately recorded. By default, the records must be stored in a non-volatile memory.

iii. Disturbance Records

The relay must be provided with a disturbance recorder. From the analogue channels it shall be possible to record either the waveform or the trend of the currents and voltage measured.

It must be possible to trigger the recording function by an analogue channel when the measured value falls below or exceeds the set triggering value. The binary signal channels should be capable of starting a recording on the rising or the falling edge of the binary signal, or on both.

Binary relay signals, such as a protection start or trip signal, or an external relay control signal over a binary input, should be capable of triggering a recording. The recorded information must be stored in a non-volatile memory and be downloadable for subsequent fault analysis.

6.2.3.13 *Setting Groups*

To handle periodic changes in the primary circuit switching conditions, i.e. the network topology, there shall be support for at least four (4) different setting groups for each of the protection functions. The change of setting group shall take place commonly for all of the protection functions.

It shall be possible to change the setting group locally from the LHMI, using a binary input signal and remotely through the communication link. The change of setting group shall happen rapidly and it shall not result in a protection relay restart, a relay malfunction or a communication break.

6.2.4 Current Protection Functions

6.2.4.1 *Solkor Current Differential*

The current differential protection shall perform magnitude and phase angle comparison of currents, on a phase-by-phase basis, although tripping shall be three phase. The protection shall be capable of compensating for mismatched CTs at each end of the feeder. The protection shall be stable for through faults at high fault levels when the line CTs saturate.

Communication between stations for Solkor protection shall be by means of a direct fibre link.

The device shall be capable of displaying the following measurements without user intervention:

- Local and remote end primary currents.
- Local and remote end secondary currents.

- Differential primary currents.

The waveform recorder records shall include the local and remote end currents in primary amps.

6.2.4.2 *Overcurrent*

The protection shall consist of a minimum of four separate freely settable non-directional overcurrent stages, covering setting ranges from 0.1 to 35 times p.u. (per unit). The operation characteristic of the low and high set stages shall be settable to either definite time or inverse time mode, supporting various types of inverse curves, including a user definable one.

One of the four stages shall work as an instantaneous stage. The instantaneous stage shall also support the peak-to-peak measurement mode and include a possibility to introduce a dedicated two times setting value peak detection for fast operation under conditions when the current transformers have saturated.

During an inrush current situation when large proportions of second harmonics are detected, it shall be possible, for each of the stages, to raise the setting value by a freely settable multiplier. It shall be possible to select the number of started phases for operation between one, two or all three.

6.2.4.3 *Earth Fault*

i. Non-Directional

The earth-fault protection shall consist of three different stages and an additional sensitive stage. The stages shall cover setting ranges from 0.01 to 35 times p.u. The first two stages and the sensitive stage shall include both definite and inverse time characteristics, supporting various types of inverse curves, including a user-definable one. The fourth stage shall work as an instantaneous stage.

ii. Directional

The earth-fault protection shall consist of three separate admittance-based or directional earth-fault stages and an additional non-directional stage using a calculated I_0 value for cross-country faults.

The admittance stages shall cover voltage setting ranges from 0.05 to 5 times p.u. The directional and non-directional stages shall cover current setting ranges from 0.01 to 35 times p.u. They shall include both definite and inverse time characteristics, supporting various types of inverse curves, including a user definable one.

It must be possible to operate the directional stages in non-directional mode. The operation mode must be selectable by means of a parameter.

During an inrush current situation, characterised by a large portion of second harmonics, it shall be possible, for each of the stages, to either block or raise the setting value by a freely settable multiplier. The third harmonic shall be attenuated at least by 40 dB.

6.2.4.4 *Cable Differential*

The line differential function shall include low set, stabilised and high set, non-stabilised stages. The stabilised low set stage shall provide a fast clearance of faults while remaining stable when high currents are passing through the protected zone, increasing current measurement errors. The second harmonic restraint shall ensure that the low set stage does not operate due to energisation of a tapped transformer.

The high set stage shall provide a very fast clearance of severe faults, including a high differential current, regardless of harmonics.

The operating time characteristic for the low set stage shall be selectable, either definite time (DT) or inverse definite minimum time (IDMT). A direct inter-trip shall ensure that both ends are always operated, even without local criteria.

It shall be possible to disable the differential function either from the LHMI on the protection relay, or externally from a pushbutton/isolate switch mounted on the switchgear panel.

6.2.5 Voltage & Frequency Protection Functions

6.2.5.1 *Over-/Under Voltage*

i. Three-Phase Overvoltage

The three-phase overvoltage function shall include a settable value for the detection of overvoltage either in a single phase, two phases or three phases. It shall include both definite time (DT) and inverse definite minimum time (IDMT) characteristics for the delay of the trip.

A residual overvoltage function shall also be included as a separate function block.

It shall be possible to block the function outputs, timer or the function itself, if so desired.

ii. Three-Phase Under Voltage

The three-phase under voltage function shall include a settable value for the detection of overvoltage in a single phase, two phases or three phases.

It shall be possible to block the function outputs, timer or the function itself, if so desired.

6.2.5.2 *Over-/Under Frequency*

The IED shall include basic over frequency, under frequency and rate-of-change-of-frequency protection. It shall be possible to use combined criteria to achieve even more sophisticated protection schemes for the system.

It shall be possible to block the function outputs, timer or the function itself, if so desired.

6.2.6 Transformer Unit Protection

6.2.6.1 *Differential Protection (Stabilised) for two Winding Power Transformers*

The protection function shall consist of two separate stages, which are independently settable. The phase difference of the currents of winding 1 and winding 2 that is caused by the vector group of the power transformer shall be numerically compensated.

The biased low-set stage shall provide fast clearance of faults while remaining stable when high currents are passing through the protected zone, increasing current measurement errors.

Blocking the operation of the relay's biased low-set stage at a magnetizing inrush current shall be based on the ratio of the amplitudes of the second harmonic filtered from the differential current and the fundamental frequency (Id2f /Id1f).

The fifth harmonic restraint shall ensure that the low-set stage does not operate on apparent differential currents caused by a harmless transformer over-excitation.

The instantaneous high-set stage shall provide a very fast clearance of severe faults with a high differential current regardless of their harmonics content.

6.2.6.2 *Low/High-Impedance Restricted Earth-Fault Protection*

The relay shall include either high-impedance restricted earth-fault protection or low-impedance restricted earth-fault protection. The stabilised restricted high-impedance earth-fault protection shall operate when I_0, the differential neutral current, exceeds the set start value. The operating characteristic shall be according to the definite time mode.

On request, the protection should be based on the low-impedance principle. In this case the stabilised restricted low-impedance earth-fault protection shall be based on the numerically stabilised differential current principle and the neutral-current second harmonic shall be used for blocking the function during a transformer inrush

6.2.6.3 *Winding Temperature*

Three-phase thermal overload detection protection shall be included as required. An alarm signal shall give an early warning to allow the operators to take action before the transformer trips. The early warning shall be based on a three-phase current measuring function using a thermal model with two settable time constants. If the temperature rise continues, the protection should operate based on the thermal model of the transformer.

After a thermal overload operation, the re-energising of the transformer is inhibited during the transformer cooling time. The transformer cooling is estimated with a thermal model.

6.2.7 General Protection Functions

6.2.7.1 *Breaker-Failure Protection*

Breaker failure protection shall be included in the form of a dedicated function. It shall be possible to initiate the protection either from an internal signal of the protection relay or via a binary input. The protection shall facilitate re-tripping of its own breaker and also back-up tripping of an up-stream breaker. In both cases the trip delays shall be adjustable.

The protection shall include different operation modes, where both the current flow and the circuit breaker position are monitored, or alternatively only either the current flow or the circuit breaker position is monitored. The current level for flow detection shall be separately adjustable for phase currents and residual current.

6.2.7.2 *Thermal overload protection*

Thermal overload protection for lines, cables and distribution transformers shall be included. The protection can utilise either one or two time constant principle.

6.2.7.3 *Arc protection*

Arc protection shall be based on the detection of current and light simultaneously. During maintenance work at the substation, it shall be possible to change the operation criteria to light only, by control via a binary input.

The current monitoring levels shall be separately adjustable for phase currents and the residual current. It shall be possible to monitor the busbar, circuit breaker and cable compartments simultaneously by means of compartment dedicated sensors. Tripping command to the up-stream circuit breaker shall be selective, based on the location of the arc. The operating time of the protection shall be less than 15 ms, including the inherent delay of the output relays.

6.2.8 On-load Tap Changer Protection and Control

6.2.8.1 *Application Aspects*

i. Protection for Electrical Faults within the Tap-Change Compartment

These protection functions are described as tap-change surge protection and tap-change pressure relief protection. These functions will operate the transformer master trip relays, which will trip the HV and MV transformer circuit-breakers.

ii. Tap-Change Lock-Out Relay

An electrically resettable latching relay shall be provided for each on-load tap-changer. Operation of the relay shall block all tap-change operations in progress, inhibit any further tap-change initiations and shall not trip the transformer circuit-breakers. The protection function(s) that energize the tap-change lock-out relay is dependent on the type of parallel control used.

iii. Line Drop Compensation

Provision shall be made for line drop compensation. The exact requirements will however only be provided at final design/settings calculation stage.

iv. Parallel Control

Parallel control is required to ensure that the respective tap changers maintain the same or similar tap positions when power transformers with on-load tap changing equipment are operated in parallel. The parallel control provided shall be sufficient to cater for all possible operating configurations of the substation. The parallel control shall preferably be adaptive, automatically adapting the algorithm based on the linking arrangement of transformers within the substation.

6.2.8.2 *Protection and Control Requirements*

i. Tap-Change Overcurrent

One instantaneous element on each phase shall be provided for the tap-change overcurrent function. Operation of the overcurrent relay shall block tap-change initiation. If an overcurrent condition should develop while a tap change operation is underway, the overcurrent relay shall block the operation of the tap changer drive motor until the overcurrent condition has passed and the overcurrent relay reset, whereupon the tap changing process may resume.

Blocking shall be performed by disconnecting the AC supply to the tap changer drive motor. For this purpose an electrically operated contactor is required in the tap-change control panel.

The overcurrent elements shall be set to operate when the primary current exceeds 1.5 to 2 times the transformer full load current rating.

ii. Motor Running Timer

The motor running timer function is applied as a tap-change “runaway” protection function. It consists of a “delay on pick-up” timer (MRT–2) used in conjunction with a “delay on drop-off” timer (MRT–1).

- The “delay on drop-off” timer (MRT−1) shall be set such that it does not operate for momentary supply interruptions during the transitional tap but it is able to detect when a subsequent tap operation is immediately initiated after a tap operation has been completed. A typical setting of 2 s to 4 s may be used.
- The “delay on pick-up” timer (MRT−2) shall be set to exceed the longest possible tap-change operating time. The transitional tap of the tap-changer invariably determines this time. Settings may vary from 10 s to 35 s, depending on the tap-change mechanism.

iii. Buswire Timer

The buswire timer is a “delay on pick-up” timer, which is used to detect when a permanent initiation condition is present (e.g. voltage regulating relay output contacts have welded closed).

The bus wire timer shall be set longer than the motor running time to ensure that a tap-change has been successfully completed. Settings may vary from 25 s to 40 s, depending on the motor running timer setting.

iv. Reference Voltage Setting

The reference voltage (Vs) is the voltage to which the relay compares the monitored system voltage. The relay will initiate tap commands to control the local system voltage to within the set deadband limit of this setting.

The selected set point voltage shall ensure that an acceptable voltage profile is attained on the system. The voltage profile is dependent on the system configuration of a particular area (e.g. shunt compensation) and whether load compensation is applied.

The maximum setting shall be determined through load flow studies and protection studies and will be finalised and provided as part of the commissioning settings for the facility.

v. Deadband

The deadband (ΔV % = 2 x bandwidth setting) is normally taken as a percentage of the reference voltage. The relay will initiate tap commands when the local system voltage remains outside the set deadband.

Suitable bandwidth settings shall be chosen to ensure adequate voltage regulation whilst minimizing the number of tap-change operations. The bandwidth setting shall ensure that "hunting" between taps is prevented. The selected total deadband shall be greater than the average step increment of the installed transformer. Typically, a bandwidth setting of ≥1 % will be suitable for a transformer step increment of 1.25 %.

vi. Initial Time Delay

The initial time delay is the mean time that the system voltage shall remain outside the deadband limit before a tap-change sequence is initiated.

- A suitable time delay shall be selected to prevent unnecessary tap-change operations due to momentary voltage fluctuations, whilst large fluctuations on the system shall be corrected as rapidly as possible, depending on the nature of the load (e.g. arc furnaces). The inverse characteristic will reduce the response time of a tap-changer to correct for large fluctuations compared to a definite time characteristic for large step changes in the voltage. A fast tap-down feature shall be used in conjunction with a definite time characteristic to ensure fast correction for large overvoltage fluctuations.
- When only definite time settings are available, then the source side transformer initial time delay shall be set long enough to filter out fast transients. With this setting, compute the number of tap operations needed by the transformer for a worst case voltage disturbance. The load side transformer's initial time delay setting shall then be set longer than the calculated number of tap operations multiplied by the initial time setting of the source transformer. It shall be ensured that the calculated time delay of the load transformer provides adequate voltage regulation.
- Definite time settings for initial time delays are well suited to minimizing tap operations where rapid, short duration voltage fluctuations (e.g. arc furnaces, mines, etc.) from the set point voltage may occur.

vii. Intertap Time

The intertap time setting determines the time between subsequent tap commands in a multiple tap sequence, usually caused by large voltage excursions outside the deadband.

The intertap time delay shall be set longer than the actual tap-changer operating time plus the motor running timer (MRT–1) time plus a safety margin, typically 1 s to 2 s, to ensure that the tap-changer "settles" between tap operations.

Certain applications utilize the initial time delay as the intertap delay. In these cases it shall be ensured that the time delay setting exceeds the calculated value.

viii. Overvoltage Detector

The overvoltage detector setting determines the upper voltage limit at which the voltage-regulating relay is prevented from initiating "raise" commands.

The maximum over-voltage setting shall not exceed 110% of the system nominal voltage, as this is the continuous rating of the system equipment. The setting shall be calculated using the following formula:

Reference voltage % + Full load LDC boost % + Upper bandwidth % + safety margin %.

Raise blocking may be effected either at the setting level or at a set limit before the setting is reached.

ix. Undervoltage Detector

The undervoltage detector determines the lower voltage limit at which the voltage-regulating relay is prevented from initiating “lower” commands or its operation is blocked.

For relays that will only inhibit “lower” commands, it is preferred that the under-voltage setting is set similar to the set point voltage, as this is the minimum voltage needed to maintain an adequate voltage profile on the system.

Lower blocking may be effected either at the setting level or at the set limit before the setting is reached.

x. Voltage Runback

Voltage runback is a facility whereby the regulating device immediately issues lower instructions when the overvoltage limit has been exceeded. This may be caused by combinations of LDC action and load shifts, or by a system disturbance without LDC action.

6.2.9 Automatic Load Management of 11 kV Loads at New Main Intake Substation

The *Contractor* shall allow for the design, fabrication, supply, installation, construction, testing and commissioning of an automatic load management system for the 11 kV loads at the new Main Intake Substation.

The purpose of this scheme is to ensure load balancing across the double busbars on the 11 kV MV board. It shall automatically, via its internal logic, take into consideration any interlocking, back feeding risks and operating procedures that could pose a risk to automatic load switching between busbars and shall only be functional whilst the substation is selected to “Remote” control. When the station is selected to “Local” control, it shall be disabled automatically to ensure operator safety.

6.3 MV Metering

6.3.1 General

The metering installation shall comply with all relevant conditions of SANS 474.

6.3.2 Metering Installation Design

Metering installation design shall conform to SANS 474 and further applicable standards.

6.3.3 Compliance of Entire Metering Installation

The requirements for commissioning, calibration and recording of results shall be in accordance with SANS 474 and further applicable standards.

6.3.4 Metering Installation Category

Metering category and class of meter worker shall be 4.

6.3.5 Meter Worker Qualifications

Meter worker qualifications shall be in accordance with SANS 474 and further applicable standards.

6.3.6 Installation

Meters shall be installed for all 11 kV circuits at the new Main Intake Substation. At Substations M and N meters shall be installed on all 11 kV feeder circuits and on all 3.3 kV feeder circuits. No meters will be installed on the 11 kV and 3.3 kV incomers at Substations M and N. Where the demand exceeds 10 MVA, full main and check metering shall be installed.

Meters for MV metering shall be installed in dedicated metering panels, with a maximum of six (6) meters per panel. Each metering circuit shall have its own dedicated set of CT and VT test blocks.

Meters for LV metering shall be installed in the LV boards.

Meters shall be sealed as per SANS 474.

6.3.7 Equipment Class

All meters shall be class 0.2S, unless otherwise specified, shown on the drawings, indicated in the BoQ or instructed by the *Employer*.

6.3.8 Communications Requirements

The use of the IEC 61850 protocol is preferred for communication between the meters and the port SCADA system (Wonderware and Historian).

Communication shall be possible via fibre, copper or serial ports, or a combination of the three.

6.3.9 Time Synchronisation

Time synchronisation shall be possible by receiving a pulse from an external clock either via IRIG-B, SNTP or by means of a pulse-per-second (PPS) input. It shall have a time stamping resolution of 1 ms.

6.3.10 Metering Functionality

The ION 8800 power quality meter, or approved equivalent, shall be used for MV metering installations.

The ION 7650 power monitoring meter, or approved equivalent, shall be used for LV metering installations.

The metering installation shall be capable of storing all data to a central server.

6.3.10.1 *Recording*

The meter shall be capable of up to ½-cycle interval burst recording. It shall have the capability to store detailed characteristics of disturbances or outages and it shall be possible to trigger a recording by a user-defined set-point, or from external equipment.

It shall be capable of recording harmonics up to the 63rd harmonic for all voltage and current inputs and analyse the severity/potential impact of sags and swells by recording magnitude and duration data suitable for plotting on voltage tolerance curves. It will allow for per phase triggers for waveform recording or control operations.

It shall be possible to trigger the recorder based on time interval, calendar schedule, alarm/event condition, or manually.

6.3.10.2 *Instantaneous Measurements*

The meter shall be capable of high accuracy (1 s) or high-speed (½ cycle) measurements, including true rms per phase / total for:

- Voltage and current.
- Active power (kW) and reactive power (kVAr).
- Apparent power (kVA).
- Power factor and frequency.
- Voltage and current unbalance.
- Phase reversal.

6.3.10.3 *Load Profiling*

It shall be possible to configure the channels for any measureable parameter, including historical trend recording of:

- Energy.
- Demand.
- Voltage.
- Current.
- Power quality.
- Any other measured parameter.

6.3.10.4 *Modbus Master*

The meter shall be capable of acting as a master for up to 32 slave devices per serial channel and store their data at programmable intervals. It shall be possible to use this data to aggregate and sum energy values and perform complex totalisation.

6.3.10.5 *Waveform Captures*

It shall be possible to simultaneously capture all voltage and current channels. It shall be possible to do a sub-cycle disturbance capture.

6.3.10.6 *Alarms*

The meter shall have adjustable pickup and dropout set-points and time delays, and numerous activation levels shall be possible for a given type of alarm.

It shall be possible for the user to define priority levels.

6.3.10.7 *Security*

The meter shall allow for multiple users each with unique access rights.

6.3.10.8 *Transformer Correction*

The meter shall be capable of correcting for phase/magnitude inaccuracies in current transformers (CT's) and voltage transformers (VTs).

6.4 Telecommunication, Substation Automation and Telecontrol (Eskom)

The *Contractor* shall be responsible for the supply, installation and testing of all *works* associated with the Eskom monitoring and control network. This shall include, but not be limited to, the following equipment:

- RTU.
- IDF.
- Substation automation.

Reference is made to the Eskom documents listed in Table 6 for further guidance on the exact requirements, standards and specifications relating to this portion of the *works*.

6.5 Communication Networks and Hardwired I/O Circuitry (Eskom)

The *Contractor* shall be responsible for the supply, installation and testing of all *works* associated with the Eskom communication networks. This shall include, but not be limited to, the following equipment:

- Fibre cables.
- Ethernet cables.
- Switches.
- Teleprotection circuits.
- Telecontrol circuits.

Reference is made to the Eskom documents listed in Table 6 and document 1924701-2-300-E-SP-0010 for further guidance on the exact requirements, standards and specifications relating to this portion of the *works*.

6.6 AC, DC and Auxiliary Supplies (Eskom)

The *Contractor* shall be responsible for the supply, installation and testing of all *works* associated with the Eskom AC, DC and auxiliary supplies. This shall include, but not be limited to, the following equipment:

- AC/DC panel.
- Station DC batteries.
- Battery charger.
- Station distribution board.
- Station lighting, including emergency lighting in control building.
- AC and DC supplies to panels and equipment.

Reference is made to the Eskom documents listed in Table 6 for further guidance on the exact requirements, standards and specifications relating to this portion of the *works*.

6.7 Yard Enclosures (Junction Boxes)

The designs for enclosures shall take account of the Site conditions as detailed in Table 7. The enclosures shall be configured so that any single component can be removed without necessitating the removal of other components and without any adverse impacts on the functionality of the cabinet.

Allowances shall be made for the manufacturer's recommendations, which shall include, but not be limited to, selection of enclosures, ventilation, air filtering (if required) and the like. Cognisance shall be taken of variations in the requirements of various manufacturers and between installations within the same facility.

Where enclosures contain equipment rated at both 230 V AC and 24 V DC power, the *Contractor* shall ensure that equipment at the different voltage levels is effectively separated and is clearly marked to indicate the relevant power levels.

Junction boxes for terminating control cables within the HV yard shall be constructed from 316L stainless steel. It shall include a brass earthing stud of M10 x 75 mm with contact resistance with the cabinet of less than 0.1 ohms. It shall have a minimum IP rating of 65 and shall be able to withstand extreme corrosive environments. Enclosures inside Eskom's 'Ystervark' yard shall be SANS 1091 'G29' Light Grey in colour and in the *Employer's* yard SANS 1091 'B26' Electric Orange. The respective insert tray shall match its enclosure colour. However, prior to manufacturing of the enclosures the *Contractor* shall confirm the colour requirements.

It shall be possible to mount the junction box against the medium equipment support by means of a suitable mounting bracket, and if applicable plinth mounted. Trays shall be mountable inside the junction box using suitable studs. The junction box shall include a pre-punched gland plate with drainage holes and shall be earthed to the brass earthing stud of the junction box.

Insert trays shall be manufactured from 316L stainless steel, 2 mm in thickness. Wiring shall be installed in trunking to keep wiring neat.

6.7.1 Voltage Transformer Junction Box

The 132 kV VTJB shall include eight separately protected VT circuits, four per VT secondary winding. All MCB's shall be single phase 10 A, type C60 rated for 110 V AC, 6 kA rated, with trip curve C.

6.7.2 Current Transformer Junction Box

The CT insert tray shall be able to accommodate up to six CT cores from three post-type CT's. It shall consist of two terminal strips, one for terminating the CT secondary and one for connecting the CT secondary to the protection equipment. The first tray shall be wired from core one through to core six, whilst the second tray shall be wired red phase cores one through six, white phase cores one through six and blue phase cores one through six. Terminals shall be 10 mm screw clamp, spring loaded insertion type. End caps, spacers and labels shall be used.

6.7.3 Isolator (Disconnector) Junction Box

The double busbar disconnector insert shall include two terminal strips each with thirty terminals of type 10mm screw clamp, spring loaded insertion type. End caps, spacers and labels shall be used.

6.7.4 Interconnection Junction Box

A customer interface junction box must be supplied for all information shared (hardwired I/O) between the *Employer* and Eskom. The junction box will be situated at the ownership boundary within the fence separating the *Employer* and Eskom yards, unless otherwise specified or instructed.

Where specified, provision shall be made for a freestanding junction box to Eskom specification, complete with lockable dual access doors, one for Eskom, one for the *Employer*. Doors shall be provided with two locks to prevent entry by one party whilst the other party is working on their equipment.

6.8 Swing Frame Panels and Wiring

6.8.1 Construction

6.8.1.1 *General*

- Panels shall be of the swing-frame type, at least 2400 mm high, with the following dimensions: 800 mm (W) x 600 mm (D).
- Panels shall make provision for top and bottom cable access.
- Panels shall be at least of protection class IP 54 and shall be supplied complete with all equipment, including, but not limited to, all terminals, terminal strips, blanking plates, cable gland plates, earthing and earth bars. Heating elements and panel lighting shall be provided in each panel. Panels forming part of the *Employer's* infrastructure shall be 3CR12 steel, Electric Orange 'B26'. Note: The *Contractor* shall prior to manufacturing confirm the colour requirement(s).
- The doors shall be fitted with a quality gasket, such that the sealing material shall always return to its original profile after compression. The material shall not deteriorate over time (typically 20 years).
- The cabinet doors shall be fitted with pad lockable lever handles.
- All holes through which wiring must pass shall have their edges protected using grommets.
- Self-tapping screws used in the construction shall have blunt points. Self-tapping screws shall not be used for fixing items that have to be removed and replaced. Pop rivets may be used for fixing of non-removable components.
- All MCB's and equipment required to have operation access shall be accessible through a front opening door that can be padlocked. All other components in the enclosure shall be covered by a removable cover plate. Rear or side access will be acceptable.
- The final equipment design shall be submitted to the *Employer* for approval before the commencement of the manufacture thereof.
- Installation shall be to NRS 083-3 and any other associated statutory standards.

