

SCOPE OF WORKS SUPPORTING ANNEXURES:

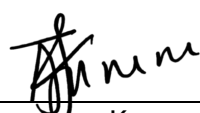
Annexure A:

**Annexure A: Contractor Document Submittal Requirements'
Standard - DOC-STD-0001 Rev 00**

Transnet National Ports Authority
Contractor Documentation Submittal Requirements
DOC-STD-0001

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1. Purpose

This standard outlines the documentation requirements that are to be implemented by the *Contractor* for the preparation, submission, receipt, review, and collection of Technical and (or) Deliverable Documentation, as detailed in the Contractor Documentation Register (CDR).

Contractor documentation is of the utmost importance for all project activities as the information contained in the *Contractor's* documentation interfaces with several other disciplines for the project, e.g., Quality, HS, ENV, Construction, Engineering..

The supply of high-quality documentation within the time required as defined in the '*Works Information*', Contractor Documentation Register (CDR), and *Contract* must be considered as one of the main objectives by the *Contractor*.

2. Scope

This scope defines the *Contractor's* responsibilities in terms of the preparation of all the *Contractor* Deliverables required for each *Contract*.

3. References

- ISO 9001:2015 - Quality Management Systems Requirements
- SANS 10111 - Code of Practice for Engineering Drawings
- SANS 10143 - Building Drawing Practice
- DOC-FAT-0004 - Contractor Documentation Register (CDR)
- DOC-FAT-0002 - Squad Check Form

4. Definitions / Abbreviations

4.1 Definitions

'As-Built' Document	Is a final record of what was actually installed / constructed according to the Fabrication / Construction <i>Contractor</i> , and includes all deviations or changes from the approved AFC document(s). As-Built document(s) are required to reflect the same degree of detail as the original document(s). As-Built document(s) shall be done by all <i>Contractors</i> .
Contract	Formal document evidencing agreement between <i>Employer</i> and <i>Contractor</i> for supply of on site or off site services (generic term used for Purchase Orders, Contracts and Service Orders in this Procedure).
Contractor	The party to a contract that provides services to the <i>Employer</i> (generic term used for Vendors, Suppliers, Contractors, Consultants, etc.).
Controlled Document	Any document where its revision and distribution are recorded to ensure that Project Team Members holding a copy of the document have the current revision, and will receive future revisions, subject to a formal review and approval process.
Documentation	Collective term used to describe drawings and documents, e.g., letters, faxes, drawings, specifications, reports, manuals, standards, publications, software, etc.
Document Control	The function that ensures systematic registration, distribution, retrieval, status reporting, and storage of revision controlled documentation, typically Technical and (or) Deliverable documentation.
Document Management	Is the over-arching term used to describe the management of documentation on a Project.

Employer	The party to a Contract or Purchase Order to whom the goods are supplied or for whom the work or services are performed. For this project Transnet Capital Projects is the <i>Employer</i> .
Employer's Documentation	Shall mean all documentation issued to <i>Contractors</i> by the Project.
Engineering Deliverables	Technical documentation generated by Engineering, i.e. drawings, drawing registers, Engineering Document Registers, calculations, requisitions, equipment lists, design specifications, etc.

4.2 Abbreviations

AB	As-Built / Recorded Documentation
AFC	Approved For Construction
CDR	Contractor Documentation Register
DC	Document Control
DCIS	Document Control Instruction Sheet
EDMS	Electronic Document Management System
FN	Final
RE	Responsible Engineer

5. Responsibilities

5.1 *Contractor*

The *Contractor* is responsible for submitting all documentation, required by the Contract, via Document Control to the relevant *Project Manager*, to comply with the requirements of this standard.

The *Contractor* is responsible for setting up and maintaining his own internal Document Control Process to ensure traceability and accountability for all information submitted to the *Project Manager*, and all information issued to Sub-Contractors.

5.2 *Sub-Contractors*

The *Contractor* is responsible for providing the *Sub-Contractors* with all the relevant information, and for ensuring that the *Sub-Contractors* applies the Standard, and submit their data via the *Contractor* for formal submission to the *Project Manager*. (If the *Contractor* sub-contracts work, he is responsible for providing the Works as if he had not sub-contracted.

6. Procedure

6.1 *Documentation to be Submitted*

6.1.1 Contractor Deliverable Register (CDR) – (DOC-FAT-0004)

The CDR states the Employer's requirement.

The *Project Manager* completes the Contractor Documentation Register (CDR) and includes it with the Enquiry and Contract as an attachment / annexure to the 'Works Information' document. The *Contractor* submits documentation as required by the Contractor Documentation Register (CDR), within the time specified in the Contract. All documentation shall be submitted according to the dates specified in the Contractor Documentation Register (CDR).

The Contractor Documentation Register (CDR) is a list of documentation that the Contractor is to submit in accordance with the Contract.

The CDR will include the documentation deliverables to be submitted by the Contractor as per the agreed submission dates.

The title of the documentation shall adequately define and describe the facility and equipment where applicable. The Contractor Documentation Register (CDR) must be submitted within 2 weeks of the *Contract* kick-off meeting, unless otherwise indicated in the kick-off meeting. Once the Contractor Documentation Register (CDR) is submitted, the Document Control assigns document numbers to each document. The Contractor Documentation Register (CDR) is reviewed and returned to the *Contractor* as defined elsewhere in this Standard. The *Contractor* is to use the exact document numbers and titles as provided and listed on the Contractor Documentation Register (CDR), on each of the documents.

The Contractor Documentation Register (CDR) is a 'live' document that shall be updated and re-submitted by the *Contractor* as agreed at the kick-off meeting to reflect any changes made, e.g., updated planned / actual submission dates or addition of new documents requiring new numbers. Changes to a row(s) of the register shall be highlighted in colour across the entire row(s).

The Contractor Documentation Register (CDR) shall be submitted in Excel (electronic format) upon each submission to the Project, and shall also be submitted with the final documentation, unless otherwise agreed.

The forecast and actual submission dates shall reflect the dates of the next issue of the documentation, and once this submission reaches conclusion the dates are to be updated to reflect the next issue, i.e., the as-built documentation submission dates.

6.2 *Format in which Documentation is to be submitted*

This Standard is to encourage all documentation to be managed and submitted electronically, with the exception of any provisions highlighted in the works information. The *Contractor* can apply to the *Project Manager* to have these requirements changed to accept paper copies of all documentation.

6.2.1 Documentation with Multiple Sheets

6.2.1.1 Drawings

If a series of drawings of a particular area is produced by the *Contractor* (e.g., loop diagrams which may have fifty (50) or more sheets) one sequential drawing number shall be used with a series of sheet numbers.

Where more than one sheet is used, the first sheet (numbered 01) shall incorporate an index for all the other sheets in the series, including their current revision status and date.

6.2.1.2 Documents

The *Contractor's* documents with several sheets (e.g., data sheets, reports, etc.) shall be compiled as sets, i.e., a multi sheet document identified as a single document with a single document number. Thus, each sheet is identified individually, e.g., "sheet 10 of 15" and all documents shall be numbered from page 2 onwards.

Each set shall include a Table of Contents and the identification data shall as a minimum contain the following, i.e., the document number, revision number, page number and continuation information shall appear on every page of the multiple page documents. The front sheet of each document shall be page 1; however the number or wording "page 1" is not shown on the first page.

6.2.2 Details Required on Documentation

Each drawing and document shall be identified with the following information, i.e.,

- Project Name and Number
- Contract Number
- Equipment Tag Number(s) (if applicable)
- Manufacturer's model / type (if applicable)
- Official Name of *Contractor's* Company
- *Contractor's* Reference Number
- Project Document or Drawing Number
- Electronic File Name (identical to the *Employer's* Document or Drawing Number and not the *Contractor's* Document or Drawing Number)

- Identification and signature of Originator, Checker, Approver, PR Eng, etc.
- Complete Descriptive Title
- Revision
- Date

6.3 *Electronic Documentation Requirements*

No "Protection" or "password" will be placed on electronic files.

Electronic submissions shall conform to the minimum quality standard as listed below i.e.,

- File Formats to be submitted
- All deliverables submitted by the *Contractor* must be supplied in the formats listed below, and be editable using the software listed in Table 1. Only exceptions that have prior approval from the *Project Manager* will be accepted. Software used shall be the latest generation, and where appropriate, shall be regularly upgraded.

Note:

All electronic documents shall be submitted in Adobe Acrobat (PDF) format and the 'Native' file shall be included as per contract.