6.8.1.2 *Cable Gland Plates*

- Pre-drilled, removable gland plates or knockout holes shall be provided for cables entering the enclosure from the bottom and the top. If gland plates are pre-drilled, all unused holes shall be plugged with a suitable PVC plug.
- The removable gland plates shall be fixed to the panel using hexagon head screws to facilitate easy removal and fitted as indicated on the drawings.
- The gland plates shall be constructed from 2 mm thick, 316L stainless steel and shall be sufficient for the AC, DC and alarm cables.
- Cable gland holes shall be arranged to permit short direct cable tails between gland plate and terminals, allowing generous working space for installing the size of cable specified.

6.8.2 Electrical Requirements

6.8.2.1 *Lightning and surge protection*

The AC input circuitry shall be protected against lightning-induced voltage surges by means of surge arresters with a nominal discharge current of 20 kA, unless otherwise specified.

6.8.2.2 *Miniature circuit-breakers and isolating switches*

All MCB's shall be wired with the source supply at the top and the load supply at the bottom (SANS 10142-1). Where MCB's are polarity sensitive, the manufacturer shall provide a diagram indicating the correct wiring with the source supply at the top.

All DC MCB's shall be rated for use on 220 V DC systems.

6.8.2.3 *Termination and Wiring*

All wire ends shall be suitably lugged and crimped.

Terminals for remote alarms shall be provided for connection of external cabling to remote alarm termination points. The type of terminal shall be Klippon RSF1 or equivalent approved, unless specified or instructed otherwise by the *Employer*.

The terminations and wiring for the various types and sizes shall be as follows:

- A wire loom shall be used to connect the components on the face plate with the terminals on the back plate. The loom shall be made of flexible multi-stranded copper wire and shall have a minimum length of between 1.1 m to 1.2 m, so as to not limit the opening of the door. The loom sock shall be continuous (without joints) and have some slack to maintain flexibility. The loom shall exit the face plate at the left hand side (viewed from the front of the panel) and also enter the back plate on the left hand side.
- The terminals used shall be spring loaded terminals suitable for the wire sizes used. The associated terminal end caps and spacers shall be used.
- All LV power supply wiring shall be a minimum of 16 mm^2 stranded copper wire, insulated with 1000 V insulation.
- All control wiring shall be 2.5 mm^2 stranded copper wire, insulated with 1000 V insulation.
- The output power (between the MCB outputs and the terminals) wiring shall be a minimum of 4 mm^2 stranded copper wire, insulated with 1000 V insulation. 3-phase busbars shall be used for connection between the AC MCB's. 2-phase busbars shall be used for connection between the DC MCB's.

Refer to document 1924701-2-300-E-SP-0008 for additional requirements regarding wiring colours, trunking, conductor, panel requirements and the like for the swing frame panels inside the new Main Intake Substation and Substations M and N respectively. Where any conflict exists, the *Contractor* shall notify the *Employer* immediately.

6.8.2.4 *Earthing and Bonding*

- A copper earth bar shall be provided at the bottom of the cabinet, with a DIN rail to accommodate surge suppression devices.
- An additional vertical running bar with pre-drilled holes shall be provided.
- The cabinet doors shall be bonded to the earth bar with braided tinned copper earthing strap.
- The earth wire shall be long enough to allow the doors to fully open.
- The bonding earth wire shall not be coiled.
- All gland plates shall also be earthed to the earth bar. The contact resistance between the brass stud and any part of the gland plate and door shall be less than 0.1 Ω
- The gland plate shall be earthed to the brass earth bar by means of a braided tinned copper earthing strap with an effective copper cross-sectional area of 12 mm^2, unless otherwise specified or required.
- All modules shall also be earthed to the earth stud and a contact resistance of less than 0.1 Ω shall be ensured.
- The cabinet shall be connected to the station earth by means of a 25 mm x 3 mm flat copper bar or 10 mm diameter solid round conductor.

Reference shall also be made to document 1924701-2-300-E-SP-0008 for further earthing requirements.

6.8.2.5 *DC Voltage Drop*

The voltage drop between the DC input terminals and the load output terminals shall be less than 500 mV.

6.9 Test Blocks

Every CT and VT circuit entering a panel shall be provided with an approved individual 4-way PK2 test block.

A 4-way PK2 test block shall be installed in the voltage circuit to enable testing of the installation. The removal of the male adapter shall ensure the open-circuiting of the voltage circuit. The terminals that protrude into the panel shall be suitably insulated from the steel edges.

A 4-way PK2 test block shall be installed in the current circuit to enable testing of the installation. The removal of the male adapter shall ensure the short-circuiting of the input (bottom) current circuit. The terminals that protrude into the panel shall be suitably insulated from the steel edges.

The test block shall comply with SANS 60947-7-1. The test block shall be rated for 10A AC at 250 V AC continuous operation. Provision shall be made to allow for shorting all the bottom terminals when the test block cover is removed from a CT circuit. To prevent accidental dislodging of the cover, the test block shall be locked in position with a re-usable spring steel clip.

7.0 CORROSION PROTECTION

7.1 General Corrosion Protection

Corrosion protection of steel materials shall be as per the requirements of these specifications, the *Employer's* standards and associated minimum SANS requirements. The protection of the specified steel materials shall make allowance for the harsh, coastal environment at the Site.

Any equipment not strictly complying with the above requirements shall be rejected. The *Contractor* shall furnish written confirmation that all equipment complies with the specifications. Should the *Contractor* fail to furnish such confirmation, the *Employer* reserves the right to reject the equipment.

7.1.1 Galvanic Corrosion Protection

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer*.

The table below provides a general indication of which metals can be connected to each other without the need of special measures to avoid interaction and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The below is intended as a guide only. The responsibility will remain with the *Contractor* to avoid bimetal/ galvanic corrosion between different metal equipment.

Table 11: Combinations Of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	StSt	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Copper	Not Permissible	Not Permissible	Permissible	Permissible	Not Permissible	Permissible
StSt	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

* Where equipment has been exothermically welded together, 3 thick layers of bitumen shall be applied afterwards, unless otherwise specified by the *Employer*.

7.1.2 Fire Stopping

The *Contractor* shall employ suitable fire stopping methods wherever deemed necessary by these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer*'s specifications or any other applicable standards and documents related to the *works*.

All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and approved standards. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localised and contained and not propagate via any electrical and/or electronic infrastructure. The *Contractor* shall fully comply with these requirements.

8.0 LABELLING

All labelling of the Eskom equipment shall comply with the relevant Eskom standards (including the new Main Intake Substation outdoor equipment).

The *Employer's* protection and metering panel and equipment labels shall be in accordance with the relevant *Employer* (Transnet) standards.

The *Contractor* shall submit label schedules to the *Employer* for approval prior to manufacture.

9.0 PACKAGING, TRANSPORTATION AND HANDLING

The following general requirements are applicable to all equipment forming part of the *works:*

- The *Contractor* shall attend to and provide all maintenance for equipment during storage, in accordance with OEM's specifications and requirements. All interim maintenance logs shall be provided as part of the O&M documentation.
- Crates supplied for transport shall be suitable for Site storage for a period up to 6 months to allow for cases where installation outages are delayed.
- The *Contractor* shall be responsible for the transportation and off-loading from OEM premises to offloading of the equipment on Site. Off-loading includes transportation from the point of off-loading the equipment after transportation to the point of installation.
- Under no circumstances shall any equipment intended for indoor installation or within sealed enclosures be stored outside or exposed to the weather. All such equipment shall be stored in weatherproof storage spaces (e.g. containers) or brought to Site only once it can be permanently installed within the designated rooms or enclosures.

10.0 SPARES, TOOLS AND CONSUMABLES

10.1 General

The *Contractor* shall provide critical and recommended spares, as prescribed by the OEMs, for all systems, including but not be limited to IED processor-, communication-, I/O-, analogue- and power supply cards.

10.2 Spares, Tools and Consumables required prior to Final Handover

The *Contractor* shall supply all spares that are required for start-up and commissioning purposes and for the 12-month period after commissioning, as recommended by the specialist subcontractors/OEM's. This shall include, but not be limited to, spares for IED processor-, communication-, I/O-, analogue- and power supply cards

The *Contractor* shall also supply all consumables required within 12 months after commissioning and any special maintenance tools, defined as tools that are not readily available from commercial tool suppliers.

Prior to placement of orders, the *Contractor* shall submit his proposed list of spares, consumables and tools to the *Employer* for his review and approval.

Each spare part shall be properly tagged with a weatherproof label, showing the manufacturer's unique part number, description of the part and expiry date for parts having a limited shelf life. Small items with the same part numbers shall be tagged and packed together in a plastic bag or box. The tag shall also be shown on the outside of the bag or box.

The cost of the above spares, consumables and tools shall be included in the rates tendered by the *Contractor*.

No spares are required for the Eskom portions of the *works*.

10.3 Spares required after Final Handover

The *Contractor* shall also provide to the *Employer* a list of all critical and recommended spares as prescribed by the specialist subcontractor/OEMs, which shall cover the operational requirements after final handover of the *works*. These lists shall include the following:

- Description of spare part.
- Supplier contact details.
- Suggested stock levels.
- Prices.
- Lead-times for ordering and delivery of such spares.

The *Employer* may issue an instruction to the *Contractor* to supply and deliver spares for operation and maintenance of the equipment after final handover. Separate payments will be made by the *Employer* for the provision of such spares.

No spares are required for the Eskom portions of the *works*.

11.0 O&M MANUALS, TRAINING AND BACK-UP SUPPORT

11.1 Eskom Substations

Handover documentation as required by Eskom shall be to Eskom standards 240-87605434, 240-54615413 and any other documents specified or referenced by these documents and/or as required by Eskom..

11.2 Main Intake Substation, Substation M and Substation N

11.2.1 O&M Manuals

Technical, training, maintenance and operating manuals shall be provided for each type and model of equipment. Technical manuals shall include all technical data, construction information, data sheets and leaflets for each individual component that is included with the equipment as provided. Where generic manuals are provided, an addendum shall be provided, indicating the applicable project-specific components. Manuals shall be of a good quality and shall, as a minimum, cover the following:

- Technical descriptions of the equipment and component parts.
- General arrangement drawings.
- Installation instructions with drawings or illustrations.
- Operating and maintenance instructions for all components.
- Detailed parts lists (accompanied by exploded view type drawings clearly detailing the part and its unique identification).
- Spare part ordering instructions

Any special instructions pertaining to storage of spare parts or their shelf life shall be included in the maintenance manual.

Comprehensive drawings as may be required for component location, dismantling and re-assembly for maintenance purposes shall be included in the maintenance manual.

All special tools required for operating and maintenance of the equipment shall be presented in the form of a schedule in the operating and maintenance manual.

The content of the training manual shall be based on the content of the technical, operating and maintenance manuals.

The *Contractor* shall provide a recommended spare parts list with part descriptions/numbers.

11.2.2 Training

The *Contractor* shall provide training to the *Employer's* operating personnel, covering the *Employer's* portion of the protection and metering equipment. No training is required for the equipment within the Eskom (Ystervark) portion of the Main Intake Substation.

The *Contractor* shall provide training on the protection and metering equipment to the various categories of the *Employer*'s technical staff (operators, maintenance and engineering personnel) for the duration of the *works*.

Training provided by the *Contractor* shall be specific to the actual equipment supplied and installed as part of the *works*. Generalised training based on similar equipment is not acceptable.

The *Employer* will provide a suitably sized air-conditioned room for training purposes, as well as trainee and trainer desks, overhead projector and flipchart or white board.

The emphasis shall be on practical hands-on training for each individual trainee. The scope of the training shall include, but not be limited to, the following:

11.2.3 Training of Maintenance Personnel

Maintenance personnel shall be trained in all components and functions of the protection and metering equipment, i.e. method of maintenance, fault finding, correction and routine maintenance. Training shall include familiarisation with documentation (maintenance plan, procedures etc.), hardware familiarisation, hardware maintenance, maintenance of protection, control and instrumentation. Maintenance training shall be provided prior to the installation of the equipment.

11.2.4 Training of Operators

Operators shall be trained and certified as being competent to operate the new systems prior to the equipment being dispatched from the factory. This will include familiarisation with documentation, including drawing configuration logic, as well as operator interface familiarisation, e.g. operational functions, alarms and the like. The *Contractor* shall make allowances for the training of all operators.

11.2.5 Engineering Training

Formal, upfront engineering training shall be provided on basic protection and metering equipment design, capabilities and procedures, prior to design freeze.

Thereafter on-the-job training shall be provided, extending through the design stage up to final commissioning and handover. The design and control/interface functions shall be covered during this training, to enable the *Employer's* engineering team to fully understand the operation and maintenance of the equipment prior to FAT's of the first switchboards, protection and metering equipment.

The *Employer's* engineering team will be in attendance throughout the installation and commissioning stages of the *works*. The *Contractor* shall accord the *Employer's* engineering team full access to the *works* and shall provide formal training and ad-hoc mentoring to ensure a seamless handover upon completion of the *works*.

11.3 Back-Up Support

Back-up support services, including the provision of on-Site technical support by the specialist subcontractors/OEMs for all the MV protection, metering and installations and equipment, shall be available 24 hours a day, 7 days a week. Contact details for the companies and persons providing these support services shall be provided to the *Employer*. Payment for such back-up support will be subject to the relevant provisions of the contract.

12.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation as described above.

13.0 INSPECTIONS, TESTING AND COMMISSIONING

13.1 General

The *Contractor* shall develop quality control procedures, test plans and the like, and shall provide all necessary resources for the management and implementation of these procedures and plans, in accordance with the general requirements as set forth in the accompanying Works Information. The further requirements as detailed below shall form an integral part of these quality management procedures.

All testing and commissioning shall be in accordance with these specifications, all relevant regulatory standards, industry best practices, *Employer* requirements and the like.

For the Eskom portion of the *works*, inspections, testing and commissioning procedures shall be in accordance with Eskom standards 240-87605434, 240-54615413 and any other documents specified or referenced in these documents.

The *Contractor* shall supply, operate and maintain all equipment and instruments required to perform all tests, inspections and commissioning, which shall only be undertaken by suitably qualified, experienced and competent persons to be appointed by the *Contractor*, using only fit-for-purpose, correctly calibrated equipment.

The *Employer* may at his discretion instruct the *Contractor* to perform additional testing and/or commissioning activities, as well as provide any additional information as required to prove the functionality and compliance of the units. Allowances shall be made by the *Contractor* in the scheduled rates included in the bill of quantities for such tests.

Should the *Contractor* fail to perform any test or properly commission equipment supplied and installed by the *Contractor*, or should any item of equipment or part of the installations fail any test or commissioning inspection, the *Employer* reserves the right to recover from the *Contractor* any reasonable cost to himself to witness the repeat of such test or commissioning.

The notice period and date(s) to be provided by the *Contractor* to the *Employer* for witnessing any testing or commissioning activities shall be as stipulated in the *Contractor Document Schedule*, unless otherwise instructed or specified.

The *Contractor* shall rectify any defects noted during the final inspection prior to final hand-over.

13.2 Test Equipment and Certificates

Test and commissioning reports and/or certificates shall be issued for all tests and commissioning that is conducted by the *Contractor*. These certificates shall be signed by the *Contractor* and the manufacturer/test laboratory (as applicable). The number of copies to be issued to the *Employer* shall be as per the *Contractor* Document Schedule and these specifications.

The *Contractor* shall at all times provide unimpeded access to the *Employer* to monitor the *works* and to attend or witness any test or event as may be required by the *Employer*.

13.3 Inspection and Testing of Equipment

The following procedures shall apply to the approval, manufacture and inspections of electrical equipment:

13.3.1 Preparations for Inspections and Testing of Electrical Equipment

Preparations for inspections and testing of electrical equipment shall be undertaken as follows:

- *Contractor* shall appoint a specialist subcontractor/OEM to fabricate, supply and install (if so instructed by the *Contractor*) the protection and metering equipment.
- *Contractor* shall appoint a specialist subcontractor/OEM to decommission and remove the Solkor-R/Rf relays on circuits connecting to Main Intake Substation.
- *Contractor* shall appoint a specialist subcontractor/OEM to supply, commission and install the Solkor-N relays on circuits connecting to Main Intake Substation.
- *Contractor* shall procure all Eskom equipment (Ystervark Substation) from the suppliers as listed in the Eskom LAP list.

- *Contractor* shall appoint a specialist subcontractor/OEM to install and test all Eskom equipment (Ystervark, Blouwater and Iscor Substations) ie. the protection, communication, telecontrol, metering, control, DC and auxiliary equipment equipment etc.
- The *Contractor* provides the project and technical requirements to the specialist subcontractor/ OEM.
- The specialist subcontractor/OEM undertakes the design of the equipment/systems for Main Intake Substation, Substation M, Substation N and Tippler 3 building transformer and submits drawings plus any other associated technical information for approval to the *Contractor*.
- The specialist subcontractor/OEM submits drawings plus any other associated technical information for Eskom equipment/systems for approval to the *Contractor*.
- Under no circumstances will the *Employer* enter into any direct discussions with the OEM. All communication with the OEM shall be via the *Contractor* only.
- *Contractor* checks the drawings and associated technical information as provided, for compliance with all the requirements of the specifications, Works Information, drawings and the like, and submits to the *Employer* for approval.
- *Employer* returns two copies as approved, or for resubmission, to the *Contractor*.
- Manufacture of equipment commences after approval of the drawings by the *Employer*.

13.3.2 Factory Acceptance Testing (FAT)

Factory acceptance testing shall follow the following process:

- FAT's shall be undertaken prior to shipment of equipment to Site, to demonstrate the functionality of the equipment.
- The *Contractor* shall ensure that a full copy of the specifications and approved signed copies of the drawings are at hand during all inspections.
- *Contractor* checks and inspects the manufactured equipment/systems at the specialist subcontractor/OEM's premises during all stages, including prior to FAT's testing and delivery to Site.
- *Contractor* presents the *Employer* with written confirmation that the equipment/systems are in full compliance with the project requirements and have been checked, inspected and fully tested. This confirmation, signed and dated by both the *Contractor* and the specialist subcontractor/OEM, is to accompany a written request for the *Employer* to witness the FAT's.
- The *Contractor* shall provide the *Employer* with at least two weeks' notice prior to such FAT's inspections.
- During the *Employer*'s inspections, a fault list shall, if necessary, be drawn up and handed to the *Contractor*. The *Employer* shall be given unencumbered access to inspect all equipment and panels prior to and during FAT's testing and manufacture.
- After satisfactory rectification of the fault list, and subsequent to re-inspection and acceptance by the *Contractor* and *Employer*, the *Contractor* shall present to the *Employer* written confirmation that the equipment are in full compliance with the specification. The equipment may then be dispatched to Site.
- The *Employer* shall be provided with copies of all signed-off FAT documentation.

13.3.3 Site Acceptance Tests (SAT)

Site Acceptance Tests (SAT) shall be conducted to demonstrate that the equipment is operational after transportation and to certify that any changes agreed to at the FAT's have been properly implemented. The following further procedures shall apply:

- Upon delivery to Site of the equipment/systems, the *Contractor* shall request the *Employer* in writing to witness the SAT's, as applicable.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval by the *Employer*, the equipment/systems may be installed.
- After the tests, written confirmation by the *Contractor* shall be provided to the *Employer* that the equipment/systems are in full compliance. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.

13.3.4 Commissioning Inspections

- Once the equipment has been installed, tested for complete functionality, operability, inter-operability and compliance as per the contract, the *Contractor* shall request the *Employer* in writing to witness the commissioning of the installed equipment/systems.

- The installed equipment/systems shall be re-tested during commissioning, so that the *Employer* may verify the functionality, operability and compliance requirements. A fault list shall, if necessary, be drawn up by the *Employer* and handed to the *Contractor.*
- Should the *Employer* determine that the final product does not fully meet the project requirements, functionality, operability, inter-operability and/or compliance requirements, the *Contractor* shall undertake the necessary repairs and re-testing, all at his own expense.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval received from the *Employer*, the equipment/systems shall be formally handed over to the *Employer*.
- After successful installation and testing, and upon approval by the *Employer,* written confirmation shall be provided by the *Contractor* to the *Employer* that the equipment/systems are in full compliance and have been commissioned correctly. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.

13.4 Staged Acceptance Testing

Staged Acceptance testing (STAT) shall be performed to enable all control system components to be simultaneously connected using temporary interconnecting cabling to realistically provide a complete and fully integrated functional system. The STAT shall be conducted by the *Contractor* and witnessed by the *Employer.*

13.5 Final Testing and Commissioning of Protection and Metering Equipment

Prior to practical completion and handover of the *works*, the *Contractor* shall arrange a final inspection of the completed and commissioned *works* with the *Employer*.

The notice period and date(s) to be provided by the *Contractor* for the final inspection by the *Employer* shall be as stipulated in the *Contractor* Document Schedule, unless otherwise instructed or specified. The *Contractor* shall rectify any defects noted during the final inspection prior to the final hand-over.

Final testing and commissioning of the protection and metering equipment shall include, but not be limited to, the following:

- The *Contractor* shall develop written procedures for the final testing, pre-commissioning and commissioning of the plant, including all protection and metering equipment.
- These procedures shall be submitted at least one month prior to final testing and pre-commissioning and shall be subject to review and approval by the *Employer*.
- Pre-commissioning shall be carried out by the *Contractor* and approved by the *Employer*.
- For Main Intake Substation, Substation M, Substation N and Tippler 3 building transformer, close coordination is required with all other associated subcontractors to test and prove communication, interlocking and intertripping etc.

Checks and tests prior to start-up, including compilation of start-up procedures, shall be in accordance with the manufacturer’s guidelines and recommendations.

The *Contractor* shall also be required to assist in the final commissioning process.

14.0 HANDOVER DOCUMENTATION

14.1 As-Built Documents

14.1.1 General

The *Contractor* shall maintain records and prepare as-built documentation for all design documents, drawings, quality control records, tests, pre-commissioning reports, commissioning reports, operation and maintenance manuals and the like. The as-built documents shall be comprehensive and shall demonstrate compliance with the project specifications and drawings. Reference shall also be made to the further requirements as detailed in the accompanying Works Information. The following details shall apply:

- The scope and format, including the required indexing, of the as-built information shall be discussed and agreed with the *Employer* prior to compilation and submission of the final documentation.
- All as-built documents shall be signed off by the *Contractor* and submitted to the *Employer* for approval, as these are developed and at completion of the *works*.
- All as-built documents shall be furnished to the *Employer* in both hard and soft copy formats.
- As-built documents shall be submitted as per the requirements as set out in the CDSR, appended to the accompanying Works Information, and the further requirements as detailed below.

The information to be submitted shall include, but not be limited to, the following:

14.1.2 As-Built Drawings

The *Contractor* shall keep a separate set of project drawings for marking up changes to the original design as the *works* progress. Marked-up red lined hard copies of drawings shall be maintained by the *Contractor* during installation of the equipment and shall be included in the handover documentation.

As-built drawings shall include the drawings issued by the *Employer* as well as any drawings compiled by the *Contractor*.

Software copies of the “as-constructed” drawings shall be provided in ‘rvt’, ‘dgn’, ‘dwg’, ‘dxf’ and ‘pdf’ formats as required by the *Employer*.

The final, as-constructed drawings shall be signed off by the *Contractor* and submitted to the *Employer* for approval at completion of the *works*.

14.1.3 Data Packs

Data packs for all equipment and materials shall be provided by the *Contractor* in electronic and hard-copy format and shall be neatly indexed and referenced to facilitate easy navigation by the *Employer* between documents. This shall include, but not be limited to, the following:

- Equipment specification sheets.
- Data sheets for instrumentation and equipment, including physical dimensions.
- Wiring diagrams.
- All test certificates.
- Type test and routine test certificates.
- Results of polarity and insulation tests, including test voltage, time duration, insulation resistance, leakage current and the like.
- Results of earth resistance and continuity tests.
- Other SANS certificates, where appropriate.
- Manufacturer’s manuals.
- Equipment specification sheets.
- Equipment and material installation standards applicable to the relevant equipment or material supply.

14.2 Quality Control Records

The *Contractor* shall, as part of the handover documentation, provide the *Employer* with all quality control records, including, but not limited to:

- Equipment and material installation standards applicable to the relevant equipment or material supply.
- All calibration certificates.
- Material certificates.
- SABS certificates, where appropriate.
- All test and calibration certificates.
- Certificates of Compliance.