6.3.1 Table 1: Acceptable File Formats

Document Type	Description
Drawings	Native: AutoCAD (DWG)
	Published In: Adobe Acrobat (PDF) version 7 or later
Data Sheets (other than instrumentation)	Native: MS Excel 2003 or later
	Published In: Adobe Acrobat (PDF) version 7 or later
Data Sheets (Instrumentation)	Native: As per software used or as otherwise specified in Contract
	Published In: Adobe Acrobat (PDF) version 7 or later
Engineering Data Lists	Native: MS Excel 2003 or later
	Published In: Adobe Acrobat (PDF) version 7 or later
Calculation Outputs / Results	Native: As per software used or as otherwise specified in Contract

	Published In: Adobe Acrobat (PDF) version 7 or later
Document Viewers – Redlining	Adobe Acrobat v7 minimum with “Comments” enabled
All Reports	Native: MS Word 2003 or later
	Published In: Adobe Acrobat (PDF) version 7 or later
Report supporting Data including: Calculations, Charts,	Native: As per software used or as otherwise specified in Contract

Graphs, Indexes, etc.	Published In: Adobe Acrobat (PDF) version 7 or later
Manuals	Native: MS Word 2003 or later
	Published In: Adobe Acrobat (PDF) version 7 or later
General Documents	Native: MS Word 2003 or later
	Published In: Adobe Acrobat (PDF) version 7 or later
Presentations	Native: MS PowerPoint 2003 or later
	Published In: Adobe Acrobat (PDF) version 7 or later
Colour Photographs / Scanned Images	Native File format: JPG Compression level 1%
Graphic Imagery	Published images in: TIF uncompressed or WMF
	Native image format: Corel Draw 7 CDR file
	Adobe Photoshop 7.0 PSD
	PowerPoint 2000 PPT file
Project Schedules	Native: Primavera P6 (preferred)
	Native: MS Project
	Published In: Adobe Acrobat (PDF) version 7 or later
Databases (preferred)	MS SQL Server 2000
Databases (non-preferred)	ODBC compliant
	Microsoft Access 2003
Data Compression	Software: WinZip 8.0
Other General Project Data	Native: Microsoft Office 2003 application or later
	Published In: Adobe Acrobat (PDF) version 7 or later

6.3.1.1 Native File

Native files shall be clean of all extraneous fonts, formats and styles to ensure inadvertent reformatting and format adjustments or difficulties that do not result in downstream handling of documents.

6.3.1.2 Adobe Acrobat (.PDF) Files

PDF files shall be of a high quality and without dark background shading as definition may otherwise become lost.

The quality of Adobe Acrobat (.PDF) files shall be such that a hardcopy of a laser printed A1 Adobe Acrobat (.PDF) drawing can clearly be read in A3 size. Similarly A3 and A4

Adobe Acrobat (.PDF) file quality shall be such that hardcopy of a laser printed A3 or A4 Adobe Acrobat (.PDF) document can clearly be read in A4 size.

The Contractor shall physically test and confirm this prior to transmitting Adobe files. PDF files shall be saved as "Reader Extent" to make provision for the use of electronic signatures. PDF files shall be "Optimized" to improve Quality and then "Reduce File Size" through Adobe.

6.3.1.3 Databases

Databases shall be presented in compatible format via a share link. Multi format documents (created from several files) shall be combined and submitted as a single Adobe Acrobat (.PDF) file.

6.3.1.4 Drawing Files

These shall be submitted in Adobe Acrobat (.PDF) and the 'Native' file format shall be submitted on the final submission unless otherwise specified. 'Native' files shall include reference / border files, etc.

A single file shall be submitted per document, i.e., under no circumstances shall different drawings with different numbers appear on one sheet under one file name, nor shall a drawing with multiple sheets be saved into one electronic file.

All CAD drawings shall be contained in one single merge file, any form of ex Ref or Reference File will not be accepted.

6.3.1.5 Sketches

These shall be A3 or A4 size scanned as Adobe Acrobat (.PDF) file.

6.3.1.6 Text Documents

Each page of a single document shall be collated into one file. (The "wet" signature

Squad Check coversheet, where required, is inserted at the beginning of the document prior to review).

6.3.1.7 Tables / Diagrams

These shall be A4 and A3 size only.

6.3.1.8 Reports

Reports containing Word, Excel, DGN, DWG, brochures, etc., shall be compiled as one Adobe Acrobat (.PDF) file.

Note:

Original colour hardcopies shall be scanned in colour to ensure all details of paper documents.

6.3.1.9 Photo's / Video's

Prints should be submitted of conventional photographs or prints and digital files of electronic images, or as specified by the Project Manager.

6.3.2 Security

Files shall be clear of known viruses and extraneous (irrelevant) macro's. The *Contractor* shall at all times have the latest version of virus protection software. The *Contractor* shall ensure appropriate security systems are in place to prevent unauthorized electronic distributions and (or) unauthorized editing or manipulation of electronic files.

6.3.3 Scanning Requirements

Where possible 'native' files shall be converted to PDF rather than scanned from hardcopy.

Where this cannot be done all drawings and documents shall be manually scanned in colour.

The settings below should be adhered to where possible and may vary depending on scanning software used. Where images rendered with these settings are unreadable, operators shall use their discretion, and adjust colour depth and resolution accordingly.

6.3.3.1 Scan Settings

- Resolution:-

Black and White - 200 dpi Colour

- 100 dpi

Fine Line Drawings - 300 dpi

- Image Type:-

Black and White	- 1 Bit
Colour Line Drawings	- 8 Bit (256 colours) minimum
Colour photos and rendered images	- 24 Bit
- Use automatic threshold to determine the white and black points

- Other Criteria to Adhere to:-

- Rotate to correct reading (i.e., viewable at correct orientation)
- De-skew (i.e., straighten if on a slant)
- De-speckle (i.e., remove background dirt)
- Optimized (i.e., reduce file size)

Note:

When a scanned drawing is printed to be re-scanned, subsequent to, e.g., mark-ups or signatures, then it shall be scanned at a setting of 400 dpi.

6.4 **Documentation Numbering**

Once the Contractor Documentation Register (CDR) has been submitted by the *Contractor*, Document Control will allocate the *Employer's* documentation numbers on the Contractor Documentation Register (CDR) and return it to the *Contractor*.

A unique sequence number is allocated to each document and remains the same for each submittal of that specific document.

The *Contractor* shall use the *Employer's* document numbers and titles exactly as per the Contractor Documentation Register (CDR) on all documentation submitted.

Electronic file names for all documentation shall be exactly as per the *Employer's* documentation numbers, including the revision number.

7. **Revising Documentation**

All documentation carries a revision block, which must be completed in full before submitting to the *Project Manager*, and typically denotes the following:

- REVISION NUMBER - Revision Number, e.g., 00, 01, etc.

- DESCRIPTION - Describes the status, e.g., Issued for Tender and a brief description of the changes made.
- REVISED BY - Person responsible for revising the document
- CHK'D - Person responsible for checking the revised document
- APP'D - Person responsible for approving the revised document
- DATE - Date of the revised document

7.1 *Revision Notes*

The revision block should record each change in revision with a brief but specific description of the changes made.

Terms such as "Minor Revision" or "General Revisions" shall be avoided in favour of a more specific notation. More than one line may be used but only the revision number and date together with the relevant initials shall appear in the top line.

7.2 *Indicating Revisions*

Revisions shall be clearly identified by placing a revision triangle with the correct revision number in the right hand column in the case of documents, and is adjacent to the area on the document that has been changed.

All revisions made on drawings shall be enclosed by a cloud except in cases where to add a cloud detracts from the readability of the drawing. At subsequent revisions all clouds and revision triangles from the previous formal revision shall be removed from the drawing.

7.3 *As-Built / Final Revisions*

As built drawings: ZZ (it is to be noted that revisions numbers may vary subject to the project and/or Transnet drawing number).

All drawings shall have the revision raised to the next applicable revision reference which shall be inserted in the revision box of the drawing title block before any drafting is started.

8. Documentation Submission

8.1 *Documentation Submission Format*

All documentation shall be submitted under cover of a *Contractor's* Transmittal Note.

8.2 *Electronic Transmission*

The Contractor Documentation Register (CDR) defines which documentation shall be transmitted electronically. All electronic documentation shall be transmitted via email or a shared link.

Note:

Per e-mail - the file size may not exceed 6 MB and the Transmittal Note shall be attached.

When sending an e-mail the *Contractor* shall ensure that the subject field of the e-mail is completed as follows, i.e.,

- Contract number, contract description and description of documentation transmitted.

8.3 *Hard Copy Transmission*

Where applicable documentation shall be submitted in printed hard copy format unless otherwise stated on the Contractor Documentation Register (CDR).

8.4 *Transmittal Notes (Annexure A)*

All documentation shall be submitted under cover of the *Contractor's* Transmittal Note indicating all *Contract* references (i.e., Project No, *Contract* No, etc.), Project Documentation Number(s), Revision Number, Title and Chronological listing of transmitted documentation.

The *Contractor's* Transmittal Note shall state the purpose / issue reason of the documentation submission.

Documentation for different purposes must be sent on separate *Contractor* Transmittal Notes. The *Contractor* shall note that documentation will be rejected if this requirement is not met.

The *Contractor* Transmittal shall be signed, dated and returned to the *Contractor* by Document Control.

8.5 *Formats and Quantities of Documentation*

The required number of copies and formats of documents / drawings shall be specified in the Contractor Documentation Register (CDR).

A typical example of quantities and formats would be as follows:-

- Pre-Construction – Hard copy and PDF (to be specified in 'CDR')
- Construction – Hard copy and PDF (to be specified in 'CDR')
- As-Built – Red Lined – Hard copies (Normally 3 off) (to be specified in CDR)
- Certified As-Built / Final – Hard copies (full size) and via shared link containing PDF and 'Native' file formats (to be specified in 'CDR')

8.6 Address for Submission

The address of submission will be as specified in the *Contract* and all submissions will be identified with the Contract Number, and the responsible *Project Manager*. All deliveries will be made to Document Control who will distribute the documentation to the relevant *Project Manager*.

9. Review and Acceptance of Contractor Documentation

The *Contractor* submits documentation as the *Contract* requires to the *Project Manager* via Document Control for review and acceptance.

9.1 Squad Check Form – (DOC-FAT-0002)

The purpose of the Squad Check Form is for the Project Manager to assign a review code to the reviewed documentation denoting the status of the documentation after consolidation of comments. The Squad Check Form is to be inserted by the Contractor as follows;

9.1.1 First Submission of Documentation

The first revision is revision '00', with subsequent revisions '01', '02', '03', etc.

9.1.2 Review of Documentation

Acceptance of documentation by the Project will in no way relieve the *Contractor* of their responsibility for the correctness of information, or conformance with the requirements. This responsibility rests solely with the *Contractor*.

Once documentation has been reviewed by the Project, all comments are consolidated and a review code is assigned on the Squad Check Form to the original reviewed / marked-up

drawing / document by the *Project Manager*.

9.1.2.1 Review Codes for Contractor Documentation

The Review Code resulting from the review is as follows, i.e.,

- Code C1 – Accepted

The *Contractor's* design / submission of documentation is accepted and the *Contractor* only needs re-submit documentation only if major changes have been made. The next submission will be the for Approval of "Redline" and / or "Final " documentation.

- Code C2 – Accepted with Comments. Revise and Resubmit

In the event that the Project returns documentation with comments noted, the *Contractor* shall, within the '*period of reply*' as defined in the *Contract Data*, make the required changes and submit the revised documentation for further review on the next revision.

- Code C3 – Rejected

In the event that the Project returns documentation with "Not Accepted, Revise and Re-submit" the *Contractor* , within the '*period of reply*', make the required changes and re-submit the revised documentation on a new revision for further review. Should these revisions necessitate changes in other related documentation, the *Contractor* shall make the appropriate changes and re-submit all the revised related documentation for further review. The *Contractor* shall not proceed with any activities controlled by the *Contractor's* documentation until it has been re-submitted and acceptance indicated.

The *Contractor* revises and re-submits documentation but on the next revision until a review code 'C1' is achieved. This review process shall not entitle the *Contractor* to submit any claims due to time loss.

- Code C4 – Information

Documentation signed at "Code C4" level is considered to be for information only and does not require further submission, and shall not be returned to the *Contractor*. However, Document Control shall issue a Transmittal only to the *Contractor* in this regard as notification.

9.1.2.2 Return of Reviewed Documentation

The original reviewed / marked-up drawing / document is scanned to PDF format and a copy is returned to the *Contractor* indicating the *Project Manager's* further instructions.

Return of the reviewed documentation is issued via shared link, email or hard copy (where applicable).

9.1.3 Review Period

The Contractor shall provide the Project Manager with a "reply period" to review and respond to submitted documentation, which begins upon receipt by the Project Manager and ends upon their response. However, if the Project Manager returns the documentation late, the Contractor may proceed with the work without delay, provided prior written notice is given by the Contractor.

9.1.4 Revised Documentation

On receipt of the reviewed documentation the *Contractor* shall make any modifications requested / marked-up and re-submit the revised documentation within '*the period of reply*' on the Contractor Documentation Register (CDR). Queries regarding comments / changes should be addressed with the *Project Manager* prior to re-submittal.

Any re-submittals, which have not included the changes / comments identified, will be marked with the applicable review code and returned to the *Contractor* to be corrected and re-submitted. The *Contractor* shall re-issue the revised documentation incorporating all comments on a new revision and other specified details not included in the previous issue within '*the period of reply*' of receipt of the marked-up documentation.

All revised data shall be submitted in its entirety and shall reflect the revision control numbers, and shall also indicate which documentation the revised documentation supersedes, if applicable.

In the case of drawings every sheet has its own revision number and is revised as an individual document.

In the case of documents all sheets under cover of one document number shall be under the same revision number and be re-submitted, even if the revision is a minor one.

10. As-Built / Final Documentation

This is Certified 'As-Built / Final Accepted' documentation or documentation for which no further review is required. The final documentation shall form part of the final *Contractor* Manual(s) or Data Packs

Contractors shall provide the 'As-Built' documentation that form part of the Operating, Instruction and Maintenance Manuals that were issued and accepted prior to 'As-Built' conditions for inclusion in these types of manuals by the *Project Manager*.

10.1 Definition of Final and As-Built Status of Documentation

10.1.1 "Final" Documentation

This applies to "As Manufactured and Delivered to Site".

Documentation submitted subsequently by the *Contractor* once "Final" status is reached shall be indicated as such in the Revision Notes Block as "Final" and shall also reflect the New Revision Number on the document in the revision block provided.

10.1.2 "As-Built" Documentation

This applies to "As Constructed or As Installed".

The Contractor Documentation Register (CDR)) shall indicate the documents which are to be brought to "As-Built" status, and must be submitted only after practical completion when the documentation qualifies for "As-Built" status, and the period after completion by which they must be finalized.

10.2 Preparation of As-Built Documents

10.2.1 Transnet National Ports Authority Documents

The *Contractor* responsible for completing the construction / installation works shall prepare three (3) marked up hard copies of the applicable documents to represent the As- Built condition(s). The mark-ups shall be in RED pencil or pen and be complete and accurate.

Once prepared the As-Built mark-up documentation is transmitted to Transnet Capital Projects for updating of the original design documentation.

Documents / drawings updated with information known by the *Project Manager* and as provided by *Contractors* at the completion of their *Contracts* is utilized by the *Project*

Manager to update Engineering Deliverables / drawings to this status, i.e., "For Record Purposes".

Note:

File naming convention on drawings / documents shall be in accordance with the Project numbers assigned on the Contractor Documentation Register (CDR).

10.2.2 Design, Supply and Install Contractor Documents

Contractors responsible for the design, supply and installation of equipment are responsible for producing As-Builts of their own documentation.

The *Contractor* shall prepare three (3) marked up hard copies of the applicable documents to represent the As-Built condition(s). The mark-ups shall be in RED pencil or pen and be complete and accurate.

Once prepared the As-Built mark-up documentation is transmitted to the *Project Manager* for Approval through the normal process. Once approved C1 the *Contractor* can proceed to update his drawings and submit as part of the final package

The mark-ups are returned to the *Contractor* so that they can produce the As-Built revisions.

11. Installation, Maintenance and Operating Manuals and Data Books

These shall be supplied by the *Contractor* as manuals in an A4 hard covered, red, grease and waterproof binder using two (2) ring type binders.

Drawings and charts larger than A4 shall be folded and those greater than A3 shall be enclosed in an A4 plastic pocket of adequate strength.

Manuals shall be well indexed and user friendly. Manuals shall include a summarized Table of Contents and in manuals comprising a number of files / volumes there should be one summarized Table of Contents in each of the files / volumes. The draft Table of Contents shall be submitted for review to the Project Manager prior to the compilation and official submittal of the manuals. The technical content of manuals shall be specified by the *Project Manager*.

The originals of all brochures shall be issued to the *Project Manager*. When a general brochure is applicable to a range of equipment, then the specific item, catalogue number or model number shall be stated, which is best achieved by introducing a separate index page, which cross-references the specific item to a tag number.

The address, phone numbers, fax numbers and reference numbers of all *Sub-Contractors* shall be provided.

Where manuals include drawings that still need to be revised to "As-Built" status, and such manuals are required prior to 'As-Built' status, the manual will not be considered to be in its final form until the "As-Built" version of each such drawing has been incorporated.

The required number of copies of the manual(s) shall be as specified by the *Project Manager* and submitted per type or model number of equipment included in the contract, or as specified by the *Project Manager*.

A typical example of what the binder / file(s) shall be marked with on the spine and the front cover is as follows:

- Project Name
- Manual Title, e.g., Installation, Maintenance and Operating Manual
- FBS No. and Title
- Manual Numbering (e.g., Volume 1 of 2, etc.)
- Contract Number
- Contractor Name

12. Cancelling and Superseding Documentation

The Document Control Procedure for cancelling and superseding is as follows:-

12.1 *Superseding*

If the document / drawing has been transmitted anywhere and is to be replaced by a different document number / drawing number, then it is superseded. The superseded item should go up a revision and always have the new drawing or document number written across it, as the normal practice.

The Document Controller is to check that this has been done on the drawing or document,

and the revision title block should be preceded with:-

- e.g. "SUPERSEDED by 222057-2-211-M-GA-0030"

12.2 Cancellling

If the item is to be cancelled, it means the item has been previously transmitted and it is not being replaced by another drawing number / document number. In this case the Document Controller should check that the revision has gone up, the word "CANCELLED" is written across the drawing / document and the word "CANCELLED" is placed at the beginning of the revision title block.

13. Procedure Maintenance

Any deviation from this procedure should be discussed with the applicable department manager. Such discussion should be documented, using the Document Change Request Form, DOC-FAT-0006, detailing the reason for the deviation as well clear instructions of the alternative process to follow. The applicable department manager or designated person is to review the proposed changes and approve or reject the alternative process.

14. Records/ Archiving

All documentation generated within TNPA Infrastructure will be subjected to the criteria for retention as specified in the "Archiving Procedure" DOC-P-0007 and in line with Transnet Policies.