14.3 Further Handover Documentation

Further handover documentation shall include, but not be limited to, the following:

- Comprehensive operation and maintenance manuals of all variants of the IED's and meters installed.
- Health and safety records.
- All equipment guarantees, which shall be ceded to the *Employer* upon completion of the *works*.
- Copies of final configured software programmes of equipment/systems.
- All software licences and programming of software, which shall be ceded to the *Employer* upon completion of the *works*.
- List of recommended spare parts lists, including suggested stock levels.
- Further information as advised by the *Employer*, as required for the hand-over, commissioning, operation and maintenance of the installed systems and equipment.
- All equipment guarantees, which shall be ceded to the *Employer* upon completion of the *works*.

15.0 MEASUREMENT AND PAYMENT

15.1 General

The tendered rates shall be deemed to include all and every cost item required for the completion, handover and commissioning of the scope of the *works* in full compliance with these specifications, the Works Information and the drawings, including, but not limited to, the following:

- Supply and installation of all Eskom protection, communication, telecontrol, metering, control, DC and auxiliary equipment and ancillary *works* that are required to deliver a complete, fully functional and fully compliant system.
- Design (including shop drawings), supply and installation of all protection, metering and ancillary *works* that are required to deliver a complete, fully functional and fully compliant system.
- Supply of installation and commissioning spares and operational spares required for normal wear and tear during plant operation for the period of one year after commissioning.
- Supply of special tools required for maintenance purposes.
- All testing and commissioning activities that are required to get the installed equipment ready for operations.
- Compilation and submission of all handover documentation as described in these specifications.
- Training of *Employer's* operational staff, as detailed in these specifications.

Allowances to be made in the tendered rates are as described below.

15.2 Eskom Equipment

15.2.1 Eskom Protection Equipment

The tendered rates shall cover all costs for the supply and installation of all Eskom protection equipment, including, but not limited to, procurement, transport, handling, storage, testing, inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' rack-mount panel, blanking plates, all switchgear, accessories, fixings, screws, mounting brackets and the like.

15.2.2 Eskom Communication Equipment

The tendered rates shall cover all costs for the supply and installation of all Eskom communication equipment, including, but not limited to, procurement, transport, handling, storage, testing, inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' rack-mount panel, blanking plates, all switchgear, accessories, fixings, screws, mounting brackets and the like.

15.2.3 Eskom Telecontrol Equipment

The tendered rates shall cover all costs for the supply and installation of all Eskom telecontrol equipment, including, but not limited to, procurement, transport, handling, storage, testing, inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' rack-mount panel, blanking plates, switchgear, accessories, fixings, screws, mounting brackets and the like.

15.2.4 Eskom Metering Equipment

The tendered rates shall cover all costs for the supply and installation of all Eskom metering equipment, including, but not limited to, procurement, transport, handling, storage, testing, inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' rack-mount panel, blanking plates, switchgear, accessories, fixings, screws, mounting brackets and the like.

15.2.5 Eskom AC and DC Equipment

The tendered rates shall cover all costs for the supply and installation of all Eskom AC, DC and ancillary equipment, including, but not limited to, procurement, transport, handling, storage, testing, inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' rack-mount panel, blanking plates, all switchgear, accessories, fixings, screws, mounting brackets and the like.

15.2.6 Eskom Batteries and Ancillary Equipment

The tendered rates shall cover all costs for the supply and installation of all Eskom batteries and ancillary equipment as required by Eskom for battery maintenance, including, but not limited to, procurement, transport, handling, storage, testing, inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' rack-mount panel, blanking plates, all switchgear, accessories, fixings, screws, mounting brackets and the like.

15.2.7 Eskom Substation Automation Equipment

The tendered rates shall cover all costs for the supply and installation of all Eskom substation automation equipment, including, but not limited to, procurement, transport, handling, storage, testing, inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all installation of equipment in a 19'' rack-mount panel, blanking plates, switchgear, accessories, fixings, screws, mounting brackets and the like.

15.3 *Employer's* Equipment

15.3.1 Protection Installed on MV Switchgear

The tendered rates shall cover all costs for the supply and installation of IED's, including, but not limited to, procurement, transport, handling, storage, testing, provision of designs and drawings for approval (multiple reiteration), inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, test blocks, communication modules and converters, mounting brackets and the like.

15.3.2 Transformer Protection and Tap Changer Control Panels

The tendered rates shall cover all costs for the supply and installation of transformer protection and tap changer control equipment, including, but not limited to, design, procurement, transport, handling, storage, testing, provision of designs and drawings for approval (multiple reiteration), inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' swing frame panel, development of schemes, all switchgear, accessories, fixings, screws, mounting brackets, test blocks, switches, MCB's, indication lamps, electrostatic discharge points and the like.

15.3.3 Metering Panels

The tendered rates shall cover all costs for the supply and installation of metering equipment, including, but not limited to, design, procurement, transport, handling, storage, testing, provision of designs and drawings for approval (multiple reiteration), inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include installation in a 19'' swing frame panel, development of schemes, all switchgear, accessories, fixings, screws, mounting brackets, test blocks, switches, MCB's, indication lamps, electrostatic discharge points, and the like.

15.3.4 Building Distribution Meters

The tendered rates shall cover all costs for the supply and installation metering equipment, including, but not limited to, procurement, transport, handling, storage, testing, provision of designs and drawings for approval (multiple reiteration), inspections, installations and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets and the like.

16.0 MATERIAL SPECIFICATIONS

16.1 Eskom Equipment

Reference shall be made to the latest Eskom list of accepted products and ENC equipment to ensure compliance with all Eskom requirements for material and equipment.

16.2 *Employer's* Equipment

Table 12: Material/Equipment

Component / Material	Make Type or Equivalent Approved
CABLE AND WIRING	
LV Cables	Aberdare, CBi
Earth Cable Safety Earth	Aberdare, CBi
Wiring in Conduit / Trunking	Aberdare, CBi
Lugs, Joints, Terminations	Not specified
GLANDS AND JUNCTION BOXES	
Glands	CCG, Pratley
Junction Box	CCG, Pratley
LABELS, CABLE IDENTS AND CABLE TIES	
Equipment Labelling/Numbering	Traffolyte and CAB 3
ELECTRONIC EQUIPMENT	
RIO	Siemens ET-200M
Network Switches	Hirschmann Ruggedized Managed Control Cabinet Switches
LV Switchgear	ABB
Protection IED's	ABB, Siemens (Reyrolle) Solkor
Metering	ION 8800, ION 7650

Technical Specification Tippler 3 Bulk Power Supply -

Monitoring and Control Installations

Document Number 1924701-2-300-E-SP-0010

Document Details

Ref (SA)	1924701-2-300-E-SP-0010
Date	03 June 2016
Prepared by	Ludaan Kohrs, Lize-Mari Botha
Reviewed by	Brett Sansom
Approved by Transnet	

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
00	13 April 2018	Issued for Construction	Colin Pym	

AECOM SA (Pty) Ltd
Waterside Place, South Gate,
Tyger Waterfront, Bellville,
South Africa, 7530
PO Box 112, Bellville, South Africa, 7535
T +27 (0) 21 950 7500 F +27 (0) 21 950 7502
www.aecom.com

AECOM SA (Pty) Ltd Disclaimer

The Document and the information within it is confidential. If you have received the Document in error please notify AECOM SA (Pty) Ltd ("AECOM") immediately. You should not copy it for any purpose, or disclose its contents to any other person. The Document is qualified in its entirety by AECOM and should be considered in the light of AECOM's Terms of Engagement and the following:

1. The Document is provided solely for your use and benefit unless expressly permitted otherwise and then only in connection with the purpose in respect of which the Document is provided. Unless required by law, you shall not provide the Document to any other party without AECOM's prior written consent, which AECOM may at its discretion grant, withhold or grant subject to conditions. Possession of the Document does not carry with it the right to commercially reproduce, publish, sale, hire, lend, redistribute, abstract, excerpt or summarise the Document or to use the name of AECOM in any manner without first obtaining the prior written consent of AECOM.
2. AECOM has used its reasonable endeavours to ensure that the data contained in the Document reflects the most accurate and timely information available to it and is based on information that was current and available to the general public or provided to AECOM as of the date of the Document.
3. The Document is based on estimates, assumptions and other information made by AECOM from its independent research effort, general knowledge of the industry and consultations with you, your employees and your representatives. No guarantee or warranty is made by AECOM in relation to the projected values or results contained in the Document. In addition, the Document is based upon information that was obtained on or before the date in which the Document was prepared. Circumstances and events may occur following the date on which such information was obtained that are beyond our control and which may affect the findings or projections contained in the Document. AECOM is not responsible for such circumstances or events and specifically disclaims any responsibility therefore.
4. AECOM has relied on information provided by you and by other parties (Information Providers) to produce the Document and arrive at its conclusions. AECOM has not verified information provided by Information Providers (unless specifically noted otherwise) and we assume no responsibility and make no representations with respect to the adequacy, accuracy or completeness of such information. AECOM is not responsible for inaccuracies in the information provided or Documented by Information Providers including, without limitation, by your employees or your representatives or for inaccuracies in any other data source whether provided in writing or orally used in preparing or presenting the Document.
5. In no event, regardless of whether AECOM's consent has been provided, shall AECOM assume any liability or responsibility to any other party to whom the Document is disclosed or otherwise made available unless AECOM expressly agrees in writing to the other party receiving the Document.
6. The conclusions in the Document must be viewed in the context of the entire Document including, without limitation, any assumptions made and disclaimers provided. The conclusions in this Document must not be excised from the body of the Document under any circumstances.
7. Without the prior written consent of AECOM, which approval may be withheld at AECOM's absolute discretion, the Document is not to be used in conjunction with any public or private offering of securities or other similar purpose where it might be relied upon to any degree by any person other than you.
8. All intellectual property rights (including, but not limited to copyright, database rights and trademarks rights) in the Document including any forecasts, drawings, spreadsheets, plans or other materials provided are the property of AECOM. You may use and copy such materials for your own internal use.
9. The Document has been prepared by AECOM solely for its Client in accordance with the Agreement signed between the Client and AECOM and is subject to the limitations, assumptions, qualifications and exclusions contained within the Agreement and within this Document. AECOM makes no representation or warranty that:
    - the Purpose of the Document will be suitable or sufficient for the Third Party's purposes; or
    - the content of the Document covers any or all matters which the Third Party may regard as material for the Third Party's purposes.
    - The Document is strictly limited to the matters stated in it and does not extend by implication to any other purpose or matter.

Table of Contents

1.0 INTRODUCTION

1.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at the Port of Saldanha by the addition of a third tippler. As part of the Tippler 3 project, new bulk electrical supply infrastructure is to be provided to increase the capacity of the existing power supply to meet current and future demands at the Port of Saldanha.

The specification covers the monitoring and control (where applicable) installations and equipment (ICT network) that are required as part of the scope of the *works*.

1.2 Purpose

The purpose of this specification is to set out the minimum technical requirements for quality and workmanship for the design (where required), fabrication, supply, installation, construction, testing and commissioning of the following but not limited to, monitoring and control (where applicable) equipment/ infrastructure:

- Servers and Storage.
- Workstations.
- Centralised time clock/server.
- Network Switches.
- RIO devices.
- Fibre Optic Cables.
- Patch panels and rack enclosures with associated equipment.
- Building management systems.
- Intruder alarm systems.
- CCTV system.
- Atmospheric pressure detection.
- Optical fibre cables.
- Data and control cables.

This specification shall be read in conjunction with the following documents and drawings:

- Works Information.
- Bill of quantities.
- Site Information.
- Drawings.

1.3 Units

The SI system of metric units shall be used for this project.

1.4 Language

All data shall be in the English language.

1.5 Hazardous Material

The following materials shall not be used or installed:

- Asbestos in any form.
- PCBs (poly-chlorinated biphenyls).
- Mercury.
- Viton seals.
- Any paints containing lead or chromates (including in the tinters).

2.0 TERMINOLOGY AND ABBREVIATIONS

2.1 Terminology

The definitions as listed in Table 1 shall be applicable throughout this specification.

Table 1 : Definitions

Definition	Description
Employer	Has the meaning defined in the contract and includes their respective successors and assigns
Project Manager	Has the meaning defined in the contract and includes their respective successors and assigns
Site	Means the portion of the land upon which the *works* are to be constructed, as well as the temporary camp and offices to be occupied by the *Contractor*
Contractor	Has the meaning defined in the contract and includes their respective successors and assigns
Subcontractor	Means a subcontractor or their subsidiary, engaged by the *Contractor*

2.2 Abbreviations

The abbreviations as listed below shall be applicable throughout this specification.

Table 2 : Abbreviations

Definition	Description
A	Ampere
AC	Alternating Current
AM	Amplitude Modulation
AOS	Application Object Server
API	Applied Programming Interface
BMS	Building Management System
BoQ	Bill of Quantities
CCR	Central Control Room
CCTV	Close Circuit Television
CD	Compact Disc
CoC	Certificate of Compliance
CPU	Central Processing Unit
Cu	Copper
dB	Decibel
DC	Direct Current
DCLS	Direct Current Level Shift
DDE	Dynamic Data Exchange

Table 2 : Abbreviations

Definition	Description
ECSA	Engineering Counsel of South Africa
FAT	Factory Acceptance Tests
GPS	Global Positioning System
HVAC	Heating, Ventilation and Air Conditioning
HV	High Voltage
Hz	Hertz
HMI	Human-machine Interface
IEC	Independent Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronic Engineers
ICT	Information and Communication Technology
I/O	Input – Output
IP	Ingress Protection / Internet Protocol
IR	Infra-Red
IRIG	Inter-range instrumentation group time codes
ISO	International Standards Organisation
LED	Light-Emitting Diode
LCD	Liquid Crystal Display
LV	Low Voltage
MV	Medium Voltage
MVA	Mega Volt Ampere
Native	Original electronic file format of documentation
NTP	Network Time Protocol
OEM	Original Equipment Manufacturer
O&M	Operating and Maintenance
OLE	Object Linking and Embedding
ºC	Degree Celsius
PC	Personal Computer
PCS	Process Control System
PIR	Passive Infrared
PLC	Programmable Logic Controller
PPS	Pulse Per Second
PTP	Precision Timing Protocol
PVC	Polyvinyl chloride
QA	Quality Assurance
RIO	Remote Input - Output device
R&D	Research and Development

Table 2 : Abbreviations

Definition	Description
RTC	Real Time Clock
SABS	South African Bureau of Standards
SANS	South African National Standards
SAT	Site Acceptance Tests
SCADA	Supervisory Control and Data Acquisition
SHE	Safety, Health and Environment
SNTP	Simple Network Time Protocol
SQL	Structured Query Language
TCP	Transnet Capital Projects
TCP/IP	Transmission Control Protocol/Internet Protocol
TFR	Transnet Freight Rail
TGC	Transnet Group Capital
TNPA	Transnet National Ports Authority
TPT	Transnet Port Terminals
TTL	Transistor–transistor Logic
UPS	Uninterruptable Power Supply
V	Volt
VOIP	Voice-Over-Internet Protocol
VPN	Virtual Private Network
W	Watt
kWhr	Kilowatt Hours

3.0 CODES, STANDARDS, SPECIFICATIONS AND REGULATIONS

3.1 General

The sequential order of precedence for the applicable codes, standards, specifications and regulatory requirements shall be as follows:

- Government acts and regulations.
- *Employer* project guidelines, specifications and standards.
- South African standards.
- International standards.

In the event of an inconsistency, conflict or discrepancy between any of the standards, specifications and regulations, the most stringent and safest requirement shall prevail. Any inconsistencies critical to the design and construction shall be brought to the attention of the *Employer* for resolution, prior to construction.

Wherever this is required, equipment shall be installed in accordance with the manufacturer's installation instructions. The *Contractor* shall also not modify any equipment that has previously been certified by the manufacturer.

The *Employer* may request that the *Contractor* submit samples of the types of materials to be used. Subject to approval by the *Employer,* such samples shall be retained for reference purpose for the duration of the *works*. The *Employer* may also request, and the *Contractor* shall provide, relevant certification for such samples, indicating compliance with the technical specifications.

The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer’s premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

3.2 Government Acts and Regulations

The *Contractor* shall comply with all applicable government acts, by-laws and regulations, as amended from time to time, including, but not limited to, the following:

- Occupational Health and Safety Act 85 of 1993.
- National Water Act 36 of 1998.
- Atmospheric Pollution Prevention Act 45 of 1965.
- Environmental Conservation Act 73 of 1989.
- Promotion of Access to Information Act 2 of 2000.
- National Road Traffic Act 93 of 1996.
- National Environmental Management Act 107 of 1998.

3.3 *Employer’s* Standards

The *Contractor* shall be responsible for compliance of all *works* with all the *Employer* standards and specifications, including, but not limited to, the following:

Table 3 : *Employer's* Standards and Specifications

Standard	Description
EEM-Q-008	Corrosion Protection Specification
EEM-Q-012	General Electrical Equipment
EEM-Q-013	Commissioning and Handover
EEM-Q-019	Cable Reel Systems
EEM-Q-020	Test on Electrical Equipment
EEM-Q-021	Electronic Equipment
H500100-2-000-J-STD-005	PLC and SCADA Standards
SYS-P-0001	Business Codification
H500100-2-000-J-STD-0008	Instrumentation Identifications Standard
H500100-2-000-J-STD-0009	Tag Naming Standard
Part 6.3 Rev-02	Transnet Group - Integrated Electronic Security and Related Systems Specification: HD IP Video Surveillance System

It is the responsibility of the *Contractor* to ensure that he obtains all of the *Employer's* standards (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the *works* by the *Contractor* to the standards.

3.4 South African and International Standards

The *Contractor* shall also ensure that the *works* comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

The South African standards shall include, but are not necessarily limited to, the following.

Table 4 : South African Standards

Standard	Description
SANS 556	Low-voltage switchgear – All applicable parts
SANS 725	IEEE Guide for Safety in AC Substation Grounding
SANS 1019	Standard voltages, currents and insulation levels for electricity supply
SANS 1091	National Colour Standard
SANS 1507	Electrical Cables with extruded dielectric Insulation for fixed Installations (300/500V to 1 900/3 300 V – All applicable parts
SANS 1765	Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA

Table 4 : South African Standards

Standard	Description
SANS 1973	Low-voltage switchgear and controlgear assemblies – All applicable parts
SANS 10142-1	The wiring of premises. Part 1: Low-voltage installations
SANS 10340	Installation of Telecommunication Cables
SANS 11801	Information Technology - Generic Cabling For Customer Premises
SANS 60439	Low-voltage switchgear and controlgear assemblies – All applicable parts
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 60793	Optical Fibres – All applicable parts
SANS 60794	Optical Fibre Cables – All applicable parts
SANS 60947	Low-voltage switchgear and controlgear – All applicable parts
SANS 61156	Multicore And Symmetrical Pair/Quad Cables For Digital Communications
SANS 61850	Communication Networks And Systems For Power Utility Automation
SANS 61312	Protection against lightning electromagnetic impulse – All applicable parts
SANS 61439-1	Low-voltage switchgear and controlgear assemblies – All applicable parts
SANS 62262	Degrees of Protection provided by Enclosures for Electrical Equipment against external Mechanical Impacts (IK Code)

International standards shall include, but are not necessarily limited to, the following.

Table 5 : International Standards

Standard	Description
IEC 60870-5-103	Telecontrol equipment and systems – Part 5-103: Transmission protocols – Companion standard for the informative interface of protection equipment
IEEE 472	Guide for Surge Withstand Capability (SWC) Tests
IEEE 1588	Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems

4.0 SITE CONDITIONS

The equipment shall be suitable for installation within the conditions as described above and indicated below.

Table 6 : Site Conditions

Condition	Description
Altitude	Sea Level
Air Temperature	45°C Maximum; -5°C Minimum
Equipment Surface Temperature (from sun)	60°C Maximum
Relative Humidity	50% Minimum; 85% Maximum; 60% Average
Air Quality	Coastal salt- laden air with high concentration of iron ore dust
Air Pressure	101.3 kPa
Average Annual Rainfall	278 mm

Additional details can be found in the Site Information document forming part of the accompanying Works Information.

5.0 SCOPE OF *WORKS*

5.1 *Works* Included

The *Contractor's* scope of *works* shall include, but not be limited to, the design (where specified), fabrication, supply, installation, testing and commissioning of all monitoring and control (where applicable) equipment related to the substation installations, programming, testing, integration with and commissioning of all communication links between equipment. It includes:

- All detailed designs, drawings and documentation as required in terms of this specification and associated other contract documentation. The *Contractor* shall engage the services of approved specialist subcontractors and/or OEM's, to be approved by the *Employer*, as necessary.
- All management, personnel, labour and other resources that are required to execute the *Contractor's* scope of *works*, in accordance with the requirements of this specification.
- Coordination between other services shall be maintained to ensure correct and proper integration of the electrical systems.
- Quality management, as described in the Works Information and these specifications.
- Supply of commissioning and operational spares, required for normal wear and tear during plant operation for the period of one year after commissioning, as described in Section 9.0.
- Operating and maintenance manuals, training and back-up support, as described under Section 9.0.
- Pre-commissioning and commissioning of installations, including supporting documentation, as described under Sections 11.0.
- All as-constructed documentation, as described under Section 13.0.

The scope of electrical facilities forming part of the *works* includes, but is not limited to, the following:

- Servers and Storage Equipment.
- Workstations.
- Network Switches.
- Remote I/O devices.
- Patch panels and rack enclosures.
- Fibre optic and Ethernet patch leads.
- Optical fibre cables.
- Data and control cables.
- Time synchronising (GPS clock) equipment.
- Panel/Enclosure switchgear, wiring etc. inside enclosures where monitoring and control (as applicable) infrastructure is installed, unless factory/OEM warranties apply, in which case the OEM shall be responsible for the complete wiring and fabrication of the panels/enclosures.
- Interface and communication links between IED's and the monitoring and control (where applicable) systems.
- Building management systems.
- Intruder detection systems.
- CCTV systems.
- Atmospheric pressure detection.
- Factory acceptance testing.
- Site acceptance testing.
- Staged acceptance testing.
- Pre-commissioning testing.
- Commissioning testing.

The *Contractor* shall also install fibre optic 19" rack enclosures, 19'' rack-mountable patch trays (panels), network switches and associated equipment at Substations A, B, H, J and K.

The installations to be provided by the *Contractor* shall also include, but not be limited to, 19" rack enclosures with patch trays, brush trays, network switches, switchgear, power supplies (if required), workstation, servers and storage at the existing Electronics Workshop/Engineering Station and CCR respectively, as shown on the drawings and bills of quantities. The overall port SCADA will be designed and installed by Others.

The entire new monitoring (and where applicable control) systems shall be detailed designed, installed and commissioned by the *Contractor* to provide a fully functional, operable and compliant system for the

network to effectively monitor and/or control the various systems as applicable. This shall include, but not be limited to, the fire detection systems, access control systems, intruder alarm systems, CCTV, building pressure loss systems, the protection, metering, automatic voltage control systems (where relevant) and respective HV and MV equipment at all new substations, in accordance with these specifications, Works Information, drawings, bill of quantities and all other related contract documentation.

The *Contractor* shall ensure that the specialist subcontractor/OEM fully cooperates, coordinates and furnishes all technical support and associated technical information to the *Employer* and Others as required, to ensure that the new infrastructure and systems are fully and correctly integrated.

Should there be any discrepancies or misunderstandings regarding the *works* to be undertaken by the *Contractor*, the *Contractor* shall immediately notify the *Employer*.

5.2 *Works* Excluded

The following is excluded from the *works* and will be supplied by Others:

- The centralised Port SCADA installation.
- Programming of main local remote main I/O devices, server, historian and workstation(s).
- The procurement, installation, configuration and integration of the Wonderware package for the centralised Port SCADA installation.
- All tippler, tippler building and conveyor SCADA/monitoring and control related systems.
- Any other monitoring and control systems supplied by Others, as detailed in the contract documentation.

5.3 Designs, Calculations and Drawings by the *Contractor*

5.3.1 General

Calculations, designs, drawings and reports to be provided by the *Contractor,* to be approved by the *Employer,* shall include, but not be limited to, the following:

- Monitoring, and where applicable, control systems (Complete ICT network).
- SCADA systems ie. servers, storage, local workstations and the like.
- Programming of local systems (excluding main RIO devices and others as described in these specifications) in printed and the OEM proprietary software format.
- Local systems programming in printed and OEM propriety software.
- Interlocking.
- Building systems such as fire detection, access control, intruder alarm, pressure loss, UPS, CCTV and the like.
- Protection and metering, switchgear and the like.

Documentation to be produced by the *Contractor* shall be compiled and submitted in accordance with the procedures included in the Works Information as well as the further requirements as detailed below. All documents, for which prior approvals are required, shall be timeously submitted to the *Employer* for review and approval, prior to placement of orders, fabrication or manufacture.

The *Contractor* shall, as necessary, appoint specialist subcontractors and OEMs to undertake the designs, calculations and drawings, which shall be prepared and checked by suitably qualified and experienced professional engineers, registered with the Engineering Council of South Africa (ECSA) or an equivalent institution recognised by ECSA.

The design engineers shall be appointed by the *Contractor,* subject to approval by the *Employer*. Designs, calculations and drawings shall not be prepared and checked by the same person and shall be reviewed by the *Employer* before the commencement of fabrication.