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[illegible]

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure B:

Model Preambles for Trades 2008



MODEL PREAMBLES FOR TRADES 2008

*forming part of
the bills of quantities*

Project: PLZENG00051

CONSTRUCTION OF NEW FIRE STATION BUILDING and related
ANCILLARY FACILITIES IN THE PORT OF PORT ELIZABETH

Contract Reference Number: _____

EXPLANATORY NOTES AND INSTRUCTIONS ON THE USE OF THESE MODEL PREAMBLES

1. The document

- 1.1 This document is published by and is available from the Association of South African Quantity Surveyors, P.O. Box 3527, Halfway House, 1685. Telephone (011) 315 4140. E-mail: administration@asaqs.co.za
- 1.2 The contents of this document are intended to cover workmanship and materials encountered in a significant majority of projects. If a material is not encountered in a significant majority of projects, its preamble will in all likelihood not be included in this document
- 1.3 By its very nature, this document is a "Model" document and one that is designed to act as a basis upon which to build. It is anticipated that it will be supplemented by a "Supplementary Preambles" document included in the text of the bills of quantities that will include, *inter alia*, the following:
 - 1.3.1 supplementary clauses of a general nature that practitioners may deem necessary to cover their own individual requirements,
 - 1.3.2 additional clauses pertaining to specific materials incorporated in a project and not covered by the Model Preambles,
 - 1.3.3 amendments to anything contained in the Model Preambles. A clause has been incorporated in the "General" section of the document stipulating that anything contained in the "Supplementary Preambles" which is at variance to that which is contained in the Model Preambles, will take precedence over the Model Preambles and apply to the works in hand
- 1.4 It is intended that this document will be used by reference only in the text of the bills of quantities and will NOT be bound or reproduced therein

2. The basic philosophy

- 2.1 Wherever possible, reference has been made throughout the preambles to South African National Standards (SANS) to describe materials and methods respectively. It is therefore incumbent on the users of these preambles to have ready access to the relevant Specifications and Codes. Where such Specifications or Codes do not exist, suitable preambles have been compiled
- 2.2 These preambles have been designed to assist in abbreviating descriptions in the text of the bills of quantities and practitioners are encouraged to make use of this facility. e.g. The description of a stormwater catchpit would read:

"Brick stormwater catchpit size internally 600 x 400 x 1 200mm deep to invert fitted with and including a 450 x 300mm x 59kg cast iron grating and frame"
- 2.3 Wherever alternatives exist in respect of materials or workmanship, specific choices have been made in these preambles. Should users require different choices to specific items, these should be referred to in the Supplementary Preambles as outlined in clause 1.3

3. Additional notes in the use of these Model Preambles

3.1 Concrete, Formwork and Reinforcement

The Project Specification embodied in these preambles was compiled in collaboration with the Authors of SANS 1200G, which forms the basis for the Concrete, Formwork and Reinforcement model preambles

Users of these preambles are advised to submit a copy of the Model Preambles to the Engineers involved in a project for their scrutiny. Any amplifications, amendments, etc required by individual Engineers would then be incorporated in the Supplementary Preambles referred to in item 1.3

3.2 Roof Coverings

The roof coverings included in these Model Preambles are limited in their content and therefore any roofing material not included in these Preambles will need to have its full preamble included in the Supplementary Preambles

3.3 Structural Steelwork

The comments made under item 3.1 apply equally to Structural Steelwork

Note that the protective treatment of the structural steel covers only the treatment up to and including the primer (and patching after erection). The finishing coats of paint must be fully described and included either in the "Structural Steelwork" or in the "Paintwork" trade, as the practitioner wishes

MODEL PREAMBLES FOR TRADES

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A. GENERAL

A.1 APPLICATION OF CLAUSES

These Model Preambles for Trades, and any Supplementary Preambles, shall be read in conjunction with and shall form part of the descriptions of items in the bills of quantities

Where descriptions or Supplementary Preambles in the bills of quantities differ from these Model Preambles for Trades, the descriptions or Supplementary Preambles in the bills of quantities shall take precedence. Where supplementary preambles differ from descriptions in the bills of quantities, the descriptions in the bills of quantities shall take precedence

Except where otherwise stated, all preambles contained in any individual Trade Preamble shall apply equally to any work of a similar nature in all other trades

A.2 ABBREVIATIONS

The following abbreviations shall apply:

AASHTO	–	American Association of State Highway and Transportation Officials
AISI	–	American Institute of Steel Industries
BS	–	British Standard
CKS	–	Coordinating Specifications issued by the Central Coordinating Committee under the auspices of the South African Bureau of Standards
CSIR	–	Council for Scientific and Industrial Research
SANS	–	South African National Standards and the number following shall refer to the relevant specification or code of practice as the case may be

A.3 MATERIALS AND WORKMANSHIP

Materials and workmanship shall be the best of their respective kinds. Only new and undamaged materials shall be used in the Works. Materials to be permanently installed into the works shall not be used for any temporary purposes on site. Work shall be to the approval of the Principal Agent and shall be executed in accordance with the relevant manufacturer's written recommendations and instructions where applicable

A.4 PROPRIETARY PRODUCTS

For the purposes of submission of tenders, rates for items described in the bills of quantities by trade names, catalogue references, etc shall be for the particular type and manufacture specified

The approval of the Principal Agent shall be obtained prior to any substitution and where products or materials etc other than those specified are used, adjustments in the rates will be made if necessary

A.5 ASSEMBLING

Rates for manufactured items shall include assembling complete and handing over in proper working order

A.6 REFERENCES IN DESCRIPTIONS

Any references given in brackets at the end of certain descriptions shall refer to the relevant references on the drawings or schedules

A.7 WATER

Water shall be clean and free from injurious amounts of acids, alkalis, organic matter and other substances and shall be suitable for its intended use

A.8 APPLICATION OF THE NATIONAL BUILDING REGULATIONS

All work shall be executed in accordance with the requirements of SANS 10400

A.9 ACCURACY IN BUILDINGS

The dimensional and positional accuracy of the buildings and their component parts shall comply with Grade II requirements of SANS 10155 unless otherwise stated

A.10 REFERENCES TO OTHER DOCUMENTS

References in these "Model Preambles for Trades" to other documents, including SANS, CKS and BS, shall pertain to the latest edition thereof including all amendments thereto at the date for submission of the tender

B. ALTERATIONS

B.1 ALTERATIONS

In taking down and removing existing work the utmost care shall be observed to prevent any structural or other damage to remaining portions of the building. The Contractor shall ensure the stability of all structures during alteration work

Special care shall be exercised during the progress of the work to ensure that any electrical installations, water supply pipes, telephone and other services which may be encountered are not interfered with and notice shall be given to the Principal Agent if any disconnection or alterations become necessary

The Contractor shall take all precautions necessary to prevent any nuisance from dust whilst carrying out the work

B.2 MATERIALS FROM THE ALTERATIONS, CREDIT, ETC

Materials recovered from the alterations (except where described as to be re-used or to be handed over to the Employer) will become the property of the Contractor, who may allow credit in respect thereof where provided for in the bills of quantities. Such materials shall not be re-used in new work without written permission from the Principal Agent

Materials described as "removed" shall be removed from the site immediately.

Materials described as "handed over to the Employer" shall be carefully dismantled where necessary, neatly stored under cover on the site where directed and protected from damage, until required

Materials described as "set aside for re-use" shall be carefully dismantled where necessary, cleaned, neatly stored under cover and protected from damage until required for re-use. Any damage caused to such materials during removal, storage or refixing shall be made good at the Contractor's expense

B.3 DISPOSAL OF DEBRIS ETC

The Contractor shall be responsible for the removal from the site of all materials, debris and rubbish resulting from the alterations

B.4 MAKING GOOD DAMAGED WORK

The Contractor shall make good in all trades to existing work where damaged or disturbed through the alterations with all necessary new materials to match the existing

B.5 FORMING NEW OPENINGS OR ALTERING OPENINGS IN EXISTING WALLS

Where new openings are formed or openings altered in existing walls, the wall above the opening shall be broken out and a new brick, in situ concrete or prestressed concrete lintel inserted, complete with all necessary reinforcement, formwork, turning piece, etc, the jambs and portions of openings as described shall be built up with new brickwork or blockwork properly toothed and bonded to existing, cavities of hollow walls shall be closed where necessary and finishes shall be made good all round and into reveals

B.6 BUILDING UP OPENINGS

Where existing openings are given in number as built up, the existing surfaces all round shall be prepared as necessary, brickwork or blockwork properly toothed and bonded to existing, wedged up to underside of existing lintel and finishes shall be made good on both sides

C. EARTHWORKS

C.1 DEMOLITIONS

C.1.1 Nature and extent

Descriptions of demolitions give a rough guide only as to the scope of the work. Tenderers are therefore advised to visit the site before submitting a tender and to acquaint themselves with the nature and extent of the work to be done and the value of recoverable materials which are not to be re-used or handed over to the Employer. Unless otherwise stated, loose furniture, kitchen and other equipment, apparatus, machinery, etc shall remain the property of the Employer and the removal thereof does not fall within the scope of this Contract

The Contractor shall completely demolish the buildings etc in a careful, skilful, practical and safe manner down to 150mm below ground level

Demolitions shall include breaking up and removing:

all floors and surface beds;

all external screen walls, steps, ramps, aprons, surface water channels, rainwater sumps, gulleys, etc attached to the building to be demolished;

all services, manholes, etc in ground to a point not less than 1m beyond the perimeter of the building including plugging off ends of all remaining pipes, drains, etc, filling in holes where necessary and ramming and levelling to ground level

Where only a portion of a building is to be demolished, it shall be done without damage to the remaining portion of the building. Any such damage shall be made good by the Contractor at his own expense