The *Employer* will provide the *Contractor* with the necessary formats for documents that are to be submitted for approval.

The *Employer* may, at his sole discretion, request additional design calculations, drawings and associated information, as deemed necessary for verification of the correctness and compliance of the designs. The cost of providing such additional information shall be deemed to be included in the tendered rates, i.e. further payments for such information will not be made.

5.3.2 Designs and Calculations by the *Contractor*

The *Contractor* shall submit all required calculations in a neat and legible manner. Where calculations are performed using specialised software programs, the *Contractor* shall also furnish copies of the final native software files, without any exclusions. The calculations shall be provided in a professional, neat format, to include, but not be limited to, the following, in the order as stated below:

- Summary of assumptions and conclusions.
- Table of contents.
- List of all associated drawings.
- List of compliancy standards.
- List of all text and references used.
- Nomenclature.
- Calculations.

5.3.3 Drawings by the *Contractor*

All design and construction drawings shall be submitted in hard and soft copies. Soft copies shall be in 'rvt', 'dgn', 'dwg', 'dxf' and PDF formats. Three hard copies are to be provided, which shall be fully signed off, unless specified otherwise.

The *Contractor* shall be solely responsible for the submission of any drawings that are to be provided by his appointed specialist subcontractors and/or OEM's.

5.4 Safety

Reference is made to the environmental and safety requirements as detailed in the Works Information and the particular requirements as described below.

The *Contractor* shall take all necessary safety precautions to prevent static electricity discharge, sparking and any other unsafe condition, which could pose a safety risk to personnel, property and/or equipment.

The location and extent of potentially explosive atmospheres are to be identified and indicated on hazardous area classification drawings. All electrical equipment and instruments for use in hazardous classified areas shall be supplied with a hazardous area certificate issued by a certifying authority approved by SABS/SANS/IEC. Certificates shall be indexed and filed in a certification register.

All *works* shall be performed under strict lockout/disconnection conditions and a register shall be kept of all isolated circuits. The *Employer's* requirements shall also be incorporated in all safety procedures. Provision shall be made for the following:

- The switching and lockout procedures shall form part of the *Contractor's* HSE documentation.
- Whenever a live circuit must be isolated, the *Employer* shall be notified.
- The *Contractor* shall maintain a full key lockout system, with appropriate registers and signatures.
- Under no circumstances shall the *Contractor* do any switching/lockout *works*. All switching shall be undertaken by the *Employer*/Eskom's authorised personnel.

5.5 South African Electrical Compliance

Any equipment designed and fabricated/manufactured overseas shall have an electrical certificate of compliance to South African Regulations before it is delivered (and operated) in South Africa. The compliance certificate(s) shall fully cover high voltage, medium voltage and low voltage equipment. These certificates shall be issued by an accredited South African professional engineer.

5.6 *Employer* QA Representative

The *Contractor*'s QA requirements shall be as set out in the accompanying Works Information.

The *Employer* may choose to appoint a QA/QC representative to monitor and report on some or all aspects of the production and fabrication processes. Full cooperation shall be extended to the appointed QA/QC representative. Associated costs for such services will be borne by the *Employer*.

5.7 *Contractor*'s Subcontractor Declaration

Where *works* are to be performed by a subcontractor, the *Contractor* shall provide notices and obtain the *Employer's* approval prior to the appointment of the subcontractor. This shall include all subcontractors providing design, fabrication, assembly, installation and related services.

6.0 SPECIFICATIONS

6.1 General

The *Contractor* shall appoint a specialist subcontractor/OEM, as applicable, to undertake the complete design, supply, installation and commissioning of the complete monitoring, and where applicable control installations forming part of the *works*.

The installation of the systems shall include any programming of local equipment as required, and complete integration of the equipment/systems with the respective main electronic monitoring and control infrastructure (ICT network), and any other local systems as applicable and required referenced in the Works Information, these specifications, drawings, bill of quantities and any other associated *Contractor* documentation. The procedures governing the detailed design approval, manufacturing, inspections, testing and commissioning of the equipment/systems, are covered in further sections of these specifications.

It will be the responsibility of the *Contractor* to ensure that the respective specialist subcontractor/OEM fully cooperates, coordinates, supports and supplies any technical and associated information to Others as required, to ensure that the systems are fully integrated, both electrically and electronically.

The *Contractor* shall familiarize himself with and follow the installation and wiring instructions as described in these specifications. The manufacturer of any given device or component shall be consulted whenever conditions arise that are not covered by the manufacturer's instructions.

6.2 CCR and Electronics Workshop/Engineering Station Additional Systems

6.2.1 General

Provision shall be made for remote monitoring of the substation systems and the building management systems from the Electronics Workshop/Engineering Station and, where applicable, the CCR SCADA. This shall include the provision for a new application object server and historian server at the Electronics Workshop/Engineering Station and data/communication links between the server, historian, network switches and all other associated equipment, to be supplied and installed by the *Contractor*, as indicated in the Works Information, drawings, bills of quantities and associated contract documentation.

The provision of the additional Wonderware and associated software installations for the integration of the two servers and workstation at the Electronics Workshop/Engineering Control Station, including upgrade and programming of the SCADA systems at the CCR, will be done by Others.

The requirements for the network switches, patch panels, RIO devices and the like are covered further down in this specification.

6.2.2 Time Synchronisation

i. *Electronics Workshop/Engineering Station*

The *Contractor* shall provide a centralised time clock/server, to be installed in the server panel within the Electronics Workshop/Engineering Station at the port, which is to be supplied and installed by the *Contractor*. This time server shall provide accurate time stamping throughout the port for all devices capable of receiving a time signal. The clock shall be supplied with an external antenna and sufficient length of coax cable to be installed such that it has an unobstructed view of the sky.

The clock shall have a built-in GPS receiver and shall synchronise the time as received from the GPS, which shall be configured to adjust for local time. It shall include a real time clock (RTC) with battery back-up to ensure continuous accurate time synchronisation of all connected equipment, should the GPS signal fail. The accuracy of the RTC shall be ± 0.5 seconds per day (one minute per month).

The time server shall be capable of acting as a master or a slave, with redundancy in synchronisation sources used, and with the ability to accept at least the following synch references:

- GPS (Antenna with internal receiver).
- 1PPS.
- 10 MHz.
- IRIG (DCLS and AM).
- PTP.
- NTP.

It shall be possible to synchronise IEEE 1588-2008 (PTPv2), NTP and SNTP clients over a TCP/IP network. The time server shall, as a minimum, have the following interfaces:

- One (1) IEEE 1588 RJ45 network interface.
- Five (5) RJ45 network interfaces.

Depending on the capability of the existing switches currently installed in the fibre-optic network, either PTPv2 or NTP time pulses shall be used by the centralised server.

6.2.3 Servers and Storage

In the event of a fault on the HV or MV networks, the SCADA system shall automatically download all fault records, to prevent the loss of valuable information following events, due to records being overwritten in a full IED buffer. Downloads shall either be triggered by the IED or be set to download daily/weekly, with preference being given to immediate download.

Any change in status of alarms or indications (digital I/O) that are alarmed to the SCADA system shall be updated, time-stamped and stored in real time for future records. These requirements shall also apply to

metering, switchgear, UPS, fire detection, access control, intruder alarm, pressure loss systems, alarms and the like.

The data shall be stored on the dedicated operational historian(s) supplied by the *Contractor* and will be installed in the Electronics Workshop/Engineering Station. Integration into the overall port SCADA system will be done by Others, as described under Section 6.2.1 above.

The following servers/storage shall be provided by the *Contractor*:

- AOS04 Server.
- Historian 2.

The servers shall be Dell PowerEdge R390, or approved equivalent, 19" rack mountable servers and shall be supplied and installed by the *Contractor* complete with all software (Note: Excluding SCADA software), including all wiring, switchgear, power supplies, fixing materials and any other equipment and accessories as required.

One IBM Storwize V7000 10TB or approved equivalent 19" rack mountable storage shall be supplied by the *Contractor,* to include at least the following:

- SAN-attached 8 Gbps and 16 Gbps fibre channel.
- 1 Gbps iSCSI and 10 Gbps iSCSI/ FCoE NAS-attached.
- 1 Gbps and 10 Gbps Ethernet.
- Software, including all wiring, switchgear, power supplies, fixing materials and any other equipment and accessories as required.

The procurement and installation of the new AOS04 server and Historian 2 shall be by the *Contractor.* The configuration and integration of the servers, storage and the new Wonderware package with the centralised Port SCADA installation shall be done by Others.

6.2.4 Local Workstation at Electronics Workshop/Engineering Station

The *Contractor* shall supply a local workstation as part of the monitoring functionalities of the entire Tippler 3 respective infrastructure (including those provided by Others) at the Electronics Workshop (Engineering Station). It shall be rack-mounted with a lockable, integrated screen, keyboard and mouse tray. The workstation shall include but not be limited to at least the following:

- 230 V AC / 110 V DC switch mode power supply.
- All wiring, switchgear and associated equipment and accessories.
- 250 Gb solid state hard drive.
- i5 processor.
- 8 Gb RAM.
- 2 x serial ports.
- 2 x Gigabit Ethernet LAN ports.
- Latest Windows operating system.
- Any additional OEM(s) software required, if applicable, to work in conjunction with the SCADA software to allow for remote interrogation of the various HV and MV equipment, BMS systems and the like.

The Wonderware SCADA software, installation thereof and configuration/integration shall be undertaken by Others.

The workstation, along with the servers, GPS clock and switch shall be installed in a 19" rack enclosure, as described in Section 6.8.

6.3 ICT Network Infrastructure for SCADA Indication and Communication

6.3.1 ICT Systems Ethernet Switches

The *Contractor* shall supply and install network switches and all associated equipment/systems at the Main Intake Substation, Substations M and N and the Electronics Workshop/Engineering Station, and elsewhere as specified, shown on the drawings and bills of materials or as instructed by the *Employer*.

These switches shall form part of the main the communication gateways between the centralised SCADA installation and new Tippler 3 ICT, and where applicable plant, systems/network. The main communications protocol shall be Ethernet TCP/IP.

Separate switches shall be provided for the following functions at the new Main Intake Substation and Substations M and N:

- Building Management System.
- CCTV.
- Plant (for infrastructure by Others).

The switches shall be of the Hirschmann MAR1040-4C4C4C4C9999SM9HR managed (layer 3) type or approved equivalent and shall comply with the following minimum requirements as set out in the table below.

Table 7: Network Switch Requirements

Item	Description
16 Port Managed Switch	
Ports	Full gigabit Ethernet 16 x combo ports (10/100/1000BASE TX RJ45 plus related FE/GE SFP slot), RJ11 and USB. Note: including M-SFP-LX/LC connectors and CAT6A cables as applicable
Power supply	230V AC 50Hz power input
Mounted	19” rack mounted
Make and model	Hirschmann MACH MAR1040 full Gigabit Ethernet switch or approved equivalent
General	
Programming	The *Contractor* shall allow for all programming of the system, including three additional reiterations, to ensure that the *Employer* is satisfied with the setup, operation of the system and commissioning.
Wiring	The *Contractor* shall allow for all wiring to make the system fully functional.
Labelling	All equipment shall be neatly and professionally labelled using Traffolyte or equivalent approved labelling.
Others	Provision and installation of any additional items, equipment and accessories that are required to render this installation complete and fully functional as required.

The same switches, along with the racks, patch panels and the like, shall also be installed at existing Substations A, B, H, J and K, as per the Works Information, drawings, bill of quantities and other associated contract documentation.

6.3.2 IEC 61850 Communication Protocol Systems Switches for HV and MV Protection and Metering

The *Contractor* shall supply all switches that are to be installed on the switchgear, at the transformer and on-load tap-changer protection and control panels as well as metering panels at the Main Intake Substation and Substations M and N as applicable. Further reference shall be made to the drawings, bills of quantities and associated contract documentation for additional information.

The switches shall be configured to operate as multiple, dedicated Ethernet rings within the substations to allow for the formation of dedicated VPN's for access control, should this be required by the *Employer.* These Ethernet rings shall be integrated into the main substation Ethernet network by the *Contractor*, which in turn will connect to the overall existing Ethernet communication system.

The Ethernet switches required for the transformer protection and metering panel shall be as shown in the table below.

Table 8: Protection and Metering Switch Requirements

Item	Description
9-10 Port Managed Switch	
Ports	9 ports in total, thereof 3 x GE, 6 x FE: 1. uplink: 2 x Gigabit SFP-Combo port; 2. uplink: Gigabit SFP-Combo port; 3. 6 x 10/100BASE TX, RJ45
Power supply	110 V DC power input; power supplies shall be supplied as part of the installation in the panel should another voltage level be required
Mounted	DIN-rail Mounted
Make and model	Hirschmann DIN Rail Gigabit Ethernet switch or approved equivalent
General	
Programming	The *Contractor* shall allow for all programming of the system, including 3 additional reiterations, to ensure that the *Employer* is satisfied with the setup, operation of the system and commissioning.
Wiring	The *Contractor* shall allow for all wiring to make this system fully functional.
Labelling	All equipment shall be neatly and professionally labelled using Traffolyte or approved equivalent labelling.
Others	Provision and installation of any additional items, equipment and accessories that are required to render this installation complete and fully functional as required.

6.3.3 Remote I/O

A remote I/O (RIO) device, with all additional equipment, accessories and software shall be provided for the monitoring of the MV breaker statuses, protection, metering, building management systems and any other equipment as specified for the new Main Intake Substation and Substations M and N. These devices will in turn interface with the main ICT network.

The *Contractor* shall, upon completion of his design, submit to the *Employer* comprehensive I/O lists for the new RIO devices in table form, for approval. These I/O's shall be used for the configuration/integration of the centralised port SCADA systems (by Others).

The items which will require indication and communication via the RIOs shall be as described in the communication philosophies and/or as shown on the drawings and/or other associated contract documentation. These parts of the *works* shall be designed, supplied and installed by the *Contractor* and shall be deemed to have been priced accordingly.

The *Contractor's* engineering design shall include, but not be limited to, all cubicles and hardware required for the RIOs. This shall include but not be limited to comprehensive equipment lists, cubicle GA's and system drawings, I/O schedules and functional descriptions.

Each RIO panel shall be capable of satisfying (as a minimum) the following communication requirements:

- RS485-Profibus DP interface module for the building management communications.
- 2 x RJ-45 (or fibre-optic ports) Profinet interface module for direct communication to the main network switch located inside each respective new Substation.

The following additional minimum requirements shall also apply:

- Hot swopping of I/O modules.
- 16 x Digital Inputs.
- 16 x Digital Outputs.
- 2 x Analogue Inputs and Outputs.
- No local human machine interface required.

The RIO shall be installed in a suitably sized floor standing rack enclosure as described elsewhere in this specification.

6.3.4 Cabling and Support Infrastructure

Cabling for all the systems shall be distributed via the services spine/backbone and respective cable management systems. The *Contractor* shall refer to the drawings and relevant sections of these specifications, as well as Specification No 1924701-2-300-E-SP-0008 and other associated contract documentation for further details.

6.3.5 Earthing Requirements

Earthing of all the systems shall be as per the OEMs requirements, including, where applicable, Specification No 1924701-2-300-E-SP-0008, other associated contract documentation, drawings and the bill of quantities.

6.4 Building Management System (BMS)

6.4.1 General

Under normal operation the substations will be unmanned and monitored from the Electronics Workshop (Engineering Station) and, where applicable, the CCR SCADA. The buildings contain numerous electrical, electronic and mechanical building systems for the operation of the building only, unrelated to the materials handling plant operation.

The main remote I/O device inside each respective substation will collect all information from the local building equipment/systems i.e. HVAC, UPS, fire detection, access control, intruder alarms, protection and metering equipment and the like.

6.4.2 System Operation

The building management system for each substation shall comprise of local building equipment/systems, linked together via Profibus DP protocol communications (and hardwired where required), except for the atmospheric pressure detectors which shall be directly hardwired to the HVAC controller. The HV and MV equipment and metering's communications shall be as indicated on the drawings.

The information to be relayed to the BMS from the respective building systems via communication connections (and where applicable hardwire inputs) shall typically include, but not be limited to, the items listed in the table below. Note: All information of all systems connected to each respective remote I/O device shall be made available to the SCADA system. The table below is a high level summary of the information provision requirements of the equipment.

Table 9: Typical BMS System I/O Information

System	Communication Links	Hard Wire Inputs
HVAC System	Profibus DP (all information) and, where applicable, I/O hardwired	• Healthy • Fault • Alarm
Fire Detection System		• Healthy • Fault • Alarm • Alarm Location • Suppression Activation • Suppression Activation Location
Intruder Alarm System		• Healthy • Fault • Alarm
Access Control System		• Healthy • Fault • Alarm
UPS		• Healthy • Fault • Alarm
MDB (Power Meter)		• Volts • Amps (per phase) • PF • kWh
Pressure Sensors via HVAC System		• Healthy • Fault • Alarm
HV and MV Equipment	IEC 61850 and where applicable I/O hardwired.	• Fault • Alarm • Breaker Status Indication

The system information shall be transferred by the RIO device, via the fibre optic network, to the port SCADA system, ready to be programmed (by Others) and displayed on the SCADA system, as described above.

6.4.3 Building Management System Equipment

The BMS equipment shall include, but not be limited to, the items as listed in the table below.

Table 10: Building Management System Equipment

Item	Description
System Infrastructure	
19" Rack Enclosure	• 47U, 19" Floor-standing rack enclosure (Maximum height = 2m) • Glass door • Side and back panels • Adjustable vertical mounting rails • Integrated electrical bonding • Accessory channels • Integrated cabling management systems • Top or bottom cable entry facilities • 3CR12, IP54 • Colour : Inside CCR & Electronics Workshop (Engineering Station) - Black Powder Coated • Colour : Inside substations - Light Grey (G29) Powder Coated **Note: Refer to Table 14**
RIO Device	Refer to previous section in this specification for the RIO and associated requirements to suit design.
Network Switch	Hirschmann MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type, or approved equivalent, with: • 16 dual combo ports • 8 x RJ45 ports • 8 x Singlemode M-SFP-LX/LC ports • Power supply expansion as required
General	
Programming	The *Contractor* shall allow for all programming of the local systems (excluding the main remote I/O device), including three additional reiterations, to ensure that the *Employer* is satisfied with the setup, operation of the system and commissioning. It shall be possible at all times to upload the stored program to a PC in order to maintain updates.
Wiring	The *Contractor* shall allow for all wiring to make this system fully functional and linked to other systems, as required.
Labelling	All equipment shall be neatly and professionally labelled, using Traffolyte or approved equivalent labelling.
Others	Provision and installation of any additional items that are required to render this installation complete and fully functional as required ie. power supplies, switchgear etc.

6.4.4 Cabling and Support Infrastructure

Cabling for the building management system shall be distributed via the services spine/backbone and the cable management systems. The *Contractor* shall refer to the drawings, further sections of these specifications, Specification No 1924701-2-300-E-SP-0008 and further associated contract documentation for further details.

6.4.5 Earthing Requirements

Earthing of all associated BMS infrastructure shall be as per the OEMs requirements, including, where applicable, further requirements as stated in Specification No 1924701-2-300-E-SP-0008, other associated contract documentation, drawings and the bill of quantities.

6.5 Intruder Alarm Systems Installations

6.5.1 General

The intruder alarm systems shall detect unauthorised access to the substation buildings for security purposes, for securing of assets and for prevention of unwanted interference with plant operations.

6.5.2 System Operation

The buildings intruder alarm systems shall consist of a central control panel connected to field devices, typically comprising of system keypads, door open/close sensors, PIR detectors, monitoring and control devices and annunciation devices.

The system control panels for Substations M and N shall be located inside their LV and Electronics room and for the new Main Intake Substation inside its LV room as shown on the drawings, unless otherwise shown or instructed by the *Employer*. The system keypads, door open/close sensors and motion detectors shall typically be installed as shown on the layout drawings, with visual (in clearly visible locations) and audible alarm indications situated external to the buildings.

The system shall keep records of system operations and events, which shall be accessible locally from the control panel and remotely via the main port SCADA system. Under intruder detection conditions, the systems shall send an appropriate alarm signal to the port SCADA system.

The operation of the system shall be field configurable from the control panel via a keypad or Windows-based software, to suit the specific application and to permit future changes. This configuration shall be maintained under power failure conditions.

The control panel shall have a control keypad with backlit graphical LCD display. The LCD display shall indicate and detail each and every event which occurs in the system.

The control panel shall be modular in design and operate as a stand-alone unit.

6.5.3 Intruder Alarm Activation and Deactivation

The intruder alarm shall be deactivated and activated under the following conditions:

- To deactivate the intruder alarm system, the user enters the building and enters in the activation/deactivation code into the wall mounted keypad within the prescribed time frame. Failure to enter in the correct code within the prescribed time frame, or entering the incorrect code three times, will result in the sounding of the intruder alarm siren as well as sending an intruder alarm signal to the SCADA system.
- To activate the intruder alarm system, the user enters in the activation/deactivation code into the wall mounted keypad and exits the building within the prescribed time frame. A confirmation tone and arm-activation LED, mounted above the door on the outside of the building, shall indicate that the system was successfully armed.

6.5.4 System Extendibility

The system shall be modular in design and supported by appropriate software to enable the intruder alarm system to be configured to meet the exact needs of each location.

System extension shall be by means of plug-in modules, automatically configured by the system.

6.5.5 System Capacity

The control panel shall be capable of monitoring a minimum of 64 zones and be controllable by 3 keypads.

The control panel shall allow the programming of a minimum of 128 user codes. The panel shall keep a log of the last 1000 events.

6.5.6 Intruder Alarm System Equipment

The intruder alarm equipment shall include, but not be limited to, the items as listed in the table below.

Table 11: Intruder Alarm System Equipment

Item	Description
System Infrastructure	
Control Panel	Centralised intruder alarm unit shall be Caddx Networx NX-8E, complete with wall mountable, powder coated, metal enclosure, power supply, battery backup and registration reader, or approved equivalent. The system shall have Profibus communication capabilities and shall form part of the Profibus link to the main RIO device. Any connection or communication converters and associated cabling that is required to establish the communication links shall be included in the scope of *works*,
Keypad	Wall mounted LCD keypad with LED backlight
Motion Detector	High quality, false alarm immune, infrared/microwave combination detector complete with: • 12 x 12 metres range • 100° viewing angle • Creep zone • Sealed Fresnel lens • Automatic temperature compensation • Tamper output
Door Open/Close Sensor	High quality, industrial, heavy duty, false alarm immune, open/close sensor
Intruder Alarm Visual Indication	• LED alarm visual indicator • Colour - amber • Harsh environment and dust proof IP65 • Outdoor wall mounted
Intruder Alarm Audible Indication	• 75dB Siren • Harsh environment and dust proof IP65 • Outdoor wall mounted
System Armed Light	Wall-mounted, super-bright blue LED, IP65 rated installed in a visible position externally of the building. Final position of the aforementioned shall be confirmed on-Site with the *Employer*.
Power Supply and Charger Unit	The power supply and charger unit shall form an integral part of the control unit and shall operate from main UPS power at 230Vac. The output shall be rated to accommodate the power required at 12Vdc, unless otherwise required. The power supply and charger unit shall contain over-voltage protection to prevent any malfunction or damage due to power line surges. In the event of a failure of the main UPS supply to the control panel, there shall be an automatic switchover to the standby battery supply without disturbing the sound operation of the intruder alarm system. This action will not cause any false alarms. The control panel shall be able to house the standby batteries of 12Vdc rated to maintain operation for a minimum of 24 hours of which at least 1 hour is at alarm status. The batteries shall have a guaranteed life span of 15 – 20 years.
Communications	Profibus DP (all information) and, where applicable, I/O hardwired

Table 11: Intruder Alarm System Equipment

Item	Description
General	
Programming	The *Contractor* shall allow for all programming of the system, including 3 additional reiterations, to ensure that the *Employer* is satisfied with the setup, operation of the system and commissioning. All programming shall be menu-driven and protected by access codes and memory lock. The programming shall allow for at least the following functions: • Programming of output relays. • Uploading/downloading of configuration data. It shall be possible at all times to upload the stored program to a PC in order to maintain updates.
Wiring	The *Contractor* shall allow for all wiring to make this system fully functional and linked to other systems as required.
Labelling	All equipment shall be neatly and professionally labelled using Traffolyte or approved equivalent labelling.
Others	Provision and installation of any additional items that are required to render this installation complete and fully functional as required.

6.5.7 Cabling and Support Infrastructure

Cabling for the intruder alarm systems shall be distributed throughout the substations via cable management systems. The *Contractor* shall refer to the drawings, further sections of these specifications, Specification No 1924701-2-300-E-SP-0008 (Low Voltage Installation) and other associated contract documentation for further details.

6.5.8 Earthing Requirements

Earthing of all associated intruder alarm systems shall be as per the OEMs requirements, Specification No 1924701-2-300-E-SP-0008 (Low Voltage Installation), other associated contract documentation, drawings and bill of quantities.