C.1.2 Notices etc

The Contractor shall, before commencing work, obtain all necessary authorisation for carrying out the work, by whatever means including the use of pneumatic equipment or blasting, give all necessary notices and pay all charges and fees in connection therewith. He shall also comply with all regulations pertaining to rodent extermination and he shall obtain the requisite Rodent Extermination Clearance Certificate and pay all necessary fees. All receipts and certificates shall be left in the safekeeping of the Principal Agent. All the abovementioned charges and fees shall be paid by the Contractor and included in his prices

The Contractor shall give ample notice to the Principal Agent and Local Authorities regarding any disconnections necessary prior to the removal or interruption of electrical or telephone cables, water and sanitary services etc

C.1.3 Loss

After the handing over of the site to the Contractor, the full risk of any loss or damage to buildings to be demolished shall be the responsibility of the Contractor and he shall take such precautions as he deems necessary against such loss or damage

C.1.4 Materials from the demolitions, credit, etc

Materials recovered from the demolitions will become the property of the Contractor, who may allow credit in respect thereof where provided for in the bills of quantities. Such materials shall not be re-used in any new work without written permission from the Principal Agent

C.1.5 Disposal of debris etc

The Contractor shall be responsible for the removal from the site of all materials, rubble, debris and rubbish resulting from the demolitions

C.2 SOIL INSECTICIDES

The application of soil insecticides shall be carried out in accordance with "The application of soil insecticides for the protection of buildings" - SANS 10124

C.3 FILLING ETC

C.3.1 Filling generally

Filling over site shall be spread, levelled, watered and consolidated in layers not exceeding 300mm

Filling under floors and backfilling to excavations shall be suitable inert material, free from clay, vegetable matter, large stones, etc, having a maximum plasticity index of 10, spread, levelled and compacted to a density of at least 90% Mod. AASHTO

C.3.2 Hardcore

Hardcore shall be broken stone or other approved hard material graded from 25mm to 75mm with the finer material on top and shall be spread, levelled and consolidated

C.4 EXCAVATIONS

C.4.1 Classification of excavated material

"Hard rock" shall mean granite, quartzitic sandstone or other rock of similar hardness, the removal of which requires drilling, wedging and splitting or the use of explosives

"Soft rock" shall mean hard material the removal of which warrants the use of pneumatic tools and includes hard shale, ferricite, compact outcrop and material of similar hardness

"Earth" shall mean all ground other than that classified as "hard rock" or "soft rock" and shall include made-up ground and any loose stones or pieces of concrete not exceeding 0,03m³ in volume

D. CONCRETE, FORMWORK AND REINFORCEMENT

D.1 SPECIFICATION FOR CONCRETE WORK GENERALLY

All in situ concrete work (plain and reinforced) shall comply with SANS 1200G supplemented by the following Project Specification. Where SANS 1200G and the Project Specification are in conflict, the Project Specification shall take precedence

Wherever the term "Engineer" appears in SANS 1200G or in the following Project Specification this shall be deemed to mean the Principal Agent's representative responsible for this section of the Works

PROJECT SPECIFICATION

The following amplifications, additions and amendments to SANS 1200G shall constitute the Project Specification. Clause numbers refer to either the existing clauses in SANS 1200G or to new clauses, which are related to the existing clauses

1. SCOPE

This clause is amended to include:

- 1.1 This specification does not cover the methods by which the finished structure is to be measured for the purpose of payment and the "Standard System of Measuring Building Work" shall apply

2. INTERPRETATIONS

2.1 SUPPORTING SPECIFICATIONS

Clause 2.1(b) shall not apply

2.2 APPLICATION

This clause shall not apply

4. PLANT

4.5 FORMWORK

4.5.2 Finish

Unless otherwise stated the quality of all formwork shall be such that the finished surface of the concrete is "Rough" in terms of clause 5.2.1(a)

5. CONSTRUCTION

5.2 FORMWORK

5.2.1 Classification of Finishes

- (a) **Rough.** No treatment of the surface of the concrete will be required after the striking of the formwork. The finish of the concrete need not be more accurate than Degree of Accuracy III
- (b) **Smooth.** Imperfections such as small fins, bulges, irregularities, surface honeycombing and surface discolorations shall be made good and repaired by approved methods. The finish of the concrete shall be accurate to Degree of Accuracy II
- (c) **Special**
- (i) **Smooth and fair**

This class of finish requires the highest standard of concrete work, formwork, accuracy and technique

Concrete placed in any one structure to give this finish shall be made from cement and aggregates from the same source. The grading of the aggregate shall be kept constant

Formwork shall be metal, wrot timber or other approved material in new condition designed and constructed to suit the particular job in hand and with shutter bolts and joints between panels in a regular pattern approved by the Principal Agent. Joints between panels shall be watertight, but the use of sealing tape which will mark the concrete shall not be permitted

Designated joints shall be in the position and of the details shown upon the working drawings. Should the Contractor wish to incorporate further construction joints or amend the position of those shown to suit his own requirements or technique, this may be allowed provided that all design considerations are met, that the prior approval of the Engineer is obtained and that any extra costs are borne by the Contractor

In the case of horizontal construction joints, the top edge of the concrete on the smooth and fair finished side shall be struck true and level with a trowel

Special care shall be taken to ensure that forms are clean and free of all pieces of tying wire, nails and other debris at the time of concreting

The standard of finish shall be such that upon removal of the formwork, no further treatment, other than treatment of bolt holes if required, shall be found necessary to provide a straight, smooth and uniform finish of good quality and consistent colour and texture, free of all honeycombing etc. Any defect shall be made good by either removing and replacing the defective concrete or, in certain instances only, by patching

5.5 CONCRETE

5.5.1.6 Prescribed mix concrete

Where prescribed mix concrete is specified the proportions of constituents, the maximum size of coarse aggregate and the estimated minimum compressive strength shall be as specified in the following table:

Class of Concrete	Estimated minimum compressive strength in MPa at 28 days	Maximum nominal size of coarse aggregate in mm	Proportions of Constituents		
			Cement (Parts)	Fine aggregate (Parts)	Coarse aggregate (Parts)
A	7	37,5	1	4	8
B	15	19	1	3	5
C	20	19	1	2,5	3,5

Cement shall comply with SANS 50917-1 of strength 32,5N or higher

Should cement and aggregates be mixed by volume, the contents of a 50kg sack of cement shall be taken to be 0,033m³

Notwithstanding the requirements contained in SANS 1200G, the Principal Agent may permit certain items of non-structural concrete to be mixed by hand

If the concrete is mixed by hand, it shall first be mixed in a dry state on a clean non-absorbent surface until it is of uniform colour and consistency. Just enough water shall then be added to permit mixing and working, at which stage the concrete shall continue to be mixed until it is of uniform colour and consistency

5.5.1.7 Strength concrete

Where strength concrete is specified it shall be designated by its specified strength followed by the size of stone used in its manufacture, eg 30 MPa/19mm

The water/cement ratio shall be as Table 5 of clause 5.5.1.5 for moderate exposure conditions

5.5.1.8 "No-Fines" concrete

"No-fines" concrete shall consist of one part cement to eight parts aggregate graded from minimum 6mm to maximum 13mm size

The quantity of water used shall be just sufficient to form a smooth grout which shall completely coat every particle of aggregate and also to ensure that the grout is just wet enough to form a small fillet at each point of contact between the stones. "No-fines" concrete mixed with excessive water, which results in a thin grout, which drops off the aggregate, will be rejected

"No-fines" concrete shall be placed in its final position within 20 minutes of mixing and shall be placed in continuous horizontal layers. Concrete shall be spade worked sufficiently to ensure that it fills the forms but vibrating, tamping or ramming will not be permitted

5.5.3.2 **Ready-mixed concrete**

The use of ready-mixed concrete and the acceptability of test results from a central concrete production facility shall be subject to the written approval of the Engineer

6. **TOLERANCES**

Degree of Accuracy II shall apply for all work unless otherwise stated

7. **TESTS**

7.1 **FACILITIES AND FREQUENCY OF SAMPLING**

7.1.2 **Frequency of sampling**

7.1.2.5 The frequency of sampling shall be as directed by the Engineer, but not less than one set of cubes from every 50m³ cast

8. **MEASUREMENT AND PAYMENT**

This clause shall not apply

D.2 **AGGREGATES OF LOW DENSITY**

Aggregates of low density shall comply with SANS 794

D.3 **HOLLOW BLOCKS, PREFABRICATED BLOCK BEAMS AND PLANKS, ETC**

Blocks, block beams, planks, etc shall be fixed and supported in such a manner that no movement can take place before or during the casting of concrete. No broken components shall be used

D.4 **SUPERVISION**

A competent and experienced foreman shall superintend personally the whole of the concrete construction and pay special attention to:

- (a) The quality, testing and mixing of materials,
- (b) The placing and compaction of concrete,
- (c) The construction and removal of formwork and
- (d) The sizes and position of reinforcement

The Contractor shall obtain the permission of the Principal Agent before commencing concreting of foundations or reinforced structure

No inspection, approval, authorisation to proceed, comment or instructions following from such an inspection, or failure of the Principal Agent to comment on any particular aspect of the work, shall be deemed to relieve the Contractor in any way from his obligation to ensure through his own supervision that the work is constructed in every way in accordance with the Drawings, Specification and Conditions of Contract, nor relieve him from his obligations to make good any fault or defect, nor shall it be deemed that there is any obligation on the Principal Agent to inspect all or any part of the Works or that such inspection is necessarily complete in every respect

D.5 **GENERAL**

Concrete

Rates for concrete work shall include all "construction joints" other than "designated joints" as defined in SANS 1200G clause 2.4.3 which are measured separately, and for the design of strength concrete mixes and all testing of concrete and materials other than compressive strength testing of concrete samples taken from concrete being placed in the Works. The Contractor shall only be entitled to payment for those samples and compressive strength tests called for by the Engineer and which pass the test requirements

Surface beds cast in panels shall be cast in panels approximately 9m²

Formwork

Formwork to slabs and beams shall be cambered where required

Rates for formwork to soffits shall include propping not exceeding 3,5m high unless otherwise described.