6.6 Closed Circuit Television (CCTV) System

6.6.1 General

The CCTV Systems within the substations shall perform both a security function, by recording who enters and exits certain areas of the buildings, and an event record function, by recording sequences of events, assisting the user with further investigation should it be required.

6.6.2 Typical System Operation

The building CCTV system shall consist of a local monitoring/setup station and remotely located CCTV cameras as indicated on the layout drawings. The system shall also be capable of being integrated with the access control systems.

The local monitoring/setup station shall, for Substations M and N, be located inside their LV and Electronics room and for the new Main Intake Substation inside its LV room as shown on the drawings, unless otherwise shown or instructed by the *Employer*. The station shall typically comprise of a PC, screen, keyboard, mouse, server, recorder and control system, all mounted within a floor standing 19" rack.

The system shall continuously record and store footage, allowing the user to review the footage at a later stage as required. The recorded or live footage shall also be remotely viewable by the *Employer* via the main ICT network.

The operation of the system shall be configurable from the local monitoring/setup station. This configuration shall be maintained under power failure conditions. Further reference shall be made to the *Employer's* Transnet Group - Integrated Electronic Security and Related Systems Specification: HD IP Video Surveillance System: Part 6.3 Rev-02 to ensure full compliance.

6.6.3 Typical System Equipment

The CCTV system shall typically include, but not be limited to, the equipment as indicated in the table below, unless otherwise shown on the drawings, bill of quantities or instructed by the *Employer*.

Table 12: CCTV System Equipment

Item	Description
Local Monitoring/Setup Station	
19" Rack Enclosure	• 47U, 19" floor standing rack enclosure (maximum height = 2m) • Glass door • Side and back panels • Adjustable vertical mounting rails • Integrated electrical bonding • Accessory channels • Integrated cabling management systems • Top or bottom cable entry facilities • 3CR12, IP54 • Colour : Inside CCR & Electronics Workshop (Engineering Station) - Black Powder Coated • Colour : Inside substations - Light Grey (G29) Powder Coated **Note: Refer to Table 14**
CCTV PC	• 19" rack mountable industrial substation PC • Solid state drives 250GB min • i3 processor (minimum) • 8GB RAM (minimum) • 2 x serial ports • 4 USB 2.0 ports • 2 x 1GB Ethernet LAN ports
CCTV Network Switch	Cisco layer 2 full gigabit Ethernet switch IE-4000-4GS8GP4G-E rack/cabinet mounted type, or approved equivalent, with:

Table 12: CCTV System Equipment

Item	Description
	• 8 gigabit POE/POE+30W RJ45 ports • 4 SFP fibre ports • Power supply expansion as required
Peripherals Combo Tray (Screen, Keyboard, Mouse)	19" rack mountable 1U screen, mouse, keyboard combo tray, mounted in rack/cabinet with PC, complete with wiring, fixing materials and all other accessories etc.
CCTV Server	• 19" Rack mountable 2U • Bosch DL380 Gen9 Management Server or approved equivalent
CCTV Recorder	• 19" Rack mountable • 128 channel • 32TB CCTV recorder • Bosch DIVAR IP 6000 2U or approved equivalent
CCTV Matrix/Control System	• 19" Rack mountable • 32 video inputs • 6 video outputs • RS-232 ports • Bosch LTC 8300/90 Allegiant Matrix/Control Systems or approved equivalent
Cameras	
Indoor Camera	• Indoor/outdoor, ceiling/wall mounted • IP54 • Fixed HD dome type • 1080p30, 160 x zoom • Built in motion detection • POE • Colour White • Bosch AutoDome Junior Fixed Camera or approved equivalent
Outdoor Camera type 1	• Outdoor, wall/pole mounted • IP66 • Auto zoom/focus HD • 1080p30 • POE • Colour White • Bosch DINION IP Imager 9000 HD or approved equivalent
Outdoor Camera type 2	• Outdoor, wall/pole mounted • IP66 • PTZ HD dome type • 1080p30, 30 x zoom • POE • Colour White • Bosch AutoDome IP Dynamic 7000HD or approved equivalent
General	
Programming	The *Contractor* shall allow for all programming and setup of the system, including 3 additional reiterations, to ensure that the *Employer* is satisfied with the setup, operation of the system and commissioning.
Wiring	The *Contractor* shall allow for all wiring to make this system fully functional and linked to other systems as required.
Labelling	All equipment shall be neatly and professionally labelled using Traffolyte or approved equivalent labelling.
Others	Provision and installation of any additional items that are required to render this installation complete and fully functional as required.

6.6.4 Cabling and Support Infrastructure

Cabling for the CCTV systems shall be distributed via the services spine/backbone and cable management systems. The *Contractor* shall refer to the drawings, further sections of these specifications, Specification No 1924701-2-300-E-SP-0008 (Low Voltage Installation) and other associated contract documentation for further details.

6.6.5 Earthing Requirements

Earthing of all CCTV systems shall be as per the OEMs requirements, Specification No 1924701-2-300-E-SP-0008 (Low Voltage Installation), other associated contract documentation, drawings and bill of quantities.

6.7 Atmospheric Pressure Detection

6.7.1 General

The substation building designs include mechanical ventilation systems that maintain a positive pressure within certain rooms of the substation buildings, to prevent dust ingress and thus protect the substation equipment against the harsh atmospheric environment at the Port of Saldanha.

To ensure that a positive pressure is maintained in the respective rooms/areas, atmospheric pressure sensors shall be installed to sense pressure loss at the positions as indicated on the drawings. The pressure sensors shall send a signal to the HVAC controller, which in turn shall send a signal to the building management system (BMS) under pressure loss conditions, allowing the user to investigate and rectify the problem.

6.7.2 Typical System Operation

The pressure sensors, located within the respective substation rooms, shall be wall-mounted as shown on the layout drawings, and linked to the HVAC controller.

The pressure sensors shall issue a signal to the HVAC controller, which in turn shall send a signal to the BMS, and then onto the CCR and Electronics Workshop (Engineering Station) SCADA systems to notify the operators of the pressure loss problem, allowing action to be taken to rectify the problem. The BMS shall also activate the audible and visual (in clearly visible locations) alarms installed externally above the main entrances of the respective substations buildings.

6.7.3 Typical System Equipment

The atmospheric pressure detection equipment shall include, but is not limited to, the items as listed in the table below.

Table 13: Atmospheric Pressure Detection Equipment

Item	Description
System Equipment	
Atmospheric Pressure Sensor	• Settable atmospheric (barometric) pressure sensor • Wall mounted type • IP20 minimum • With 24V DC supply • 5V DC output • RS232 serial link
Visual Alarm Indication	• LED alarm visual indicator • Colour - white • Harsh environment and dust proof IP65 • Outdoor wall mounted
Audible Alarm Indication	• 75dB Siren • Harsh environment and dust proof IP65 • Outdoor wall mounted
General	
Programming	The *Contractor* shall allow for all programming and setup of the system, including 3 additional reiterations, to ensure that the *Employer* is satisfied with the setup, operation of the system and commissioning.
Wiring	The *Contractor* shall allow for all wiring to make this system fully functional and linked to other systems as required.
Labelling	All equipment shall be neatly and professionally labelled using Traffolyte or approved equivalent labelling.
Others	Provision and installation of any additional items that are required to render this installation complete and fully functional as required.

6.7.4 Cabling and Support Infrastructure

Cabling for the atmospheric pressure detection systems shall be distributed via the services spine/backbone and respective cable management systems allowed for. The *Contractor* shall refer to the drawings, further sections of these specifications, Specification No 1924701-2-300-E-SP-0008 and other associated contract documentation for further details.

6.7.5 Earthing Requirements

Earthing of the atmospheric pressure detection systems shall be as per the OEMs requirements, Specification No 1924701-2-300-E-SP-0008, other associated contract documentation, drawings and bill of quantities.

6.8 Patch Panels and Rack Enclosures

The *Contractor* shall install rack enclosures to house the relevant monitoring and control (where applicable) equipment as well as optic fibre patch panels etc. respectively, as per these specifications, drawings, BoQ and associated contract documentation.

The designs for remote I/O (ET200) enclosures shall take account of the Site conditions. The enclosures shall be configured so that any single component can be removed without necessitating the removal of other components and without any adverse impacts on the functionality of the cabinet.

Indoor enclosures shall be 3CR12 Stainless Steel IP54.

Allowances shall be made for the manufacturer's recommendations, which shall include, but not be limited to, selection of enclosures, ventilation, air filtering (if required) and the like. Cognisance shall be taken of variations in the requirements of various manufacturers and between installations within the same facility.

Where enclosures contain equipment rated at both AC and DC power, the *Contractor* shall ensure that equipment at the different voltage levels is effectively separated and is clearly marked to indicate the relevant power levels. Reference shall also be made to Specification No 1924701-2-300-E-SP-0008 for the different wiring colour requirements.

The rack enclosures and patch panels shall comply with the following minimum specifications and shall be provided as complete, fully functional, operable and compliant systems.

Table 14: Patch Panel and Rack Enclosure Requirements

Item	Description
48 Port Patch Tray (Panel)	
Mode	Single-mode
Termination	To suite
Mounted	19" rack mounted
Rack Enclosures	
47U (2.089 m)	• 19" floor standing rack enclosure (maximum height = 2m) with glass door, side and back panels, adjustable vertical mounting rails, integrated electrical bonding and accessory channels. • All integrated cabling and management systems, including allowance for top or bottom cable entry facilities • Brush trays between patch trays • Any switchgear, power supplies, wiring, fixing materials and all other equipment, accessories and the like • 3CR12, IP54 • Colour : Inside CCR & Electronics Workshop (Engineering Station) - Black Powder Coated • Colour : Inside substations - Light Grey (G29) Powder Coated
15U (0.667 m)	• 19" wall mounted rack enclosure with glass door, side and back panels (if applicable), adjustable vertical mounting rails, integrated electrical bonding and accessory channels • All integrated cabling and management systems, including allowance for top or bottom cable entry facilities • Brush trays between patch trays • Any switchgear, power supplies, wiring, fixing materials and all other equipment and accessories and the like if required • 3CR12, IP54 • Colour : Inside CCR & Electronics Workshop (Engineering Station) - Black Powder Coated • Colour : Inside substations - Light Grey (G29) Powder Coated

Item	Description
Remote I/O enclosure	• Floor standing rack enclosure to suit, with glass door, side and back panels, adjustable vertical mounting rails, with integrated electrical bonding and accessory channels. • All integrated cabling and management systems, including allowance for top or bottom cable entry facilities • Any switchgear, power supplies, wiring, fixing materials and all other equipment, accessories and the like. • 3CR12, IP54. • Colour : Inside CCR & Electronics Workshop (Engineering Station) - Black Powder Coated • Colour : Inside substations - Light Grey (G29) Powder Coated
Brush Trays	
1U	19" rack mountable brush tray, mounted between patch trays for cable management
General	
Wiring	The *Contractor* shall allow for all wiring to make this system fully functional.
Labelling	All equipment shall be neatly and professionally labelled using Traffolyte or approved equivalent labelling.
Others	Provision and installation of any additional items that are required to render this installation complete and fully functional as required.

Note: The final colour(s) and associated requirements of the enclosures/panels shall be confirmed with the *Employer* prior to manufacturing.

6.9 Optical Fibre Cables

6.9.1 General

This portion of the *works* forms part of the design, supply, installation and commissioning to be undertaken by the specialist subcontractor, to be appointed by the *Contractor* and approved by the *Employer*, as part of the main electronic monitoring and control (where applicable) infrastructure (ICT network).

The cables shall be transported and stored in accordance with the requirements of SANS 60793. Stored cables shall have the cable ends thoroughly sealed prior to termination to prevent the ingress of moisture. Damaged cables and/or drums delivered to Site will not be accepted. If the drum and/or cable are damaged, the entire cable reel will be rejected and replaced at the expense of the *Contractor*.

The fibre optic cables shall be of the 48 core and 12 core, single mode, direct burial in ground, corrugated steel tape, armored type, in full compliance with SANS 60793 and other relevant standards and specifications, as applicable. Further reference shall be made to the drawings and BoQ. The fibre optic cable shall also be of the fire retardant, self-extinguishing zero toxic emission type. The *Contractor* shall furnish all relevant factory certificates for the cables, whenever so instructed by the *Employer*.

The 48 core fibre optic cables shall be to the following minimum specifications:

- Number of fibre cores : 48
- Cable diameter : 16.6 mm
- Cable weight : ± 233 kg/km
- Cable armour : Corrugated steel tape
- Sheath material : To suit requirements for being fire retardant, self-extinguishing zero toxic emission
- Maximum installation load : 4000 N
- Minimum bending radius : 250 mm
- Crush resistance : 5000 N
- Impact resistance : 4 Nm Blows
- Temperature performance : - 10 to + 70°C
- Water penetration : No leakage
- Drip test : No leakage

The optical properties shall be to the following minimum specifications:

- Fibre type : Single mode (9/125 um)
- Fibre core size : 10.3 ± 0.5 um (Mode field diameter @ 1550 nm)
- Cladding diameter : 125 um
- Primary coating diameter : 245 um
- Operating wavelength : 1550 nm
- Maximum attenuation : 22 dB/km
- Bandwidth
  - i. Maximum dispersion : 18 ps/nm.km
  - ii. PMD : 0.2 ps/km^2

The 12 core fibre optic cables shall be to the following minimum specifications:

- Number of fibre cores : 12
- Cable diameter : 14.8 mm
- Cable weight : ± 192 kg/km
- Cable armour : Corrugated steel tape
- Sheath material : To suit requirements for being fire retardant, self-extinguishing zero toxic emission
- Maximum installation load : 2700 N
- Minimum bending radius : 220 mm
- Crush resistance : 5000 N
- Impact resistance : 4 Nm Blows
- Temperature performance : - 10 to + 70°C
- Water penetration : No leakage
- Drip test : No leakage

The optical properties shall be to the following minimum specifications:

- Fibre type : Single mode (9/125 um)
- Fibre core size : 10.3 ± 0.5 um (Mode field diameter @ 1550 nm)
- Cladding diameter : 125 um
- Primary coating diameter : 245 um
- Operating wavelength : 1550 nm
- Maximum attenuation : 22 dB/km
- Bandwidth
  iii. Maximum dispersion : 18 ps/nm.km
  iv. PMD : 0.2 ps/km^2

6.9.2 Optical Fibre Cable Installation

The installation of optical fibre cables shall be in accordance with SANS 60793 and other relevant standards and specifications, as applicable. The *Contractor* shall ensure that only appropriate tools and equipment are used for the installation of cables. The *Contractor* shall be responsible for making off of cables at both ends and terminating accordingly. The *Contractor* shall also submit a cabling diagram showing all cable feeds, locations and the like, for approval by the *Employer*.

The *Contractor* shall be responsible for the planning of all cable routes. This applies in particular to buried cables. The *Contractor* shall take account of other services and shall at all stages endeavour to identify and optimise the cable routes. The *Contractor* shall work closely with Others to ensure that the installed cables do not interfere or adversely impact upon other services. The final routes shall be confirmed with the *Employer*.

During installation the *Contractor* shall ensure that the maximum tensile forces and bending radii of the cables are not exceeded, as prescribed by the cable manufacturer. Cables shall be buried below ground or installed on trays, ladders, racks or in ducts, as applicable. The cables shall not be installed in conduits, unless specific permission has been granted by the *Employer*.

Where fibre optic cables are installed on trays, ladders, wire meshes or racks, the cables shall be strapped/fixed with heavy duty 316L stainless steel bandit strapping, unless otherwise instructed by the *Employer*. Where steel bandit strapping is used to fix cables, extra cable insulation shall be placed between the cable and the steel strapping to prevent damage to the cable.

The spacing of the strapping fixings shall not be greater than 500 mm, to avoid sagging of the cables. The *Contractor* may propose alternate fixing spacing for consideration and approval by the *Employer.* Such alternate proposals shall be accompanied by a proper analysis and calculations covering the cable loads on trays, ladders or racks. Proof shall also be provided that the manufacturer's requirements will in all cases be adhered to.

Optical fibre cables shall not be installed in or along the same cable management systems used for electrical cables and/or conductors or other data and control cables, unless specific approval has been granted by the *Employer*. The optical fibre cables shall also not be installed in areas where they will be exposed directly to UV and/or sunlight.

Where optical fibre cables are to be installed below ground, they shall be installed at a final depth of 850 mm below finished ground level, measured to the top of the cable (laid on a 150 mm bedding layer, then covered by a 150 mm layer padding material), unless specified otherwise by the drawings or so instructed by the *Employer*.

In trenches, the following minimum clearances/spacing shall be adhered to, unless specified, instructed or shown otherwise on the drawings (Note: The *Contractor* may request approval from the *Employer* for relaxation on the below clearances where deemed necessary by the *Contractor*. The *Contractor* may not implement any reduced clearance unless specific approval has been obtained from the *Employer*):

- Between optical fibre cables and electrical cables/conductors : 650 mm minimum
- Between optical fibre cables and other services : 650 mm minimum

In trenches, where optical fibre cables cross other electrical cables or other services, protective concrete slabs shall be installed up to 2 m to either side of the crossing. Concrete slabs shall be placed between the cables or services, as specified in SANS 10198-8. Where such crossings occur, protective sleeves shall also be provided and cover tiles shall be placed in conjunction with the protective slab. All further requirements included in SANS 10198-8 and other relevant standards shall be adhered to. Details of final clearances and protection measures shall be submitted to and approved by the *Employer*.

The number of cables that may be installed in one sleeve shall be confirmed with and approved by the *Employer*. A maximum of four cables may be installed through a single sleeve.

450 mm wide, 150 micron thick PVC electrical danger warning tape shall be installed above all optical fibre cables 300 mm below finished ground level. The electrical warning danger tape shall as a minimum include the wording “DANGER/INGOZI/GEVAAR” and shall have the black thunder flash symbol and be orange in colour.

6.9.3 Optical Fibre terminations and Joints/Termination Boxes

No joints (either via in-line joints or patch panels/termination boxes) shall be allowed in the cable runs, unless specific approval has been granted by the *Employer* or this is specified. Each cable length shall be continuous up to the final termination points.

Should any cable be damaged during installation, the *Contractor* shall be required to replace the entire length of the cable at his own expense. In the event where approval has been given for the use of joints by the *Employer*, only manufacturer-prescribed SABS approved types of joints shall be used.

The final termination points of the cables shall be in suitable patch panels/termination boxes or the like. These shall be SANS approved and to the specific requirements of the *Employer*. Further details, including the core allocations, are indicated in the bill of quantities and drawings.

Optical fibre cables shall be terminated in the patch panels/termination boxes or the like by means of pigtails/fly-leads of no more than 3 meters in length. The ends of the fibres shall be LC type connectors or similar approved, suitable for the equipment they are to connect onto.

6.9.4 Testing

Optical fibre cables shall, as a minimum requirement, be subjected to the following tests in accordance with SANS IEC 60794:

- Tensile performance.
- Cable bend.
- Crush.
- Temperature cycling.
- Water penetration.

In addition to the above, compatibility with the particular installation conditions shall, as a minimum requirement, be demonstrated through the following tests:

- Impact.
- Kink.
- Torsion.
- Sheath abrasion resistance.

The *Employer* may, at his sole discretion, order the *Contractor* to perform additional tests and/or provide additional information to prove the functionality, compliance and the like of the optical fibre cables. This shall be to the account of the *Contractor* and the necessary allowances shall be made in the scheduled rates in the bill of quantities.

6.9.5 Labelling

Labelling of the optical fibre cables and terminations shall be by means of a combination of white Traffolyte labels (on the cable itself), with engraved black wording, sized accordingly for the application and fastened via black UV resistant cable ties, and clip on lettering labels.

On the terminations (on individual cores/wires) at the patch panels/termination boxes, labelling shall be by means of clip-on lettering type markers (e.g. CAB 3 type markers), appropriately sized for the size of the core. All cables shall, as a minimum, be labelled at both termination points. Prior to commencement of labelling, the *Contractor* shall present to the *Employer* samples of the labels, including the wording, for approval.

6.9.6 Cabling and Support Infrastructure

All fibre optic cables systems shall be distributed via the services spine/backbone and cable management systems. The *Contractor* shall refer to the drawings, relevant sections of these specifications, Specification No 1924701-2-300-E-SP-0008 and other associated contract documentation for further details.

6.9.7 Earthing Requirements

Where applicable, earthing of fibre optic cables shall be as per the OEMs requirements, Specification No 1924701-2-300-E-SP-0008, other associated contract documentation, drawings and bill of quantities.

6.10 Data, Communications and Signalling Cables/Conductors

6.10.1 General

All data, communications and signalling cables shall be 600/1000V rated, and shall be of the fire retardant, self-extinguishing, zero toxic emission type, unless a given cable is not covered/allowed by SANS standards to be of the zero toxic emissions type. All cables shall bear the SABS mark of approval.

Cables shall typically be a combination of fibre optic, CAT 6A, Profibus DP, twisted pair signalling, PH120 fire detection cables and LV I/O hardwired conductors. Reference shall also be made to the sections of Specification No 1924701-2-300-E-SP-0008 covering LV conductors. The cables shall have incorporated screening. For multi-core cables, each embedded core shall be individually numbered.

The *Contractor* shall be responsible for the planning of all cable/conductor routes. The *Contractor* shall take account of other services and shall at all stages endeavour to identify and optimise the cable/conductor routes. The *Contractor* shall work closely with Others to ensure that the installed cables do not interfere or adversely impact upon other services. The final routes shall be confirmed with the *Employer*.

During installation the *Contractor* shall ensure that the maximum tensile forces and bending radii, as prescribed by the cable manufacturer of the cables, are not exceeded.

6.10.2 Data, Communications and Signalling Cables/Conductors Installation

All data, communications and signalling cables/conductors shall only be installed in conduits or dedicated ducts where specified. The cables shall not be installed on trays, wire meshes, ladders or racks, unless specific permission has been obtained from the *Employer*. Prior to installation the *Contractor* shall submit a cabling diagram showing all cable feeds, sizes, colouring, locations and the like for approval by the *Employer*.

Where approval has been granted to install the cables/conductors on trays, wire meshes, ladders, racks and the like, or where this has been specified, it will be on the basis that all trays, wire meshes, ladders, racks and the like shall have suitable coverings.

Where data, communications and signalling cables/conductors are installed on trays, ladders or racks, the cables shall be strapped/fixed with heavy duty 316L stainless steel bandit strapping. Where steel bandit strapping is used to fix cables, extra cable insulation shall be placed between the cable and the steel strapping to prevent damage to the cable.

No data, communications and signalling cables/conductors shall be installed in or along the same cable management systems for electrical cables/conductors or optical fibre cables, unless specific approval has been granted by the *Employer*. Conductors shall also not be installed in areas where they will be exposed directly to UV and/or sunlight.

The *Contractor* shall ensure that only appropriate tools and equipment are used for the installation cables.

6.10.3 Data, Communications and Signalling Cables/Conductors Terminations and Joints

The *Contractor* shall be responsible for making off of cables at both ends using the appropriate tools. Pairs shall remain twisted up to the termination point and the screen shall be terminated.

The correct type of terminations shall be used for all data, communications and signalling cables/conductors. Where cables/conductors must be terminated by means of lugs, suitably sized tinned lugs (with associated bolts/nuts/washers where applicable), terminals and other fittings shall be used to match the different sizes and methods of construction of the cables/conductors to be terminated onto the applicable equipment.

Lugs with a colour coded heat shrink covering, in accordance with the cables' conductor/core colour, and suitably sized bolts and washers shall be used for all bolted terminations. The correct type of crimping tools shall be used to crimp lugs, terminals and other fittings onto conductor cores.

No joints shall be allowed in any data, communications and signalling cables/conductors, unless specific approvals have been granted by the *Employer* or if this is specified. Should any cables/conductors be damaged during the installation, the *Contractor* shall be required to replace the entire length of the respective cable at his own expense. In the event where approval has been given for the use of joints or such joints are specified, only manufacturer-prescribed SABS approved heat shrink joints shall be used.

6.10.4 Testing

The testing and commissioning of data and control cables shall be in accordance with all applicable SANS/IEC standards and any further, relevant specifications or standards. The *Employer* may at his sole discretion order the *Contractor* to perform additional tests and/or provide additional information as required to prove the functionality, compliance and the like of the data, communications and signaling cables/ conductors. The *Contractor* shall allow for the cost of these tests in the scheduled rates included in the bill of quantities.

6.10.5 Labelling

Labelling of the data, communications and signalling cables/conductors and terminations shall be by means of a combination of white Traffolyte labels (on the cable itself), with engraved black wording, sized accordingly for the application and fastened via black UV resistant cable ties, and/or clip on lettering labels (e.g. CAB 3 type markers), as applicable.

Labelling of the cables/conductors shall, as a minimum, be at both termination points respectively and at each inspection/junction box if applicable. Prior to commencement of labelling, the *Contractor* shall present to the *Employer* samples of the labels, including the wording, for approval.