Formwork to walls and columns is not exceeding 3,5m high above bearing level unless otherwise described

Reinforcement

Standard welded steel fabric reinforcement shall be as included in Table 1 of SANS 1024 and shall have 300mm wide laps.

The mass of binding wire is not included in the mass of the reinforcement and the cost thereof shall be included in the rates for the reinforcement

E. PRECAST CONCRETE

E.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Precast concrete paving slabs SANS 541

Cement, water, aggregates and reinforcement shall be as described under D. CONCRETE, FORMWORK AND REINFORCEMENT

E.2 CONCRETE

Concrete shall be as described under D. CONCRETE, FORMWORK AND REINFORCEMENT and unless otherwise stated shall be prescribed mix concrete Class C but with coarse aggregate of an appropriate size

E.3 MOULDS

Before each casting, moulds shall be coated with a suitable release agent which will not in any way discolour the surface of the finished product or impair its strength. Where items are described as "finished smooth from the mould" or as "precast terrazzo", moulds shall be made to a high degree of accuracy and shall be such as to leave even and smooth surfaces

E.4 FINISHES TO BLOCKS

Where described as "precast terrazzo", such surfaces shall have a facing of terrazzo described under O. PLASTERING. The facing shall be poured into the moulds in a wet state (not dry pressed) and thoroughly worked up against finished faces to ensure that it finishes smooth from the mould

Projections shall be rubbed off and faces shall be of even colour and free from blemishes, cracks and other imperfections. Salient angles shall be arris rounded

E.5 CASTING ETC

Items shall be suitably cured, shall not be handled whilst still green and shall not be built in within 21 days of casting

E.6 REINFORCEMENT

Unspecified reinforcement required for manufacturing, handling and erection purposes and for reinforcing projecting and other unwieldy portions of blocks shall be provided by the Contractor at his discretion

E.7 BEDDING, JOINTING AND POINTING

Blocks shall be bedded and jointed solidly in Class I mortar as described under F. MASONRY and shall be pointed with slightly keyed joints

Blocks finished with "precast terrazzo" shall have joints raked out and pointed with slightly keyed joints in tinted waterproofed mortar composed of one part cement and three parts sand to match terrazzo facing

E.8 GENERAL

Precast concrete work shall include reinforcement required for manufacturing, handling and erection purposes, steel rod or wire hooks and/or mortices for lewis bolts required for handling and transporting, any necessary temporary propping and strutting and bedding, jointing and pointing

F. MASONRY

F.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Burnt clay masonry units	SANS 227
Limes for use in building	SANS 523 {Slaked (hydrated) limes}
Aggregates from natural sources – fine aggregates for plaster and mortar	SANS 1090
Concrete masonry units	SANS 1215
Prestressed concrete lintels	SANS 1504
Burnt clay paving units	SANS 1575
Metal ties for cavity walls	SANS 28
Common cement	SANS 50197-1 (Class 32,5N)
Masonry cement	SANS 50413-1 (Class 22,5X)
Concrete masonry construction	SANS 10145
The structural use of masonry	SANS 10164-1
Masonry walling	SANS 10249
Concrete floors	SANS 10109-1&2

F.2 SAND

Sand shall be washed where necessary and screened through a 2,4mm mesh sieve

F.3 BURNT CLAY BRICKS

Burnt clay bricks shall be of nominal size 222 x 106 x 73mm unless otherwise stated

Common bricks shall be General Purpose bricks

Extra hard burnt bricks shall be General Purpose (Special) bricks

Facing bricks shall exhibit a liability to efflorescence not in excess of "Slight" and water absorption when tested in conformity with the requirements of SANS 227 shall not exceed 14%

Particular care shall be taken to preserve arrisses and faces of facing and paving bricks during transit and handling

F.4 CONCRETE BRICKS

Concrete bricks shall have a nominal compressive strength of 8 MPa

F.5 QUARRY TILES ETC

Quarry, cement and similar tiles shall be of approved manufacture, even in shape and size, free from cracks, twists or blemishes and uniform in colour

F.6 WIRE TIES

Wire ties shall be of galvanized steel of the single wire type for solid walls and either the "Butterfly" or Modified PWD type for hollow walls. Ties shall be of sufficient length to allow not less than 75mm of each end to be built into brickwork or embedded in concrete

F.7 BRICKWORK REINFORCEMENT

Brickwork reinforcement shall be manufactured from hard drawn steel wire conforming to BS 785 and shall consist of two 2,8mm diameter main wires with 2,5mm diameter cross wires at 300mm centres welded at intersections

Brickwork reinforcement shall be lapped not less than 300mm at end joints and for a length equal to the width of the widest reinforcement at intersections

F.8 MORTAR

Mortar shall comply with the following table:

1	2	3	4
Mortar Class	Minimum compressive strength MPa	Cement:sand (common cement)	Cement:sand (masonry cement)
I	10	1:4 or 50kg to 130 litres	1:3 or 50kg to 100 litres
II	5	1:6 or 50kg to 200 litres	1:5 or 50kg to 170 litres
III	1,5	1:9 or 50kg to 300 litres	1:6 or 50kg to 200 litres

Mortar shall be Class II unless otherwise specified

Mortar plasticizers may only be used with the approval of the Principal Agent

The materials shall be mixed dry until of uniform colour, water added and the mixture turned over until the ingredients are thoroughly incorporated

Mortar shall be produced in such quantities as can be used before commencement of set and no mortar that has set shall be used

F.9 COMPO MORTAR

Compo mortar shall be Class III mortar in accordance with clause F.8 but with a lime content of 80 litres

The lime and sand shall be mixed dry until of uniform colour, water added and the mixture turned over until the ingredients are thoroughly incorporated. Immediately before use, the cement shall be mixed in and the requisite amount of water added. Compo mortar shall be produced in such quantities as can be used before commencement of set and no compo mortar that has set shall be used

F.10 BRICKWORK

Wherever practicable, brickwork shall be built in stretcher bond. Unless legitimately required to form bond, no false headers shall be used. English bond shall only be used where specifically so indicated or where stretcher bond is not practicable

Brickwork, unless otherwise described, shall be built in Class II mortar

Bricks shall be laid on a solid bed of mortar and all joints shall be grouted up solid

The brickwork shall be carried up in a uniform manner, no part being raised more than 1,2m above adjoining work

Where necessary, bricks shall be wetted before being laid and the course of bricks last laid shall be well wetted before laying a fresh course upon it

Walls in thicknesses of more than one skin shall have at least five wire ties per square metre. Linings to concrete, unless otherwise specified, shall be tied to the concrete with at least five wire ties per square metre

Hollow walls, unless otherwise specified, shall be built of two half brick skins with cavity between, tied together with at least five wire ties per square metre. The cavities shall be kept free of all rubbish, mortar droppings and projecting mortar. Mortar joints to brickwork shall be not less than 8mm or more than 12mm thick

F.11 BLOCKWORK

Unless otherwise described, all blockwork shall be built in stretcher bond. Whole blocks shall be used except where bats or closers are required to form bond. Blockwork, unless otherwise described, shall be built in Class II mortar

Solid blocks shall be laid on a solid bed of mortar and all joints shall be grouted up solid

Hollow blocks shall be laid in shell bedding, ie only the inner and outer shells of the blocks shall be covered with mortar. Vertical joints shall be similarly formed

The blockwork shall be carried up in a uniform manner, no part being raised more than 1,2m above adjoining work

Clay blocks shall be wetted before being laid and the course of blocks last laid shall be well wetted before laying a fresh course upon it

F.12 CENTRES AND TURNING PIECES

Centres and turning pieces to soffits of arches and lintels shall be left in position for not less than 14 days

F.13 FACE BRICKWORK

Face brickwork shall be built in stretcher bond, unless otherwise specified, to a true and fair face. Perpendents shall be vertically aligned

Facing bricks shall be mixed to ensure that the proper blending of bricks within the colour range of each facing brick being used is obtained

F.14 PAVINGS, SILLS, COPINGS, ETC

Clay bricks and tiles shall be wetted before fixing and shall be solidly bedded and jointed in Class I mortar and pointed with slightly keyed joints

G. WATERPROOFING

G.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Bituminous damp-proof courses	SANS 248 (Type FV)
Polyolefin film for damp- and waterproofing in buildings (walls, sills, etc)	SANS 952 (Type B)
Polyolefin film for damp- and waterproofing in buildings (floors and basements)	SANS 952 (Type C)
Mastic asphalt for roofing	SANS 297
Mastic asphalt for damp-proof courses and tanking	SANS 298
Bituminous roofing felt	SANS 92 (Type 60)
Polyolefin film for damp- and waterproofing in buildings (flat roofs)	SANS 952 (Type A)
Chloroprene rubber sheet (for waterproofing)	SANS 580
Sealing compounds for the building industry, two-component, polysulphide base	SANS 110 (Type 2 - Gun Grade)
Sealing compounds for the building and construction industry, two- component, polyurethane base	SANS 1077
The waterproofing of buildings (including damp-proofing and vapour barrier installation)	SANS 10021

G.2 WATERPROOFING TO ROOFS, BASEMENTS, ETC

Waterproofing to roofs, basements, etc shall be carried out by workmen who are experienced in this type of work

G.3 DAMP-PROOF COURSE TO WALLS

All joints in damp-proof course to walls shall be lapped a minimum of 150mm except at junctions and corners where the lap shall equal the full thickness of the wall

H. ROOF COVERINGS ETC

H.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Concrete roofing tiles	SANS 542
Clay roofing tiles	SANS 632
Sawn softwood timber battens	SANS 1783-4
Fibre-cement sheets (flat and profiled)	SANS 685
Aluminium alloy corrugated and troughed sheets	SANS 903
Continuous hot-dip zinc-coated carbon steel sheet of commercial, lock-forming and drawing qualities	SANS 3575
Continuous hot-dip zinc-coated carbon steel sheet of structural quality	SANS 4998
Polyolefin film for damp- and waterproofing in buildings	SANS 952
Metal roofing tiles	SANS 1022
Glass-reinforced polyester (GRP) laminated sheets (profiled or flat)	SANS 1150
Fasteners for roof and wall coverings in the form of sheeting	SANS 1273
Materials for thermal insulation of buildings	SANS 1381-1&4
Expanded polystyrene thermal insulation boards	SANS 1508
Fixing of concrete interlocking roofing tiles	SANS 10062
Roof and side cladding	SANS 10237
Sheet zinc	BS 849
Sheet lead	BS 1178
Sheet aluminium	BS 1470
Sheet copper	BS 2870

H.2 GALVANIZED STEEL PROFILED SHEETS ETC

Galvanized steel profiled sheets, ridge and hip coverings, etc shall be coated with a minimum of 275 g zinc per m² and shall be free of white rust

H.3 GALVANIZED SHEET IRON

Galvanized sheet iron shall be rolled steel sheet coated on both sides with a minimum of 275 g of zinc per m² and shall be free from white rust

H.4 NAILING AND SCREWING

Where nailing and screwing is required:

- galvanized iron nails and screws shall be used for galvanized sheet iron and sheet zinc
- copper or copper alloy nails and screws for sheet copper and sheet lead
- aluminium alloy or stainless steel nails and screws for sheet aluminium

H.5 LAPS

Sheet metal flashings shall have minimum 100mm laps and linings to valleys, secret gutters, etc minimum 225mm laps

H.6 GENERAL

Rates for profiled sheet roofing and rolled edges, ridge and hip coverings, flashing pieces, etc of metal, fibre-cement, plastic, etc shall include fixing accessories

I. CARPENTRY AND JOINERY

I.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Sawn softwood timber : General requirements	SANS 1783-1
Sawn softwood timber : Stress-graded structural timber and timber for frame wall construction	SANS 1783-2
Sawn softwood timber : Branderling and battens	SANS 1783-4
Softwood flooring boards	SANS 629
Hardwood furniture timber	SANS 1099
Hardwood block and strip flooring	SANS 281
Wooden ceiling and panelling boards	SANS 1039
Laminated timber (glulam)	SANS 1460
Gypsum plasterboard	SANS 266
Fibreboard products	SANS 540
Wood-wool panels (cement bonded)	SANS 637
Fibre-cement sheets (flat and profiled)	SANS 685
Fibre-cement boards	SANS 803
Plywood and composite board	SANS 929
Wooden ceiling and panelling boards	SANS 1039
Particle boards	SANS 50312-1to7
Decorative laminates	SANS 4586
Wooden doors	SANS 545
Fire doors	SANS 1253
Materials for thermal insulation of buildings	SANS 1381-1,2,4&6
Expanded polystyrene thermal insulation boards	SANS 1508
Mild steel nails	SANS 820
Metal screws for wood	SANS 1171
Wood-preserving creosote	SANS 539

Softwood shall bear the relevant SABS mark and shall be ordered in the sizes in which it will be used as no scantlings of marked timber will be allowed. Should SABS marked timber be unavailable, the Principal Agent's prior permission shall be obtained before using unmarked timber

I.2 HARDWOODS

All hardwoods shall be specially selected, well seasoned, free from sapwood and well kiln dried. Meranti shall be Red or Medium Brown Meranti, even in grain and colour, selected from "Standard and Better" quality from Malaysia

I.3 INFECTION AND PRE-TREATMENT OF TIMBER

All timber used on the site, whether for permanent or temporary work, shall be free of borer or other beetle and termite infection. If the work under this contract falls within an area designated under Government Notice R2577 of 1978/12-29, permanent softwood fixed in the building shall be treated against borer etc in accordance with Government Notice R451 of 1969-03-28 using Class B or C preservative

When treated timbers are cut, the cut surfaces shall be effectively brushed with at least two coats of preservative solution

I.4 CONSTRUCTION IN GENERAL

Where applicable, construction methods shall comply with SANS 10082. Wood and laminate flooring shall be installed in accordance with SANS 10043. Roof trusses shall be manufactured, erected and braced in accordance with SANS 10243

I.5 STRUCTURAL TIMBER

Timbers generally shall be in single lengths and jointing of timbers will only be permitted when the required length is unobtainable. Only the absolute minimum of joints to obtain a particular length will be permitted and such joints are to be evenly spaced along the length of the timber

Finger-jointing of structural timber will be permitted, in which case it shall be manufactured in accordance with SANS 10096

I.6 PLATE NAILED TIMBER ROOF TRUSSES

Plate nailed timber roof trusses shall be of approved design and manufacture and constructed with softwood structural timber by a truss Fabricator holding a current Certificate of Competence awarded by the Institute of Timber Construction

Each roof truss shall have all its members accurately cut and closely butted together and rigidly fixed by CSIR approved patented galvanized metal spiked connectors, precision pressed on both sides of each intersection by an approved method, all in accordance with the manufacturer's instructions

The design, manufacture and transportation of the roof trusses, bracing, etc shall be under the control of a registered Structural Engineer in accordance with SANS 1900, SANS 10160 and SANS 10163, who shall, after erection, provide a certificate confirming that the design, manufacture, transportation, erection and bracing has been carried out in accordance with this specification

The design shall include for all live loads, wind loads and for dead loads imposed by roof covering, purlins, ceilings, etc

Fully detailed shop drawings of all trusses etc, indicating sizes, bracing, loading, etc, shall be submitted to the Principal Agent for approval prior to fabrication

Unless specific erection instructions are given, erection shall be carried out in accordance with the procedures and recommendations of the manual "The Erection and Bracing of Timber Roof Trusses" published by the Institute for Timber Construction and the Council for Scientific and Industrial Research or as detailed by the designer

Roof trusses and bracing shall include design and preparation of shop drawings

I.7 TONGUED AND GROOVED BOARDING

Tongued and grooved boards for floors, panelling, etc shall be in long varying lengths with joints tightly cramped up and secret nailed. Flooring boarding shall be flush jointed with staggered heading joints and machine sanded after fixing

I.8 JOINERY

Skirtings, cornices, rails, etc shall be in single lengths wherever practicable and shall have splayed heading joints where necessary. Skirtings shall be trenched at back

All horns of door frames shall be checked and splayed back where frames are fixed projecting or flush with surface and built in

Heads of screws in exposed faces of hardwood joinery shall be sunk and match pelleted

Joinery shall have arris rounded angles and shall be blocked and planted on

I.9 VENEERS

All face veneers shall be of kiln dried timber, free from knots, cracks, patchwork, sapwood and other defects, selected and glued, dried and machine-sanded to a smooth finish. All veneers shall be applied under hydraulic pressure

I.10 DOORS

Flush doors shall have solid timber edge strips with concealed edges. Where doors are to be finished with a transparent finish, the veneer and the edge strips shall be timber of the same species and as far as possible of matching colour. Unless otherwise described all flush doors shall be of interior quality, but where exterior quality doors are specified the glue used shall be of the WBP type

Framed and ledged batten doors described as filled in with V-jointed boarding shall be filled in flush on one side with tongued and grooved vertical boarding, V-jointed on one or both sides and of the thickness stated. The boarding shall be in narrow widths, closely cramped up, rebated or tongued on outer edges and housed to grooves in stiles and rails and twice countersunk brass screwed at each intersection with ledges and braces and the inner edges of the abutting stiles and rails shall be chamfered to form a V-joint at junction with the board

Unless otherwise described double doors shall have rebated meeting stiles

I.11 FIXING

All nails and screws shall be of the size, length and type appropriate to their respective uses. All screws for hardwood joinery work shall be brass

Items described as "plugged" shall be screwed to fibre, plastic or metal plugs at not exceeding 600mm centres. Where items are described as "bolted", the bolts have been given separately

I.12 ADHESIVES

Adhesives shall comply with BS 1204 and 4071 where applicable. Adhesives used in the manufacture of external joinery exposed to excessive moisture (eg kitchen and laboratory worktops) shall be of the WBP type

J. CEILINGS, PARTITIONS AND ACCESS FLOORING

J.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Gypsum plasterboard	SANS 266
Fibreboard products	SANS 540
Gypsum cove cornice	SANS 622
Wood-wool panels (cement-bonded)	SANS 637
Sawn softwood timber : Brandering and battens	SANS 1783-4
Sawn softwood timber : Timber for frame wall Construction	SANS 1783-2
Fibre-cement boards	SANS 803
Plywood and composite board	SANS 929
Wooden ceiling and panelling boards	SANS 1039
Materials for thermal insulation of buildings	SANS 1381-1&4
Expanded polystyrene thermal insulation boards	SANS 1508
Raised access flooring	SANS 1549