6.10.6 Cabling and Support Infrastructure

All data, communications and signalling cables/conductors shall be distributed via the services spine/backbone and respective cable management systems allowed for. The *Contractor* shall refer to the drawings, relevant sections of these specifications, Specification No 1924701-2-300-E-SP-0008 and other associated contract documentation for further details.

6.10.7 Earthing Requirements

Where applicable, earthing of the data, communications and signalling cables/conductors shall be as per the OEMs requirements, Specification No 1924701-2-300-E-SP-0008, other associated contract documentation, drawings and the bill of quantities.

6.11 Fibre Optic Patch Leads

6.11.1 General

All fibre optic cables installed within buildings shall comply with the applicable parts of the latest published version of SANS 60793.

6.11.2 Installation

Installation of fibre optic cables shall be in compliance with SANS 10340 part 1.

6.11.3 Single-Mode Fibres

Only cables with fibres conforming to the following characteristics shall be supplied and installed:

i. *Cable Transmission Mode*

Only cables with fibres designed and manufactured for single-mode light propagation shall be used.

ii. *Core and Cladding Size*

Single-mode fibres shall have a core size in the range 8 to 10 microns in diameter. The cladding diameter shall conform to international standards. The outer cladding diameter shall be 125 microns for the glass and 245 microns for the coating.

iii. *Connection*

The *Contractor* shall ensure that the terminations are correct as per each OEMs requirements.

6.11.4 Multi-Mode Fibres

Only cables with fibres conforming to the following characteristics shall be supplied and installed:

i. *Cable Transmission Mode*

Only cables with fibres designed and manufactured for multi-mode light propagation shall be used.

ii. *Core and Cladding Size*

Multi-mode fibres shall either have a core size of 50 or 62.5 microns in diameter, depending on equipment application. The cladding diameter shall conform to international standards. The outer cladding diameter shall be 125 microns.

iii. *Connection*

The *Contractor* shall ensure that the terminations are correct as per each OEMs requirements.

6.11.5 Application

The *Contractor* shall ensure that the correct fibre patch leads are installed as per each OEMs requirements.

6.12 Corrosion Protection

6.12.1 General Corrosion Protection

Corrosion protection of steel materials shall be as per the requirements of these specifications, the *Employer's* standards and associated minimum SANS requirements. The protection of the specified steel materials shall make allowance for the harsh, coastal environment at the Site.

Any equipment not strictly complying with the above requirements shall be rejected. The *Contractor* shall furnish written confirmation that all equipment complies with the specifications. Should the *Contractor* fail to furnish such confirmation, the *Employer* reserves the right to reject the equipment.

6.12.2 Galvanic Corrosion Protection

Particular attention shall be given to bimetal/galvanic corrosion protection. Where required, suitable protection measures shall be employed to avoid bimetal/galvanic corrosion interactions. Before any measures are implemented, these shall be confirmed with the *Employer*.

The table below provides a general indication of which metals can be connected to each other without the need of special measures to avoid interaction, and which metals cannot be connected to one another. This will dictate the use of special measures to avoid any corrosion interactions.

The table below is intended to be used as a guide only. The responsibility will remain with the *Contractor* to avoid bimetal/galvanic corrosion between different metal equipment.

Table 15: Combinations of Different Possible Metal Connections

Metal Type	Steel (St/tZn)	Aluminium	Copper	StSt	Titanium	Tin
Steel (St/tZn)	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Aluminium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Copper	Not Permissible	Not Permissible	Permissible	Permissible	Not Permissible	Permissible
StSt	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible
Titanium	Permissible	Permissible	Not Permissible	Permissible	Permissible	Permissible
Tin	Permissible	Permissible	Permissible	Permissible	Permissible	Permissible

Where equipment has been exothermically welded together, 3 thick layers of bitumen shall be applied afterwards, unless otherwise specified by the *Employer*.

6.13 Fire Stopping

The *Contractor* shall employ suitable fire stopping methods wherever deemed necessary in terms of these specifications, drawings, Works Information, statutory codes and regulations/standards, the *Employer*'s specifications or any other applicable standards and documents related to the *works*.

All products used for fire stopping shall be SABS approved and/or be in accordance with other recognised and approved standards. Typical fire stopping products that may be considered by the *Contractor* include intumescent sealants, special coatings, foams and the like. Particular attention shall be given to instances where electrical and electronic equipment enters or leaves buildings, traverses through walls or similar types of installations.

The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localised and contained and not propagate via any electrical and/or electronic infrastructure. The *Contractor* shall fully comply with these requirements.

6.14 Labelling

All monitoring and control/SCADA installations shall be labelled in accordance with these specifications, drawings, *Employer* standards and, where applicable, Eskom requirements, unless otherwise specified or instructed.

The *Contractor* shall submit label samples and schedules to the *Employer* for approval prior to manufacture. These shall all be included in the tender rates.

7.0 PACKAGING, TRANSPORTATION AND HANDLING

The following general items are applicable to all equipment forming part of the *works:*

- If any equipment requires special maintenance or attention during storage, this shall be clearly stated prior to placement of orders and the *Employer's* attention shall be drawn to this fact.
- Crates supplied for transport shall be suitable for Site storage for a period up to 6 months to allow for delays in the installation of equipment.
- The *Contractor* shall be responsible for loading all materials and equipment at the OEM premises, transportation, handling and off-loading thereof on Site, including also any further handling of equipment until it is placed in the final, permanent position.
- Under no circumstances shall any equipment be stored outside or exposed to the weather. All secondary equipment shall be brought to Site once it can be installed in the relevant rooms where it is to be permanently installed.

8.0 SPARES, TOOLS AND CONSUMABLES

8.1 General

The *Contractor* shall provide critical and recommended spares, as prescribed by the OEMs, for all systems, including but not limited to the items listed, other instrumentation and any similar installations.

- Network switches.
- RIO's.
- Patch panels and patch trays.
- Fibre optic and Ethernet patch leads.
- Optical fibre cables.
- Data and control cables.
- Time synchronising (GPS clock) equipment
- Servers and storage equipment
- Panel wiring, power supplies, switchgear and the like inside enclosures where monitoring and control (where applicable) infrastructure is installed, unless factory/OEM warranties apply, in which case the OEM shall be responsible for wiring and modifications.
- Interface and communication links between IEDs.
- Building management systems.
- Intruder detection systems.
- CCTV system.
- Atmospheric pressure detection.

8.2 Spares, Tools and Consumables required prior to Final Handover

The *Contractor* shall supply all spares that are required for start-up and commissioning purposes and for the 12-month period after commissioning, as recommended by the specialist subcontractors/OEM's.

The *Contractor* shall also supply all consumables required within 12 months after commissioning and any special maintenance tools, defined as tools that are not readily available from commercial tool suppliers.

Prior to placement of orders, the *Contractor* shall submit his proposed list of spares, consumables and tools to the *Employer* for his review and approval.

Each spare part shall be properly tagged with a weatherproof label, showing the manufacturer's unique part number, description of the part and expiry date for parts having a limited shelf life. Small items with the same part numbers shall be tagged and packed together in a plastic bag or box. The tag shall also be shown on the outside of the bag or box.

The cost of the above spares, consumables and tools shall be included in the rates tendered by the *Contractor*.

8.3 Spares required after Final Handover

The *Contractor* shall also provide to the *Employer* a list of all critical and recommended spares as prescribed by the specialist subcontractor/OEMs, which shall cover the operational requirements after final handover of the *works*. These lists shall include the following:

- Description of spare part.
- Supplier contact details.
- Suggested stock levels.
- Prices.
- Lead-times for ordering and delivery of such spares.

The *Employer* may issue an instruction to the *Contractor* to supply and deliver spares for operation and maintenance of the equipment after final handover. Separate payments will be made by the *Employer* for the provision of such spares.

9.0 O&M MANUALS, TRAINING AND BACK-UP SUPPORT

9.1 O&M Manuals

Technical, training, maintenance and operating manuals shall be provided for each type and model of equipment. Technical manuals shall include all technical data, construction information and leaflets for each individual component used in the equipment as provided. Where generic manuals are provided, an addendum shall be provided, indicating the applicable project specific components.

Manuals shall be of a good quality and cover the following, as a minimum:

- Technical descriptions of the equipment and component parts.
- General arrangement drawings.
- Installation instructions with drawings or pictures.
- Operating and maintenance instructions for all components.
- Detailed parts lists, accompanied by exploded view-type drawings, clearly detailing the part and uniquely identifying it.
- Spare part ordering instructions.

Any special instructions pertaining to storage of spare parts or their shelf life shall be included in the maintenance manual. All drawings requested for component location, dismantling and re-assembly for maintenance purposes shall be included in the maintenance manual.

All special tools required for operation and maintenance of the equipment shall be presented in the form of a schedule in the operating and maintenance manual respectively. The content of the training manual shall be based on the content of the technical, operating and maintenance manuals.

The *Contractor* shall provide a recommended spare parts list with order numbers.

9.2 Training

The *Contractor* shall arrange certified/accredited training for the *Employer*'s operating personnel, to be provided by the *Contractor* in conjunction with knowledgeable representatives of the equipment suppliers/ OEM's. The scope, content, venue and duration for training shall be approved by the *Employer*.

Training shall be directly applicable to the actual equipment supplied for the *works*. Generalised training based on similar equipment shall not be acceptable. The training shall also include practical hands-on training for each individual trainee.

The training to be provided shall demonstrate the operation, function, trouble-shooting and maintenance requirements of the services, including, but not limited to, the following:

- Monitoring and control systems (ICT network).
- SCADA infrastructure.
- Time synchronising (GPS clock) equipment.
- Telecontrol equipment.
- Servers and storage equipment.
- BMS system.
- Intruder alarm system.
- CCTV system.
- Atmospheric pressure sensor system.

9.3 Training of Maintenance Personnel

Maintenance personnel shall be trained to operate all components and understand the function of the equipment, i.e. methods of maintenance, fault finding, correction, routine maintenance (frequency and methods of testing).

Training shall include familiarisation with documentation (maintenance plan, procedures and the like), hardware familiarisation and maintenance on all new electronic systems. Maintenance training shall be provided prior to the installation of the equipment.

9.4 Training of Operators

Operators shall be trained and declared competent to operate the new systems prior to the equipment being dispatched from the factory. This will include familiarisation with the relevant documentation, including drawing configuration logic, as well as operator interface familiarisation, e.g. operational functions, alarms and the like. The *Contractor* shall make provision for training of all the operators.

9.5 Engineering Training

Formal, upfront engineering training shall be provided prior to design freeze to cover the basic ICT network, protection, metering and all other associated systems equipment design, capabilities and procedures as described in these specifications, drawings and BoQ.

Thereafter on-the-job training shall be provided, extending through the design stage up to final commissioning and handover. The design and control/interface functions shall be covered during this training, to enable the *Employer's* engineering team to fully understand the operation and maintenance of all the systems prior to FAT of the first switchboards, protection and metering equipment.

The *Employer's* engineering team will be in attendance throughout the installation and commissioning stages of the *works*. The *Contractor* shall accord the *Employer's* engineering team full access to the *works* and shall provide formal training and ad-hoc mentoring to ensure a seamless handover upon completion of the *works*.

9.6 Back-Up Support

Back-up support services, including the provision of on-Site technical support by the specialist subcontractors/OEMs for all the monitoring and control/SCADA equipment and the like, shall be available 24 hours a day, 7 days a week. Contact details for the companies and persons providing these support services shall be provided to the *Employer*. Payment for such back-up support will be subject to the relevant provisions of the contract.

10.0 *CONTRACTOR* DOCUMENT SCHEDULE

The returnable documentation and associated information to be provided by the *Contractor*, as listed in the *Contractor* Document Schedule, may not represent the full scope of information and deliverables to be provided by the *Contractor.*

The *Contractor* shall also provide further details, documentation, information and the like, as may be deemed necessary by the *Employer* and as required for approval and verification purposes, to successfully commission, hand over, manage, operate and maintain the installations and equipment provided by the *Contractor*. Such information shall be timeously provided by the *Contractor* so as not to delay final hand-over to the *Employer*.

The *Contractor* shall allow in the tendered rates for the provision of all documentation as listed in the *Contractor* Document Schedule as well as any further documentation, information and the like as described above.

11.0 INSPECTIONS, TESTING AND COMMISSIONING

11.1 General

The *Contractor* shall develop quality control procedures, test plans and the like and shall provide all necessary resources for the management and implementation of these procedures and plans, in accordance with the general requirements as set forth in the accompanying Works Information. The further requirements as detailed below shall form an integral part of these quality management procedures.

All testing and commissioning shall be in accordance with these specifications, all relevant regulatory standards, industry best practices, *Employer* requirements and the like.

The *Contractor* shall supply, operate and maintain all equipment and instruments required to perform all tests, inspections and commissioning, which shall only be undertaken by suitably qualified, experienced and competent persons to be appointed by the *Contractor*, using only fit-for-purpose, correctly calibrated equipment.

The *Employer* may at his discretion instruct the *Contractor* to perform additional testing and/or commissioning activities, as well as provide any additional information as required to prove the functionality and compliance of the units. Allowances shall be made by the *Contractor* in the scheduled rates included in the bill of quantities for such tests.

Should the *Contractor* fail to perform any test or properly commission equipment supplied and installed by the *Contractor*, or should any item of equipment or part of the installations fail any test or commissioning inspection, the *Employer* reserves the right to recover from the *Contractor* any reasonable cost to himself to witness the repeat of such test or commissioning.

The notice period and date(s) to be provided by the *Contractor* to the *Employer* for witnessing any testing or commissioning activities shall be as stipulated in the *Contractor Document Schedule*, unless otherwise instructed or specified.

The *Contractor* shall at all times provide unimpeded access to the *Employer* to inspect the *works* and to attend or witness any test or event as may be required by the *Employer*. All equipment and instruments required to perform all tests and inspections shall be supplied, operated and maintained by the *Contractor.*

The *Contractor* shall rectify any defects noted during the final inspection prior to final hand-over.

11.2 Factory Inspections and Tests

All project specific, factory built or *Employer*-selected equipment shall be tested and inspected at the manufacturing premises prior to delivery to Site. The *Contractor* shall notify the *Employer* in advance of the tests and inspections, as indicated in the *Contractor* Documentation Schedule. The *Employer* may, at his discretion, wish to witness these tests and inspections.

11.3 Site Inspections and Tests

During construction, the *Contractor* shall notify the *Employer* at least seven (7) working days in advance of the dates of the following main events:

- SCADA hardware commissioning and testing.
- Optical fibre cables commissioning and testing.
- Data, communications and signalling cables/conductors commissioning and testing.
- BMS commissioning and testing.
- Intruder alarm system commissioning and testing.
- CCTV system commissioning and testing.
- Atmospheric pressure sensor system commissioning and testing.

Typical Site acceptance testing and inspections shall include, but not be limited to the following:

- Inspection and testing of delivered equipment/systems in accordance with the specifications, Works Information, drawings and applicable statutory regulations, standards and associated requirements.
- Verification of the functionality, operability and compliance of equipment/systems.
- BMS commissioning and testing.
- Intruder alarm system commissioning and testing.
- CCTV system commissioning and testing.
- Atmospheric pressure sensor system commissioning and testing.
- Data network commissioning and testing.

The *Contractor* shall at all times provide unimpeded access to the *Employer* to monitor the *works* and to attend or witness any test or event as may be required by the *Employer*.

11.4 Test Equipment and Certificates

The *Contractor* shall supply, operate and maintain all equipment and instruments required to perform all tests and inspections.

Test reports and/or certificates shall be issued for all tests that are conducted. These certificates shall be signed by the *Contractor* and the manufacturer/test laboratory (as applicable). The number of copies to be issued to the *Employer* shall be as per the *Contractor* Document Schedule.

Unless separately scheduled, the cost of all equipment, instruments and tests shall be included in the scheduled rates for the relevant items.

Typically the following, but not limited to, test certificates will be required:

- Certificates of Compliance.
- SCADA hardware report and test certificates.
- BMS testing report and test certificates.
- Intruder alarm system report and test certificates.
- CCTV system report and test certificates.
- Atmospheric pressure sensor system report and test certificates.
- SANS report and test certificates.
- Data network report and test certificates.
- Certificates for integration report and test certificates.

11.5 Repetition of Tests and Inspections

Should the *Contractor* fail to perform any test, or should any item of equipment or part of the installations fail any test, the *Employer* reserves the right to recover from the *Contractor* any reasonable cost to himself to witness the repeat of such test.

11.6 Final Inspection and Handover

Prior to practical completion and handover of the *works*, the *Contractor* shall arrange a final inspection with the *Employer*.

The *Contractor* shall give at least fourteen (14) working days' notice of the date of the final inspection, unless otherwise instructed or specified. Documentation to be submitted by the *Contractor* to the *Employer* at the final inspection shall include, but not be limited to, the following:

- O&M manual.
- Test reports and certification.
- As-built documentation and drawings.
- Certificate of Compliance(s).

The *Contractor* shall rectify any defects noted during the inspection prior to the hand-over inspection.

12.0 DESIGN APPROVAL, MANUFACTURING, INSPECTIONS, TESTING AND COMMISSIONING PROCEDURES

The following procedures shall apply to the design approval, manufacture, inspections, testing, installation and commission of the equipment/systems.

- *Contractor* appoints the specialist subcontractor/OEM.
- *The Contractor* provides the project and technical requirements to the specialist subcontractor/ OEM.
- The specialist subcontractor/OEM undertakes the design of the equipment/systems and submits drawings plus any other associated technical information for approval to the *Contractor*.
- *Contractor* checks the drawings and associated technical information as provided, for compliance with all the requirements of the specifications, Works Information, drawings and the like and submits three copies, signed off as checked, to the *Employer* for approval.
- *Employer* returns copies as approved, or for resubmission, to the *Contractor*.
- Manufacture of the equipment/systems commences after approval of the drawings and associated technical information by the *Employer*.
- *Contractor* checks and inspects the manufactured equipment/systems at the specialist subcontractor/OEM's premises during all stages.
- *Contractor* presents the *Employer* with written confirmation that the equipment/systems are in full compliance with the project requirements and have been checked, inspected and fully tested. This confirmation, signed and dated by both the *Contractor* and the specialist subcontractor/OEM, is to accompany a written request for the *Employer* to witness factory acceptance tests (FAT), i.e. re-inspection and retesting of the equipment/systems.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list and approval from the *Employer*, the equipment/systems may be dispatched to Site.
- On arrival on Site of the equipment/systems, the *Contractor* shall request in writing the *Employer* to witness the associated Site acceptance tests (SAT) as applicable. After the tests, written confirmation by the *Contractor* shall be provided to the *Employer* that the equipment/systems are in full compliance. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor*.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval from the *Employer*, the equipment/systems may be installed.
- Once the equipment has been installed, tested for complete functionality, operability and compliance as per the contract, the *Contractor* shall request the *Employer* in writing to witness the installed equipment/systems.
- The installed equipment/systems shall be re-tested on Site so that the *Employer* may verify the functionality, operability and compliance requirements. Upon approval of the *Employer*, after the installation and tests, written confirmation by the *Contractor* shall be provided to the *Employer* that the equipment/systems are in full compliance and have been commissioned correctly. This confirmation shall be signed and dated by both the *Contractor* and the specialist subcontractor/OEM.
- During the *Employer*'s inspections, a fault list, if necessary, shall be drawn up and handed to the *Contractor.*
- Should the *Employer* determine that the final product does not fully meet the project requirements, functionality, operability and/or compliance requirements, the *Contractor* shall undertake the necessary repairs and re-testing, all at his own expense.
- After subsequent re-inspection and satisfactory rectification of the fault list, and approval received from the *Employer*, the equipment/systems shall be formally handed over to the *Employer*.
- Under no circumstances will the *Employer* enter into any discussions regarding conformance to the project requirements with the specialist subcontractor/OEM. All communications shall be between the *Employer* and *Contractor* only.
- The *Contractor* shall ensure that full copies of the project requirements, specifications, approved signed copies of the drawings and any other associated technical information, are at hand during all inspections.
- All relevant statutory testing, commissioning and certification of the equipment/systems shall be performed by the specialist subcontractor/OEM.
- The *Contractor* shall notify the *Employer* in advance of the tests and inspections, as indicated in the *Contractor* Documentation Schedule.

13.0 HANDOVER DOCUMENTATION

13.1 As-Built Documents

The *Contractor* shall maintain records and prepare as-built documentation for all design documents, drawings, quality control records, tests, pre-commissioning reports, commissioning reports, operation and maintenance manuals and the like. The as-built documents shall be comprehensive and shall demonstrate compliance with the project specifications and drawings. Reference shall also be made to the further requirements as detailed in the accompanying Works Information. The following details shall apply:

- The scope and format, including the required indexing of the as-built information shall be discussed and agreed with the *Employer* prior to compilation and submission of the final documentation.
- All as-built documents shall be signed off by the *Contractor* and submitted to the *Employer* for approval, as these are developed and at completion of the *works*.
- All as-built documents shall be furnished to the *Employer* in both hard and soft copy formats.
- As-built documents shall be submitted as per the requirements as set out in the CDS, unless otherwise instructed by the *Employer*, and the further requirements as detailed below.

13.2 As-Built Drawings

The *Contractor* shall keep a separate set of project drawings for marking up changes to the original design as the *works* progress. Marked-up red lined hard copies of drawings shall be maintained by the *Contractor* during installation of the equipment and shall be included in the handover documentation.

As-built drawings shall include the drawings issued by the *Employer* as well as any drawings compiled by the *Contractor*.

Software copies of the “as-constructed” drawings shall be provided in ‘rvt’, ‘dgn’, ‘dwg’, ‘dxf’ and ‘PDF’ formats as applicable and requested by the *Employer*.

The final, as-constructed drawings shall be signed off by the *Contractor* and submitted to the *Employer* for approval at completion of the *works*.

13.3 Data Packs

Data packs for all equipment and materials shall be provided by the *Contractor* in electronic and hard-copy format and shall be neatly indexed and referenced to facilitate easy navigation by the *Employer* between documents. This shall include, but not be limited to, the following:

- Final design calculations, including native software files if applicable.
- Equipment specification sheets.
- Data sheets for instrumentation and equipment, including physical dimensions.
- Wiring diagrams.

13.4 Quality Control Records

The *Contractor* shall, as part of the handover documentation, provide the *Employer* with all quality control records, including, but not limited to:

- Equipment and material installation standards applicable to the relevant equipment or material supply.
- All calibration certificates.
- Material certificates.
- SABS certificates, where appropriate.
- All test and calibration certificates.
- Certificates of Compliance.

13.5 Further Handover Documentation

Further handover documentation shall include:

- Comprehensive operation and maintenance manuals.
- Health and safety records.
- All equipment guarantees, which shall be ceded to the *Employer* upon completion of the *works*.
- Copies of final configured software programmes of equipment/systems.
- All software licences and programming of software, which shall be ceded to the *Employer* upon completion of the *works*.
- List of recommended spare parts lists, including suggested stock levels.
- Further information as advised by the *Employer*, as required for the hand-over, commissioning, operation and maintenance of the installed systems and equipment.

14.0 MEASUREMENT AND PAYMENT

14.1 General

The tendered rates shall be deemed to include all and every cost item required for the completion, handover and commissioning of the scope of the *works* in full compliance with these specifications, the Works Information and the drawings, including, but not limited to, the following:

- Design (including shop drawings), supply and installation of the *works* that are required to deliver a complete, fully functional and fully compliant system.
- Supply of installation and commissioning spares and operational spares required for normal wear and tear during plant operation for the period of one year after commissioning.
- Supply of special tools required for maintenance purposes.
- All testing and commissioning activities that are required to get the installed equipment ready for operations.
- Compilation and submission of all handover documentation as described in these specifications.
- Training of *Employer's* operational staff, as detailed in these specifications.

Allowances to be made in the tendered rates are as described below.

14.2 Pay Items

14.2.1 Network Switches

The tendered rates shall cover all costs for the supply and installation of all switches, including, but not limited to, procurement, transport, storage, inspections and testing, programming, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets, software and the like.

14.2.2 Time Synchronisation

The tendered rates shall cover all costs for the supply and installation of the time synchronisation equipment including, but not limited to, procurement, transport, storage, inspections and testing, designs, programming and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets, software and the like.

14.2.3 Servers

The tendered rates shall cover all costs for the supply and installation of the server equipment required in the Engineering Workshop, including, but not limited to, procurement, transport, storage, inspections and testing, designs, drawings for approval, installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects. Note: SCADA Software and programming by Others.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets, any additional software and the like.

14.2.4 Data Storage

The tendered rates shall cover all costs for the supply and installation of the storage equipment required in the Engineering Workshop, including, but not limited to, procurement, transport, storage, inspections and testing, designs, drawings for approval, installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects. Note: SCADA Software and programming by Others.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets, any additional software and the like.

14.2.5 Local Workstation

The tendered rates shall cover all costs for the supply and installation of the entire local workstation equipment required in the Engineering Workshop, including, but not limited to, procurement, transport, storage, inspections and testing, designs, drawings for approval, installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects. Note: SCADA Software and programming by Others.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets, any additional software and the like.

14.2.6 Remote I/O Devices

The tendered rates shall cover all costs for the supply and installation of remote I/O devices, including, but not limited to, procurement, transport, storage, inspections and testing, programming (except main remote I/O devices at substations), designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, accessories, fixings, screws, mounting brackets, software and the like.

14.2.7 Optical Fibre Cables

The tendered rates for optical fibre cables shall cover all costs for the supply and installation of cables, including, but not limited to, procurement, transport, handling, inspection, laying in trenches, pulling through ducts, installing on cable trays, bedding in, cutting, temporary sealing and testing of cables, including suitable fire stopping material where required.

14.2.8 Data, Communications and Signalling Cables/Conductors

The tendered rates for the data, communications and signalling cables/conductors shall cover all costs for the supply and installation of cables, including, but not limited to, procurement, transport, handling, inspection, laying in trenches and pulling through ducts (if applicable), installing on cable trays, cutting, temporary sealing and testing of cables, including suitable fire stopping material where required.

14.2.9 Building Management Systems

The tendered rates shall cover all costs for the supply and installation of the building management systems, including, but not limited to, procurement, transport, storage, inspections and testing, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all accessories, fixings, screws, mounting brackets and the like.

14.2.10 Intruder Alarm Systems

The tendered rates shall cover all costs for the supply and installation of the intruder alarm systems, including, but not limited to, procurement, transport, storage, inspections and testing, programming, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all accessories, fixings, screws, mounting brackets, software and the like.

14.2.11 CCTV Systems

The tendered rates shall cover all costs for the supply and installation of the CCTV systems, including, but not limited to, procurement, transport, storage, inspections and testing, programming, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment and all *works*

that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all accessories, fixings, screws, mounting brackets, software and the like.

14.2.12 Atmospheric Pressure Sensor Systems

The tendered rates shall cover all costs for the supply and installation of the atmospheric pressure sensor systems, including, but not limited to, procurement, transport, storage, inspections and testing, programming, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all accessories, fixings, screws, mounting brackets and the like.

14.2.13 Patch Panels and Rack Enclosures

The tendered rates shall cover all costs for the supply and installation of the patch panels and rack enclosures, including, but not limited to, procurement, transport, storage, inspections and testing, designs and drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all switchgear, associated equipment, accessories, fixings, screws, mounting brackets and the like.

14.2.14 Patch Leads

The tendered rates shall cover all costs for the supply and installation of the patch leads, including, but not limited to, procurement, transport, storage, inspections and testing, installation and testing of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall be for a complete patch lead. Patch leads shall not be made up on Site.

14.2.15 Visual and Audible Alarm Indicators

The tendered rates shall cover all costs for the supply and installation of the visual and audible alarm indicator systems, including, but not limited to, procurement, transport, storage, inspections and testing, drawings for approval (multiple reiteration), installation and commissioning of the equipment, and all *works* that are required to ensure that the systems are fit for purpose, completely functional, operable and compliant in all aspects.

The rates shall also include all accessories, fixings, screws, mounting brackets and the like.

15.0 MATERIAL SPECIFICATIONS

Table 16: Approved Material/Equipment

Component / Material	Make Type or Equivalent Approved
Fibre Optic Cables and Patch Leads	
Fibre Optic Cables	CBI or approved equivalent
Fibre Optic Patch Leads	Not specified
Data, Communications and Signalling Cables/Conductors	
Cables/Conductors	Not specified
Glands and Terminations	
Glands	CCG, Pratley or approved equivalent
Terminations	Not Specified
ICT, SCADA and BMS Equipment	
Time Synchronisation	• Meinberg Lantime M600/MRS/PTPv2 GPS Clock, or approved equivalent
Remote I/O Device	ET 200
Network Switches HV and MV Equipment	Hirschmann DIN Rail Gigabit Ethernet or approved equivalent.
Network Switches (Main Network Switches)	Hirschmann MACH1040 layer 3 full gigabit Ethernet fanless switch MAR1040-4C4C4C4C9999SM9HR rack/cabinet mounted type with 16 dual combo ports, mounted in rack/cabinet with switch, or approved equivalent. Complete with all associated wiring, fixing materials, additional equipment, accessories and the like, as required
Servers	Dell PowerEdge R930 or approved equivalent
Storage	IBM Storwize V7000 10TB or approved equivalent
Workstation	Not specified
Intruder Alarm System	
Control Panel and Equipment	Caddx NetworX NX-8E Control Panel or approved equivalent
CCTV	
Network Switches (CCTV)	Cisco, layer 2, full gigabit Ethernet switch IE-4000-4GS8GP4G-E rack/cabinet mountable, or approved equivalent
CCTV Server	Bosch DL380 Gen9 Management Server or approved equivalent
CCTV Recorder	Bosch DIVAR IP 6000 2U Recorder or approved equivalent
CCTV Matrix/Control System	Bosch LTC 8300/90 Allegiant Matrix/Control Systems or approved equivalent
Indoor Camera	Bosch AutoDome Junior Fixed Camera or approved equivalent
Outdoor Camera Type 1	Bosch DINION IP Imager 9000 HD or approved equivalent
Outdoor Camera Type 2	Bosch AutoDome IP Dynamic 7000HD or approved equivalent
Atmospheric Pressure Detectors	
Sensor	Wilmers Aneroid Sensor – 50 to 110 kPa settable or approved equivalent

Table 16: Approved Material/Equipment

Component / Material	Make Type or Equivalent Approved
Visual and Audible Alarm Indicators	
Visual Alarm Indicators	AC DC IP65 L-shape wall mounted 24V Signal Tower LED Light (One LED Light only per Indicator), or approved equivalent. LED colours as specified in bills of quantities or instructed otherwise.
Audible Alarm Indicators	AC DC IP65 32 Tone 75dB Eagle Audible Alarm Colour Red, or approved equivalent

Transnet Group Capital

Tippler 3 Bulk Power ICT and Security System Technical Specification

Engineering Design Services: Control & Instrumentation

Document No: 1924701-2-300-J-SP-0001

TGC:

Prepared By:	Tebogo Mahlalela Engineer	2020/08/12 Date
Reviewed By:	Ntombifuthi Vilakazi Engineer	2020/08/12 Date
Approved By:	Lonwabo Mgushelo Engineer	2020/08/12 Date
Approved By:	Richard Shandu Engineering Manager	21/08/2020 Date
Approved By:	Irvin Mashabane Project Manager	Date

TPT:

Accepted by:	Tonny Mhondiwa Regional Engineering, Projects and Quality Manager	Date
Accepted by:	Marlene Nel Security Manager	27.08.2020 Date
Accepted by:	Daubert Vermeulen IT Manager	27/08/2020 Date

01	11 August 2020	Issued for Construction
0A	25 June 2020	Issued for Client Review
Rev No.	Date	Revision Details

Contents

1 Acronyms And Abbreviations

The acronyms and abbreviations applicable to this document are summarised in the following table:

Abbreviation	Description
BoQ	Bill of Quantities
BTS	Bulk Terminal of Saldanha
CCTV	Closed Circuit Television
CCR	Central Control Room
CST	Corrugated Steel Tape
ECSA	Engineering Council of South Africa
FAT	Factory Acceptance Test
FoV	Field of View
GA	General Arrangement diagram
HD	High Definition
ICT	Information and Communication Technology
LED	Light Emitting Diode
NVR	Network Video Recorder
OEM	Original equipment manufacturer
PC	Personal Computer
PoE	Power over Ethernet
PTZ	Pan, Tilt and Zoom
QA/QC	Quality Assurance/ Quality Control
SAT	Site Acceptance Test
SWA	Steel Wire Armour
SI	International System of Units
TCP/TGC	Transnet Capital Projects/ Transnet Group Capital
TCP/IP	Transmission Control Protocol/ Internet Protocol

Abbreviation	Description
TNPA	Transnet National Ports Authority
TPT	Transnet Port Terminals
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair
VOIP	Voice Over IP

2 Introduction and Background

2.1 Overview

The *Employer* is undertaking a major programme of projects in Cape Town, Saldanha and Postmasburg to upgrade and expand the capacity of their infrastructure, as part of the *Employer's* Market Demand Strategy. The scope of this project is to sustain the materials handling capacity at Saldanha Port by the addition of a third Tippler. As part of the Tippler 3 project, ICT and Security system infrastructure are to be provided for the newly built facilities forming part of the scope.

The Site is located at the Port of Saldanha. The *Employer* is Transnet Group Capital (TGC) and the eventual owners of the *Works* will be Transnet Port Terminals (TPT) and Transnet National Ports Authority (TNPA).

2.2 Purpose

The purpose of this technical specification is to set out the minimum technical requirements for quality and standards for the design, supply, installation, construction, testing and commissioning of equipment and associated infrastructure for the ICT and Security system required the Tippler 3 Bulk Power scope of work.

2.3 Document Terminology

This document makes use of the words shall, should, may and will, with regard to requirements and specifications. To avoid any confusion among these terms, their legal and binding meaning, is indicated here. The reader is advised to be familiar with their contextual usage and meaning.

#1 In this document the word:

- Shall is used to indicate a mandatory requirement.
- Should is used as a preference.
- May is used as a permissive (i.e. neither mandatory nor necessarily recommended).
- Will is used as a declaration on behalf of something/ someone else.

#2 The word should shall be treated as a requirement by the *Contractor*, although it may be negotiated, amended, approved or declined by the *Employer* based on appropriate justification.

3 Statutory Requirements

#3 In addition to the specifications detailed on this document, the design shall comply with the following relevant South African Standards and Regulations and shall apply in the order of precedence as listed below:

- Occupational Health and Safety Act 85 of 1993
- South African National Standards and Codes of Practice
- IEC Standards and Recommendations
- International Standards and Codes – ISO, DIN, BS, ASME, ASCE, ANSI, ASTM, EU
- All local, provincial or S.A. Government laws in force at the time.

4 Guidelines, Standards And Specifications

#4 All equipment and material to be supplied for the project must be designed, assembled and inspected in accordance with the publications shown in tables below. Each publication shall be the latest revision and addendum in effect on the date the specification is issued for construction unless noted otherwise.

#5 Where conflicts occurs the more stringent requirement of the code, standards and project specifications must be met.

#6 The *Contractor* shall adhere to the following further requirements:

- All installations shall be inspected and witnessed in accordance with this specification, the manufacturer's instructions and recommendations and the approved quality control plans for each activity.
- All calibration and test equipment shall hold valid, traceable calibration certificates, which shall be held on Site and shall form part of the quality control dossiers.
- All equipment, instruments and accessories shall, where appropriate, be calibrated and tested at the manufacturer's premises or by a duly authorised representative of the manufacturer.
- All test and calibration certificates shall be included in the on Site quality control dossiers and the as-constructed data packs.

4.1 Transnet Standards

The Transnet standards listed below, shall take precedence in terms of compliance.

Title		Doc. No.
[1]	CAD Drawing Standards	ENG-STD-0001
[2]	Specification for Equipment Tag Numbering System	1924701-SP-0006
[3]	Group Security Management – Transnet Physical Security Systems Standard	TPSSS20/05/2016
[4]	Transnet Group - Integrated Electronic Security and Related Systems Specification: HD IP Video Surveillance System Part 6.3 Rev-02	-
[5]	Transnet Group - Integrated Electronic Security and Related Systems Specification: Access Control System Part 6.2 Rev-02	-
[6]	Transnet Group - Integrated Electronic Security and Related Systems Specification Part 6.17: Auxiliary And Related System	-
[7]	Transnet Group - Integrated Electronic Security and Related Systems Specification: General Specification Part 5.2 Rev-02	-
[8]	Transnet Group - Integrated Electronic Security and Related Systems Specification: Part 6.21. Security System installation Standards	-
[9]	Transnet Group – Integrated Electronic Security And Related Systems Specification: Access Control Hardware System Part-6.16	-
[10]	Corrosion Protection Specification	EEM-Q-008

Title		Doc. No.
[11]	General Electrical Equipment	EEM-Q-012
[12]	Commissioning and Handover	EM-Q-013
[13]	Cable Reel Systems	EEM-Q-019
[14]	Test on Electrical Equipment	EEM-Q-020
[15]	Electronic Equipment	EEM-Q-021
[16]	Project Documentation Management	DOC-P-0006 Rev.02
[17]	Transnet ICT Equipment Standardization Specification – 2016-06-07_v2.01(1)(002)	-
[18]	Transnet ICT Physical and Environmental Security Standard 1.1	-
[19]	Transnet Network Security Standard version 1.0	-
[20]	Transnet Information Security Policy	-
[21]	Transnet Multi-Function Device Security Configuration Standard	-

#7 It is the responsibility of the *Contractor* to ensure that he/she obtains all of the *Employer*'s standards (latest amendments apply). The *Employer* shall not be held liable for any losses incurred by the *Contractor* which may arise as a result of non-compliance of the *Works* by the *Contractor* to the standards.

4.2 National and International Standards

#8 These national and international standards must be adhered to, except where it conflicts with Transnet standards. The *Contractor* shall also ensure that the Works comply with all relevant national and international standards, including the standards as listed below. The latest edition of such standard shall apply.

#9 Where South African National Standards (SANS) do not cover a specific item, the *Contractor* shall ensure that the item is supplied and installed in compliance with all other relevant/mandatory national and/or international standards, as applicable. Where South African National Standards (SANS) fully cover the item(s) in question, further reference to associated international standards is not required.

#10 The *Contractor* may request approval by the *Employer* for the adoption of a standard not listed in the tables below. Acceptance of such standards will however be at the sole discretion of the *Employer*.

Title		Doc. No.
[22]	Degrees of protection provided by enclosures (IP code)	SANS IEC 60529
[23]	Optical fibres	SANS IEC 60793
[24]	Optical fibre cables	SANS IEC 60794
[25]	Splices for optical fibres and cables	SANS 61073-1
[26]	The wiring of premises. Part 1: Low-voltage installations	SANS 10142-1

Title		Doc. No.
[27]	Protection against lightning electromagnetic impulse – All applicable parts	SANS 61312
[28]	Guide for the protection of electronic equipment against damaging transients	NRS 042-2
[29]	Electrical security installations Part 5-1-2: CCTV installations - CCTV surveillance systems for use in security applications - System design requirements	SANS 10222-5-1-2: 2007
[30]	Electrical security installations Part 1: General	SANS10222-1: 2013
[31]	Information technology - Biometrics	SANS 29164
[32]	The application of the National Building Regulations	SANS 10400
[33]	National Fire Protection Association National Fire Codes	NFPA Standards
[34]	EIA/TIA-568 Commercial Building Telecommunications wiring standard	EIA/TIA-568
[35]	EIA/TIA-569 Commercial Building for Telecommunications pathways and Spaces	EIA/TIA-569
[36]	EIA/TIA-606 Administrative Standards for the Telecommunications infrastructure of Commercial Building	EIA/TIA-606
[37]	EIA/TIA-568A premises cabling standard	EIA/TIA-568A
[38]	Power over Ethernet standard	IEEE 802.3at

5 References

The following documents and drawings serve as reference for this technical specification.

5.1 Documents

Title		Doc. No.
[39]	Tippler 3 : Supply and Install Bulk Electrical Supply including Transformers, Switchgear, MCC and Sub-Station Buildings	1924701.E004-SOW-0001_00
[40]	Monitoring and Control Installations	1924701-2-300-E-SP-0010_00
[41]	Meeting with TPT minutes	1924701-MM-0113

5.2 Drawings

Title		Doc. No.
[42]	MIS Level 00 Electronic Services	1924701-2-300-E-LA-0054-01-AE_00
[43]	MIS Level 01 Electronic Services	1924701-2-300-E-LA-0055-01-AE_00
[44]	MIS Level 02 & Roof Electronic Services	1924701-2-300-E-LA-0056-01-AE_00
[45]	New Main Intake Sub - Electronic Services Block Diagram	1924701-2-300-E-PD-0011-01_00
[46]	Sub M Level 00 Electronic Services	1924701-2-300-E-LA-0036-01-AE_00
[47]	Sub M Electronics Services Block Diagram	1924701-2-300-E-PD-0007-01-AE_00

Title		Doc. No.
[48]	AE_00_Sub N Level 00 Electronic Services	1924701-2-300-E-LA-0046-01
[49]	AE_00_Sub N Electronic Services Block Diagram	1924701-2-300-E-PD-0009-01
[50]	High Level Network Architecture and Integration Block Diagram	1924701-2-300-E-PD-0012-01_01

6 General

6.1 Site Conditions

#11 The following environmental conditions shall apply:

Altitude:	Sea level up to 2500m above
Temperature range:	-5°C to +45°C
Equipment Surface Temperature (from sun)	60°C Max
Relative humidity:	50% Min; 85% Max; 60% Average
Atmospheric conditions:	Coastal Salt laden air with high concentration of iron ore dust.
Air Pressure	101.3 kPa
Average Annual Rainfall:	278mm

Additional details can be found in the Site Information document forming part of the Works Information given to *Contractor*.

6.2 Maintenance and Warranty

#12 All equipment used shall come with a certified warranty with a minimum 2 years, with an option to extend (with a letter from the manufacturer which shall be issued to Transnet Group with the end user being TPT, stating warranty/extended-warranty periods and guarantees on those periods, independent of the *Contractor*).

#13 The system implementing *Contractor* must be accredited and certified by the manufacturer as an EXPERT (or equivalent) integrator, whether as a direct or indirect *Contractor.*

#14 System warranty shall take effect from date of first use, after site acceptance testing.

#15 All equipment and consumables shall comply with TPT existing spares holdings and installed equipment types.

6.3 Other

#16 Earthing philosophy shall comply with Transnet standards.

#17 The *Contractor* shall verify that there are adequate measures in place to protect against lightning strikes and power surges. If not they shall inform TGC for corrective action.

#18 Cables, boxes, cabinets and equipment shall be marked and labelled as per the Specification for Equipment Tag Numbering System [2].

#19 The SI system of units and measures shall be used to express all numerical quantities.

#20 Use of any component or device, not expressly specified herein, that is required to implement the work, shall be subject to Transnet engineer's approval of required submittals.

7 Scope of Work

As part of the Tippler 3 project, Access Control system, CCTV and ICT Infrastructure are to be provided to the newly built and existing facilities forming part of the Tippler 3 project. The Scope of the *Contractor* includes;

7.1 Security System

#21 The Security system scope includes further developing *Client* designs, installation, configuration, commissioning and handing over of the CCTV, Access Control systems in the new substations:

- New Main Intake Substation
- Substation M
- Substation N

#22 The new CCTV system in the above mentioned areas shall be integrated to the existing CCTV system monitored in Security Control room in the BTS building.

#23 *Contractor* shall provide and install access control system workstations and servers in the BTS building. The access control system shall monitor and control all the access control and intruder detection in the new substations and other areas in the Port.

#24 *Contractor* shall configure and integrate the conveyor line CCTV cameras to the Port CCTV system. (these cameras shall be installed by Conveyor Line Contractor).

7.2 ICT

#25 The ICT scope includes the design, supply, installation, configuration, commissioning and handover of an ICT infrastructure to facilitate communications for ICT and Security systems in the following new and existing facilities:

- New Main Intake Substation
- Substation M
- Substation N Tippler 3 Building
- Substation A
- Substation B
- Substation H
- Substation J
- Substation K
- Central Control Room
- Electronics Workshop

#26 The ICT scope also includes the integration of the new ICT Infrastructure with the exiting ICT network and telephone system.

7.3 General Requirements

The scope of the Work to be undertaken by the *Contractor* also includes, but is not limited to, the following:

#27 Evaluate existing designs and make changes where necessary as requested by the *Employer*.

#28 Supply, installation, construction and commissioning of all infrastructure and equipment required as covered in this document, design drawings, bills of quantities, specifications and further documents as referenced in this specification.

#29 Maintaining coordination with other services to ensure the correct and proper integration of the scoped systems.

#30 Supply of commissioning and operational spares, required for normal wear and tear during plant operation for the period of one year after commissioning.

#31 Operating and maintenance manuals, training and back-up support.

#32 The configuration and integration of all the respective equipment shall include the development, in conjunction with the *Employer*, of the final requirements and functionality for monitoring, control, logic and integration of the entire systems. Additional payments will not be made for costs resulting from any omissions, additions or time required for programming, integration and subsequent re-iterations, as described in the contract.

#33 Detailed designs, supply and installation of the respective Security system and ICT infrastructure with associated equipment, including complete integration with other associated systems.

7.4 Designs, Calculations by the *Contractor*

#34 All documents, for which prior approvals are required, shall be timeously submitted to the *Employer* for review and approval, prior to placement of orders, fabrication or manufacture.

#35 The *Contractor* shall, as necessary, appoint specialist *Subcontractors* and OEMs to undertake the designs, calculations and drawings, which shall be prepared and checked by suitably qualified and experienced professional engineers, registered with the Engineering Council of South Africa (ECSA) or an equivalent institution recognised by ECSA.

#36 The design engineers shall be appointed by the *Contractor,* subject to approval by the *Employer*. Designs, calculations and drawings shall not be prepared and checked by the same person and shall be reviewed by the *Employer* before the commencement of fabrication.

#37 The *Employer* will provide the *Contractor* with the necessary formats for documents that are to be submitted for approval.

#38 The *Employer* may, at his sole discretion, request additional design calculations, drawings and associated information, as deemed necessary for verification of the correctness and compliance of the designs. The cost of providing such additional information shall be deemed to be included in the tendered rates, i.e. further payments for such information will not be made.

#39 The *Contractor* shall submit all required calculations in a neat and legible manner. Where calculations are performed using specialised software programs, the *Contractor* shall also furnish copies of the final native software files, without any exclusions. The calculations shall be provided in a professional, neat format, to include, but not be limited to, the following, in the order as stated below:

- Summary of assumptions and conclusions.
- Table of contents.
- List of all associated drawings.
- List of compliancy standards.

- List of all text and references used.
- Calculations.

7.5 Documents and Drawings by the *Contractor*

#40 The *Contractor* shall be solely responsible for the submission of any drawings that are to be provided by his appointed specialist *Subcontractors* and/or OEM's. Drawings shall be accompanied by instruction manuals properly bound for maintenance purposes. The drawings and manuals shall conform to specifications and standards in Section 4 and 5.

#41 The scope of information to be provided by the *Contractor* shall include, but is not limited to:

- Type and routine tests, including provision of certificates for equipment.
- FAT and SAT tests, including the provision of certificates for the equipment.
- Detailed schematics and any applicable other associated drawings.
- Data sheets and associated detailed specifications of equipment.
- Operations and maintenance manuals.
- Detailed designs and calculations. The native software files for any detailed design calculations undertaken in software programmes shall also be provided to the *Employer* for verification purposes. Accepted software programmes for detailed designs and calculation purposes shall include, but are not limited to, AutoCAD.
- As-built drawings in hard and soft copies ('dwg' and 'PDF' formats.)
- Any other as-built documentation as required by the *Employer*.
- Other information required for the completion of engineering design reviews.
- Critical and routine spare part lists.
- Equipment guarantees/warrantees.
- Cable schedules.
- Applicable systems software and licenses, including all final programming of equipment on CD-ROMs.
- Testing and measuring equipment calibration certificates.
- Detailed designs and method statements for horizontal directional drilling.
- Electrical Load schedules
- Bills of Material
- Certificate of Compliance where applicable
- Patching Schedule
- Equipment lists
- Equipment data sheets
- Schedule of IP addresses, switch ports used, PoE on and off, etc.
- Specification of software.
- Document Register
- Configuration documents

#42 All project engineering drawings shall include, but not be limited to, the following:

- Single line diagrams
- System block diagrams
- Schematic diagrams
- Network diagrams
- General Arrangement diagrams (GA)
- Site/building layouts drawings where applicable
- Rack/Panel Layout drawings

#43 Unless specifically directed otherwise, Transnet standard format and symbols shall be used.

7.6 Safety

#44 Reference is made to the environmental and safety requirements as detailed in the Works Information and the particular requirements as described below.

#45 The *Contractor* shall take all necessary safety precautions to prevent static electricity discharge, sparking and any other unsafe condition, which could pose a safety risk to personnel, property and/or equipment.

#46 The location and extent of potentially explosive atmospheres are to be identified and indicated on hazardous area classification drawings. All electrical equipment and instruments for use in hazardous classified areas shall be supplied with a hazardous area certificate issued by a certifying authority approved by SABS/SANS/IEC. Certificates shall be indexed and filed in a certification register.

7.7 South African Electrical Compliance

#47 Any equipment designed and fabricated/manufactured overseas shall have an electrical certificate of compliance to South African Regulations before it is delivered (and operated) in South Africa. The compliance certificate(s) shall fully cover high voltage, medium voltage and low voltage equipment. These certificates shall be issued by an accredited South African professional engineer.

7.8 *Employer* QA Representative

#48 The *Contractor*'s QA requirements shall be as set out in the Works Information.

#49 The *Employer* may choose to appoint a QA/QC representative to monitor and report on some or all aspects of the production and fabrication processes. Full cooperation shall be extended to the appointed QA/QC representative. Associated costs for such services will be borne by the *Employer*.

7.9 *Contractor's Subcontractor* Declaration

#50 Where Works are to be performed by a *Subcontractor*, the *Contractor* shall provide notices and obtain the *Employer*'s approval prior to the appointment of the *Subcontractor.* This shall include all *Subcontractors* providing design, fabrication, assembly, installation and related services.

8 Specification

#51 The access control system and CCTV design drawings presented in 5.2 serve as a provisional guideline to the *Contractor*, the architecture and device numbers shall be verified and validated in the final *Contractor's* design, and is subject to TGC's engineer approval.

#52 All Access control (controllers) and CCTV (cameras) end devices shall be connected to access switches which shall be housed in the indoor ICT panels and outdoor field junction boxes.

#53 Installation of the CCTV system shall conform to the Transnet Group - Integrated Electronic Security and Related Systems Specification: Part 6.21. Security System installation Standards. Where there is a clash/disagreement between the standard and other Tippler 3 Project related standards, the Contractor shall notify the Project Manager of such development.

#54 Equipment fixing shall comply with the Transnet Group - Integrated Electronic Security and Related Systems Specification: General Specification. Where the specification requirements clashes with other related standards used on the Tippler 3 Project, the Contractor shall notify the Project Manager of such developments.

8.1 Access Control System

8.1.1 General

#55 The Access Control system to be installed shall be Babylon XMP system or proposed equivalent subject to *Client* approval.

#56 The Access Control system shall comply with the Transnet Group - Integrated Electronic Security and Related Systems Specification: Access Control system. Where the specification conflicts with the requirements of this document then this document shall take precedence.

#57 The Access Control System shall be an integrated system that will be managed and controlled from the Security office in the BTS building for control, monitoring and managing access cards.

#58 All Access Control System installation shall comply with the Group Security Management – Transnet Physical Security Systems Standard.

#59 The access control system shall accept cards already used by TPT at other Ports or that has been approved by the *Client* TPT.

#60 Software for the access control system shall have a time and attendance feature that gives it the capability to interface to the Transnet SAP system.

#61 All outdoor access control devices shall be IP65 and IK10 rated.

#62 All access control equipment shall be durable and suitable for coastal area environments.

#63 Equipment installed in a hazardous area shall comply to ATEX standards.

#64 The access control system shall cater for future expansion.

#65 Access controllers and readers shall be upgraded to the latest versions.

#66 The Access Control shall have the capability to integrate to other systems such as Intrusion system, CCTV system and SMS text messaging system.

#67 The ACS shall be integrated with the fire and smoke detection systems for monitoring of fire alarms to unlock doors during an emergency.

#68 The Access Control will have the capability to integrate to other systems such as a UPS.

#69 Comprehensive access control system shall be installed at the areas in section 8.1 and monitored and controlled from the BTS building in the Security office. The system shall be in accordance with the applicable legislation and regulations.

#70 The areas of scope in section 8.1 shall be equipped with the following *Client* preferred systems:

a. Hardware: Babylon XMP or proposed equivalent

b. Software: Babylon XMP or proposed equivalent

#71 Each access control system shall comprise of, but not be limited to, the following:

a. Main system controller and servers.

b. Door controllers.

c. Proximity card readers compatible with the access control system, with LED and tone indication.

d. Push and no-touch door release buttons compatible with the access control system, with LED and tone indications.

e. Override key-switches.

f. ML1200 magnetic locks complete with, LED and tone indication.

g. Door monitors/ position sensors (alternative is to install a monitored maglock with LEDs).

h. Conventional green break glass resettable manual call point units with and without additional I/O, all with LED indication.

i. Visual and audible indication installations.

j. CAT6 Ethernet cabling and Mylar hardwired interfacing cabling connections, as applicable, between all respective installations.

#72 Power supply shall conform to requirements in Transnet Group – Integrated Electronic Security And Related Systems Specification Part-6.2 Access Control System

8.1.2 Field (Hardware)

#73 The Access control electronic end devices shall be further developed and installed as per the drawings in 5.

#74 Substations main entrance doors to the outside shall have a full access control comprising of:

a. 1-entry and 1-exit proximity card readers

b. Break-glass unit for exit during emergency

c. Emergency key switch where required

d. Door monitor/sensor

e. Maglock

f. A single leaf door shall have one maglock

g. A double leaf door shall have two maglocks

h. Door Controller with a power supply and back-up battery-pack

#75 All roller Shutter doors that can only be opened from the inside shall have a Door monitor/sensor.

#76 Areas in the building where pressure leaks are of concern, mechanical door-closers and sensors to monitor the door status shall be installed. Door sensors shall be interfaced to the Access control system controllers and monitored in the BTS building.

#77 All areas in the building where there are windows but less human movements shall have Passive Infrared sensors (PIRs) installed (subject to *Client approval)* and integrated to the access control system to be monitored for alarms in the Security Control room.

#78 Door Controller:

a. Shall communicate via TCP/IP to the central control system

b. Shall be able to operate independently of the server

c. Shall have the following properties;

- Number of Cards: 50000 (expandable to 250000)
- Bookings/templates storable and pins: 50000
- Doors per controller: 4 (expandable to 8)
- Readers per controller: 4 (expandable to 8)
- I/O per controller: 16 supervised inputs / 8 outputs
- Communication: Ethernet network interface (fixed IP recommended) and RS485 network reader bus
- Enclosure / Housing: powder coated aluminium, IP54, tamper-proof & monitored, lockable (key)

d. Shall be housed in a control-box which shall be installed in the building on secure side of the door inside the ceiling or on the wall above a specific door.

e. The door controller shall be connected to the local access switch in the building as guided by the network layout drawings

f. Only one controller shall be assigned per door.

g. Controllers shall be installed with integrated UPS, battery-pack for back-up power.

h. Controller and back-up power supply shall be housed in lockable coated aluminium wall mount box (size and material of box subject to approval by *Client*).

#79 Input Terminals/ Output Terminals

a. Where input/ output modules are required for installation instead of door controllers, the I/O devices shall conform to the minimum requirements in the Transnet Group - Integrated Electronic Security and Related Systems Specification: Access Control System Part 6.2.

#80 Card readers

a. Make shall be XMP-TMC (Babylon) or equivalent

b. Shall be tamper proof

c. Shall be of Multi-Mode Multi-Discipline type, which can read the following (and latest) 125kHz and 13.56MHz tags on the same Reader and must be able to read cards already used on the Port

- 1.7.9.3 125kHz EM Marin
- 1.7.9.4 125kHz Impro Hi Tag (read/write)
- 1.7.9.5 125kHz Impro proprietary Tags (1074 and 2074)
- 1.7.9.6 125kHz HID Tags (H10301, H10302 and H10304)
- 1.7.9.7 13.56MHz HID iClass Tags (ISO 15693-2)
- 1.7.9.8 13.56MHz Sony FeliCa Tags (ISO 18092)

- 1.7.9.9 13.56MHz Phillips MIFARE® Tags. (ISO 14443A)

d. The reader shall be connected to the access control system via a door controller.

e. The card readers support infield firmware upgrade and feature Zero Down-time firmware upgrades.

f. Shall have the following properties;

- Case: ABS material (impact-proofed housing)
- Dimensions: subject to approval by *Client*
- Protection type: IP 65
- Signalling: minimum 3 LED statuses, buzzer

g. Card readers shall be approved by the *Client* and Engineer regarding appearance, final finish, and mounting detail. Card readers shall be adaptable for surface and/or flush mounting.

h. Card readers shall be approved by the *Client* and Engineer regarding appearance, final finish, and mounting detail. Card readers shall be adaptable for surface and/or flush mounting.

#81 Access Cards:

a. *Contractor* shall supply 50 printable cards for the system.

b. Card look design shall be subject to approval by Transnet.

c. If the *Client* prefers, all cards shall have a unique serial number engraved on the back and shall be delivered completely adaptable to all the card readers.

d. It shall be the responsibility of the contractor, however, to do the initial programming of card readers and controllers regarding the serial numbers of cards valid for any reader to obtain the desired level of security for each card.

e. Cards shall have the following properties

- Type: MIFARE® RFID 4K, ISO/IEC 14443 Type A (subject to *Client* approval)
- Operating frequency: 13.56 MHz
- Dimensions: ID-1 (ISO/IEC 7810:2003)
- Printable: Yes
- Suitable hole to attach stainless steel carrying clips.

#82 Break glass unit;

a. Break glass unit and magnetic locks shall be connected to the controller for the specific door.

b. Shall use a resettable element

c. Legend & logo: BG cover “EMERGENCY DOOR RELEASE” , BG window “Emergency Break Glass” including “PRESS HERE” logo

d. Shall be surface mount

#83 Magnetic Lock:

a. Maglock shall be monitored (with LED, Hall effect IC and NO/NC relay)

b. Maglock shall be fail safe

c. Doors shall be assessed for the correct bracket prior to installation

d. No cables shall be exposed, where required flexible steel Sprague shall be used to protect cables.

e. Maglock size: ML1200 or 600kg

f. Dual voltage 12 & 24VDC

g. MOV (metal oxide varistor) Surge protection

h. CE Approved

#84 **Fingerprint-enrolment-station**

a. Shall be installed in the Security Control room in the BTS building.

b. Shall be compatible with the Access control system installed.

c. Will be used for the enrolment and verification of fingerprints.

d. Shall allow a minimum of four fingerprints to be stored.

e. Shall have the following properties;

- Connection: USB 2.0/3.0 and Ethernet RJ45.
- Power supply: via USB-interface and power supply via power adapter.
- Sensor technology: Optical.

#85 **Access Card printer**

#86 Shall be installed in the Security Control room in the BTS building.

#87 Subject to *Client* confirmation.

8.1.3 Monitoring

#88 All Access control system shall be monitored and controlled from the Security Control room in the TPT BTS Building.

#89 The *Client* preferred Access Control monitoring system software is Babylon XMP, if Contractor proposes something different, it shall be similar to the Babylon XMP system and shall be subject to *Client* Approval.

#90 The Access Control system software shall conform to the operational minimum requirements in the Transnet Group - Integrated Electronic Security and Related Systems Specification Part 6.2: Access Control system specification.

#91 The *Contractor* shall provide a client workstation (pc tower, 1 screen, keyboard and mouse) that will be used by *Client* to control and monitor the newly installed Access control system, as well as to issue cards.

#92 The client workstation shall have the Babylon software or equivalent to use by the security personnel to control and monitor access control system in the Port.

#93 The *Contractor* shall provide an access card-printer, blank access cards, a camera and ink for the printer to use by *Client* for Access cards printing.

#94 The type of Access cards shall be subject to approval by *Client*.

#95 The access control system server shall be installed in the ICT server room.

#96 The Workstations system shall be capable of accommodating upgrades in colour monitor, hard disk drive, RAM and I/O port capacity, without rendering the workstation hardware and/or software obsolete.

#97 Additional licences shall be provided by *Contractor* where required by the system, server or workstations.

#98 Access Control Server minimum requirements

- *Client* preferred brand is Dell or similar
- 1U Rack Server
- Intel Xeon 3.0GHz processor
- 1x 16GB RAM
- 2 x Gigabit Ethernet LAN ports
- 4x 2TB Hot-plug Hard Drive
- Dual, Hot-plug Power Supply (1+1)
- Windows Server 2012, Standard Edition R2

#99 Access Control *Client* PC minimum requirements

- *Client* preferred brand is Dell or similar
- CPU: Intel i7
- Memory: 16GB
- Network Interface card: 2 x Ethernet (1000Base-T)
- Graphics card: 2GB
- Disk: 500GB SSD
- OS: Windows 10 64 bit (adhere to Transnet ICT standards)

#100 Monitor minimum requirements

- *Client* preferred brand is Dell or similar
- Display: 24" LED Backlight
  Designed for 24/7 operation
  4K Resolution
  16:9 aspect ratio
  1000:1 contrast ratio
- Audio**:** Built-in Speakers
- Inputs: VGA, HDMI

#101 Access Control Software Minimum requirements

- Developed for Windows 10, 2012, 2016 and latest
- Multi-user capability and network support via TCP/IP
- Online monitoring of all connected devices
- Roll call and muster reporting
- Security lockdown
- Integration of monitoring and control *functions* within the building management access automation system

- Unlimited number of graphics to visualize alarms and processes
- Video log
- Optional user-defined Time Recording and Accounting
- Guard tour patrol system for monitoring e.g. security guards at appointed checkpoints
- Transmission of alarms via e-mail or text message
- Workflow
- Integrated SNMP server
- Open software interface feature to enable communication with third-party systems (e.g. SAP® R/3® HR via TCP/IP)
- Optional Visitor management software
- Integrated module for badge layout definition
- Graphical user interface for creating, modifying or deleting cardholder records and access profiles

#102 Events Log Printer minimum requirements

- A high quality Network capable Laser Printer shall be supplied, installed and commissioned as part of this contract, for use with the management workstation in order to generate user defined management reports.
- Page feed capable of accepting paper at least up to 242 mm (A4) wide. Single page paper shall be used to allow users to print out historical events and system activity.
- Shall conform to minimum requirements in Transnet Group - Integrated Electronic Security and Related Systems Specification: General Specification Part 5.2 Rev-02, but with consideration for the latest technology.
- The printer shall incorporate a visible control panel with LED indication for power on, paper out and ready.
- The printer shall be installed and configured into the Access Control workstation to be installed within the BTS building.
- The printer shall be supplied with both power and data cables of suitable length to suit the location. In addition, the printer shall be set up complete with one full box of paper and two spare cartridges.

#103 Access Card Printer

#104 The access card printer shall be a heavy duty Direct-to-Card Printer Encoder that provides for double sided thermal printing of the cards in a single operation as well as to provide lamination of the cards for additional durability.

#105 The card printing software shall be fully integrated with the access control system.

#106 The printer required conform to the Access card printer requirements in the Transnet Group - Integrated Electronic Security and Related Systems Specification: Access Control System Part 6.2, but provide printer of latest technology version or may offer an alternative that exceed specification.

8.2 CCTV Security System

8.2.1 General

#107 The CCTV system to be installed shall be compatible with the current CCTV system currently used at the Port which is monitored with the NiceVision Enterprise system.

#108 The CCTV system shall conform to the Transnet Group - Integrated Electronic Security and Related Systems Specification: HD IP Video surveillance system, but with the consideration for latest technology. Where the specification conflicts with the requirements of this document then this document shall take precedence.

#109 Comprehensive CCTV systems shall be installed at the new areas listed in 8.1 and shall be monitored from the BTS building – Security Control room through integration with the existing CCTV system.

#110 The new CCTV shall have the capability to integrate with other systems such as UPS, Access Control and Intruder detection system.

#111 The systems will be used to provide the following key functions:

- Real time surveillance;
- Recording of real time events and historical video data for video evidence of a security event; and
- Provide a deterrent to criminal and unacceptable behaviour.

#112 The CCTV systems shall comprise of, but not be limited to, the following:

- Indoor/outdoor, ceiling/wall mounted PoE fixed HD dome camera units with built-in motion detection.
- CCTV servers and additional storage (where required)
- Additional client workstation at the Security Control room (if required by *Client*)
- Where required, additional PoE Network switch(es) and managed media converters, onto which CCTV cameras connect directly via CAT 6 cabling. The network switches shall in turn be connected via the fibre optic patch panels onto the main Port ICT network.

#113 The current used TPT Port CCTV system make is as follows;

- Cameras: Axis make
- Software: NiceVision Enterprise

#114 CCTV cameras shall be installed to monitor all access points and critical areas within the buildings.

#115 The system shall incorporate as standard motion detection video analytics and have activities recorded and stored.

#116 The CCTV network shall be secure against both physical and network intrusion. The *Contractor* shall provide an effective network protection and securing strategy.

#117 Video storage capacity shall be considered at the beginning of the design process of the CCTV system to ensure additional equipment and additional storage requirements needed for the new system to operate at optimal performance level is catered for.

#118 The system shall be IP based.

#119 The system shall be available 24/7.

#120 The system shall be capable of unlimited expansion for the addition or modification of video inputs.

#121 CCTV equipment network settings such as IP address and mask will be provided by *Client* upon Request.

#122 The CCTV system including all cameras shall be powered from a UPS.

8.2.2 Cameras

#123 All cameras will be at least full High Definition (HD) 2.0MP resolution. The cameras shall be selected for suitability for internal and external Surveillance.

#124 The selected CCTV cameras shall meet or surpass the camera requirements on the Transnet Group - Integrated Electronic Security and Related Systems Specification: HD IP Video surveillance system, with the consideration for latest technology.

#125 Suitable lenses shall be selected to accomplish the monitoring functions for each camera at its point of installation, datasheet to be submitted for *Client* approval.

#126 The CCTV system cameras shall produce sharp, detailed and stable images on the monitor in sufficient detail to provide positive identification of individuals within the protected areas under all conditions of light.

#127 All fixed CCTV cameras shall be PoE powered and shall be fitted with surge protection against possible lightning and electrical interference.

#128 Dome cameras shall be used for indoor monitoring or where covert monitoring is required

a. Cameras shall be strategically placed to monitor critical access doors, passage ways and storage rooms.

b. Shall be standard vandal resistant ceiling/wall mount fixed dome and fitted with built in variable focal, dc-auto iris lenses to ensure optimal optical efficiency.

#129 Fixed box or bullet cameras shall be used to monitor outdoor areas

a. Cameras shall be strategically placed to monitor gates, perimeter, parking and access roads.

b. Shall be mounted in purpose made weatherproof housings to protect camera from dust, rain and strong winds.

#130 Where required, wide coverage public areas shall be viewed with PTZ and panoramic cameras, to provide close up images and tracking of events.

#131 The CCTV shall operate in all light conditions, including low light conditions, and shall automatically compensate for changing light conditions.

#132 Where a camera must operate in total darkness, the nature of the possible events will be analysed to determine whether the situation requires a special application camera such as one that uses infra-red illumination or thermal.

#133 The CCTV system shall be interfaced with the intercom system and the access control system depending on the requirements of the specific installation.

#134 All equipment shall have the correct type IP rating as specified, taking account also of the location of installation, including in particular the harsh and dusty environments.

8.2.3 Camera Mounting and Housing

#135 External cameras shall have IP66 rated housings and function satisfactorily in all weather conditions.

#136 Camera masts shall be mounted on suitably sized and constructed bases to withstand the mass of the masts and any wind moments on the masts.

#137 Steel Camera masts shall be designed according to Transnet standards and be hot-deep galvanised, powder coated/ painted and earthed.

8.2.4 Monitoring

#138 The surveillance cameras on the Port will be controlled and monitored only from the Security control room in the BTS building.

#139 Camera settings and configurations shall be the same as the Port existing CCTV system and subject to approval by *Client*.

#140 Operating system for the client workstation and all software in the client station shall conform to the Transnet ICT standards.

#141 Operating system shall support Transnet active directory.

8.2.5 Video Recording and Storage

#142 All CCTV cameras connected to the system shall digitally record for a minimum of 30 days and additional storage shall be considered for event recording.

#143 Where the existing CCTV system is found obsolete, *Client* shall be advised for an upgrade or a new system for project.

#144 All camera recordings shall be done with the *Client* existing system, where server or storage are found to be not sufficient, additional servers and storage approved by *Client* shall be provided by the *Contractor*.

#145 The *Contractor* shall be responsible to integrate all the new cameras in the existing NVRs and setup to be as per existing system configurations.

#146 All abnormalities shall be digitally recorded for a period of no less than 30 days, and shall be capable of being used appropriately by the police in evidence and stored, copied and viewed without interfering with recording.

#147 The system shall be capable of unlimited expansion for the addition or modification of video inputs.

#148 Whereby recording space is not enough, this shall be expanded to cater for the additional cameras.

#149 All required licences, firmware compatibility and legacy equipment interface requirement shall be provided by the *Contractor*.

#150 *Contractor* shall first make an assessment on the current available storage capacity.

8.2.6 Communication and cabling

#151 All cables and conductors, except fibre optic cables, that act as a control, communication, or signal lines shall include surge protection.

#152 The CCTV network shall be secure against both physical and network intrusion. The *Contractor* shall provide an effective network protection and securing strategy.

#153 Horizontal cabling of CCTV equipment shall be a responsibility of the *Contractor*.

#154 All CCTV equipment shall use CAT6 cabling or Fibre where required.

#155 Jointing of cabling shall not be allowed.

#156 All CAT6 cabling shall be no more than 90m

#157 CCTV network equipment and recording information shall be access controlled.

8.3 ICT

8.3.1 General

#158 An ICT Network Infrastructure shall be installed to facilitate communication for:

a. Voice Over IP communication

b. Power Metering System

c. Security Systems communication

#159 The ICT Local Area Network shall be integrated to the existing TPT ICT network.

#160 The equipment selection shall conform to the Transnet ICT Equipment Standardization Specification.

#161 The ICT equipment shall be protected from physical and environmental threats in accordance with Transnet ICT Physical and Environmental Security Standard.

#162 The design and deployment of hosts on the Transnet network shall conform to the Transnet Network Security Standard.

#163 Network wiring shall comply with EIA/TIA-568.

#164 Separation from electrical wiring and pathways shall be according to EIA/TIA-569.

#165 Fibre Optic cabling shall comply with SANS IEC 60793 , SANS IEC 60794 and SANS 61073-1.

#166 This specification must be read together with the Technical Specification: Tippler 3 Bulk Power Supply Monitoring and Control Installations (1924107-2-300-E-SP-0010). Where there is a conflict between this specification and the specifications mentioned above, this specification shall take precedence.

8.3.2 ICT Network Infrastructure

#167 Fibre optic cabling

a. 48 core single mode fibre optic cables, including patch leads, shall be installed between the new and existing facilities mentioned in Section 8.2

b. The 48 core optic fibre cables shall be installed in the same trench as the Process Network optic fibre cable.

c. Fibre optic cabling shall comply with the following design guidelines:

   i. Single mode fibre cable shall comply with SANS IEC 60793

   ii. Fibre optic cabling shall have CST or SWA protection layer.

d. Be adequate to allow for bandwidth requirements.

e. No jointing of fibre optic cables is permitted.

f. Fibre optic cables to be clearly marked with the manufacturer specifications.

g. Cable manufacturers recommendations to be followed to minimise tension on fibre optic cables during and after installation.

h. Cable manufacturer design specification should be followed regarding cable bend radii; these specifications shall not be exceeded.

i. Fibre optic patch leads, patch panels and brush panels shall be provided and installed to ensure the complete integration of all local installations to the main ICT network.

j. Installation of fibre optic cables shall comply with SANS 61073-1 and SANS IEC 60794

#168 Network points/Outlet boxes

a. Network points shall be provided in the following new facilities to facilitate VOIP and Power metering communication only in the following facilities:
   i. New Main Intake Substation
   ii. Substation M
   iii. Substation N
b. The *Contractor* shall do an assessment to determine the number and location of the network points. Approval from the *Employer* shall be obtained before procurement and installation.
c. Network cables shall be terminated with RJ45 outlet jack rated for Cat 6 Ethernet cable used for the installation.
d. All new Ethernet cables installed shall be terminated at connectors using EIA/TIA-568 T568A pin assignments.
e. Network points shall not be located more than 5 meters away from the end user/device.

#169 Ethernet cabling

a. Network cabling shall comply with Cat 6 solid core UTP Gigabit Ethernet cable for 1000BASE-T and PoE.
b. No copper Ethernet cable length shall exceed 90m.
c. No patch cable length shall exceed 5m.
d. The cable shall have identifiable printing from the manufacturer on the side of the cable sheath, stating the cable type and specifications.
e. The colour of the cabling shall comply with Transnet specification.
f. Ethernet cables shall be terminated using RJ45 connector.

#170 Ethernet cable pathways

a. Cables shall be protected continuously along the entire route.
b. Cable bend radius shall be kept to no less than four times the outer diameter of the cable.
c. All cables shall be labelled at both ends indicating the cable ID tag as per the Specification for Equipment Tag Numbering System.
d. ICT data cables shall be segregated from electrical power cabling.
e. Cable slack shall be available after termination of the cable.

#171 Network switches

a. Network switches shall be provided and installed to ensure the complete integration of local installations to the main ICT network in the facilities listed in Section 8.2
b. Layer 3 network switches shall be supplied and installed.
   i. The *Contractor* shall do an assessment to determine the size of the switches required to accommodate Security Systems, VOIP and Power Metering systems.
   ii. Switches shall have at least 20% spare capacity for future expansion.
c. Properties of the switches shall be in accordance with the Transnet ICT equipment Standardization Specification.
d. Switches shall be rack mountable.

e. All switches shall be easily accessible for maintenance purposes.

f. Switches shall be fed from a UPS supply.

#172 Racks and Cabinets

a. Network equipment shall be housed in the same cabinet as the Process Network equipment.

#173 VOIP

a. LAN points shall be provided for telephones to facilitate voice communication only on the following new facilities:

   i. New Main Intake Substation
   ii. Substation M
   iii. Substation N

b. The telephony system shall be IP based.

c. The VOIP telephony system shall be integrated with the existing IP Telephony system in the Port.

d. The Telephones shall be powered through PoE.