J.2 TONGUED AND GROOVED BOARDING

Tongued and grooved boarding for ceilings shall be in long varying lengths, V-jointed one side and with joints tightly cramped up and secret nailed

J.3 CEILINGS ETC

J.3.1 Brandering

Brandering for ceilings and eaves soffit coverings shall be symmetrically arranged with necessary smaller panels. Main branders shall be at right angles to roof timbers, with cross branders cut in between and branders shall be fixed with galvanized wire nails driven in on skew alternately in opposite directions

J.3.2 Ceiling boards

Ceiling boards shall be in long lengths symmetrically arranged with necessary smaller panels, closely butted and secured at 150mm centres to brandering with galvanized or cadmium-plated clout-headed nails

J.4 GYPSUM SKIM PLASTER

Gypsum skim plaster shall be pure gypsum plaster finished with a steel trowel

J.5 EXPOSED TEE-SYSTEM SUSPENDED CEILINGS

The ceiling panels shall be as described in the items and the panels shall be stiffened at back as recommended by the manufacturer to prevent bowing or sagging

The exposed surfaces of all ceiling panels and supporting members shall be uniform in colour and free from surface blemishes

The suspension grid system shall be an approved patent suspension system comprising 38mm galvanized steel main and cross tee bearers spaced in both directions at centres to suit sizes of ceiling panels used, with the cross bearers fitted between and notched to form flush fit with main bearers. The exposed flange of the tees shall be 25mm wide, covered with a rolled aluminium cap painted a low sheen satin white. Cornices etc shall be as described in the items and shall be finished to match the exposed tees

The main tee bearers shall have holes for cross tees at 300mm centres and holes for hangers at 50mm centres. In addition, main and cross tee bearers shall be holed as necessary for and provided with timber wedges or steel clips where recommended by the manufacturer to prevent ceiling panels from lifting

The web of the exposed cross tee bearers shall extend to form a positive interlock with the main tee bearers and the lower flange shall be cut back to provide a joint free appearance

All hangers shall be galvanized and shall be at centres to meet the requirements of the specification with one end fixed to the suspension grid main bearers and the other end fitted with suitable galvanized fixing cleat securely fixed to the structure. Fixing points shall be agreed to by the Principal Agent before any power shot fixings are made. Hangers shall not be suspended from air-conditioning ducts. Where recommended by the manufacturer, hangers shall be of the rigid type

Component parts and fixings shall be non-corrosive and able to withstand atmospheric pollution. Surfaces of aluminium which are in contact with other materials when fixed, particularly metals, shall be suitably insulated to prevent electrolytic corrosion

Ceilings shall comprise hangers, suspension grid system and ceiling panels, shall be constructed in a manner suitable for carrying air-conditioning diffusers and light fittings in the positions required, shall be set out to layouts approved by the Principal Agent and shall have the standard suspension systems modified as necessary to work around any pipes or light fittings

J.6 FLUSH PLASTERED SUSPENDED CEILINGS

Gypsum plasterboard panels of the specified thickness generally in 1200mm widths and in long lengths shall be fixed grey side down with self-tapping screws to the suspension system with the joints between boards loosely butt jointed and covered with 50mm wide strips of self-adhesive fibre tape

The plasterboard panels shall be finished with gypsum skim plaster trowelled to a smooth polished surface to the thickness etc recommended by the manufacturer

The suspension system shall be an approved patent concealed suspension system consisting of galvanized mild steel bearers suspended on approved non-rusting metal hangers spaced generally at 1200mm centres or to suit layout of air-conditioning ducts and other services etc above ceiling with one end bolted to the bearer and the other end fitted with a galvanized fixing cleat securely fixed to the structure as required

Fixing points shall be agreed to by the Principal Agent before any power shot fixings are made. Hangers shall not be suspended from air-conditioning ducting

Ceilings shall comprise hangers, suspension system, ceiling panels and plaster finish, shall be constructed in a manner suitable for carrying air-conditioning diffusers and light fittings in the positions required, shall be set out to layouts approved by the Principal Agent and shall have the standard suspension system modified as necessary to work around any pipes or light fittings

K. FLOOR COVERINGS, WALL LININGS, ETC

K.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Semi-flexible vinyl floor tiles	SANS 581
Resin modified vinyl floor tiles	SANS 586
Flexible vinyl flooring	SANS 786
Hardwood block and strip flooring	SANS 281
Wood mosaic flooring	SANS 978
Textile floor coverings (pile construction)	SANS 1375
Textile floor coverings (needle-punched construction)	SANS 141
Carpet underlays	SANS 1419
The installation of wood and laminate flooring	SANS 10043
The installation of resilient thermoplastic and similar flexible floor covering materials	SANS 10070
The installation of textile floor coverings	SANS 10186
Sheet linoleum (calendered types), cork, carpet and linoleum tiles	BS 810
Solid rubber flooring	BS 1711
Felt backed linoleum	BS 1863

K.2 LAYING OF MATERIAL

Floor tiles shall be laid with continuous joints in both directions

Patterned floor coverings shall be matched at joints

K.3 GENERAL

Floor coverings, wall linings, skirtings, nosings, etc shall include all preparatory work to screeded or plastered surfaces etc, priming coats and adhesives

Floor coverings and wall linings shall be dressed around and into corners. Wood block and wood mosaic flooring shall be sanded with a sanding machine and sealed with a coat of approved penetrating sealer

Plastic handrails shall have welded and polished butt joints

L. IRONMONGERY

L.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Locks, latches and associated furniture for doors. (Domestic type)	SANS 4
Kitchen cupboards: Built-in and free-standing	SANS 1385
Single action closers	SANS 1510
Padlocks	SANS 1533
Fasteners	SANS 1700
Chalk writing boards for schools	CKS 36

L.2 KEYS

Locks shall have the minimum possible number of interchangeable keys. Cylinder locks and locks described as “en suite” shall be clearly marked with consecutive numbers and each key shall be punched with the corresponding number of the relative lock

L.3 FIXING

Unless otherwise described, ironmongery is to be fixed to wood

Items described as “plugged” shall be screwed to fibre, plastic or metal plugs

Screws, bolts, etc for fixing of ironmongery shall be of matching metal and finish, except for aluminium ironmongery or ironmongery fixed to aluminium in which cases stainless steel screws may be used

All necessary preparation of pressed steel door frames for the fixing of ironmongery to the frames has been included with the pressed steel door frames

L.4 KITCHEN CUPBOARDS

Steel cupboards shall be finished with baked enamel. Tops of floor cupboards shall have laminated plastic covering

Cupboards shall be fitted with all necessary hinges, handles, catches, etc. Cupboards shall be securely fixed with all necessary screws and fibre, plastic or metal plugs

Where cupboards are described as a “series”, tops shall be continuous and cupboards shall be bolted or screwed together, including bolts, screws, holes, etc

M. STRUCTURAL STEELWORK

M.1 SPECIFICATION

All structural steelwork shall comply with SANS 1200H or 1200HA as applicable. Structural fasteners shall comply with SANS 1700

Whenever the term "Engineer" appears in SANS 1200H or 1200HA or in the following Project Specification this shall be deemed to mean the Principal Agent's representative responsible for this section of the Works

M.2 PROJECT SPECIFICATION INCORPORATING AMPLIFICATIONS, ADDITIONS AND AMENDMENTS TO SANS 1200H AND 1200HA

The following amplifications, additions and amendments to SANS 1200H and SANS 1200HA shall apply and clause numbers refer to either the existing clauses in the relevant SANS or to new clauses which are related to the clauses therein

SANS 1200H

3.1.1 Weldable structural steel

Weldable structural steel shall comply with SANS 1431

5.1.2 Contractor provides shop details

The Contractor shall be responsible for the preparation of all shop detail drawings

5.1.3 Engineer provides shop details

This clause shall not apply

5.3.9 Protective treatment

Structural steelwork shall be cleaned and prepared by wire brushing in accordance with SANS 10064 and all surfaces shall be primed as specified to a minimum dry film thickness of 30 micrometres before leaving the workshop. Upon delivery to the site and again after erection all bared surfaces shall be made good with similar primer

8. Measurement and payment

This clause shall not apply

SANS 1200HA

5.2.10 Protective treatment

Structural steelwork shall be cleaned and prepared by wire brushing in accordance with SANS 10064 and all surfaces shall be primed as specified to a minimum dry film thickness of 30 micrometres before leaving the workshop. Upon delivery to the site and again after erection all bared surfaces shall be made good with similar primer

5.3.7 Repairs to paint and site painting

This clause shall not apply

8. Measurement and payment

This clause shall not apply

N. METALWORK

N.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Fasteners	SANS 1700
Expanded metal	SANS 190-1&2
Windows and doors made of rolled mild steel sections	SANS 727
Hot-dip galvanized zinc coatings on fabricated iron and steel articles	SANS 121
Strongroom and vault doors	SANS 949
Anodized coatings on aluminium (for architectural applications)	SANS 999
Steel door frames	SANS 1129
Mushroom- and countersunk-head bolts and nuts	SANS 1143
Welding of metalwork	SANS 1044
Adjustable glass-louvred windows	CKS 413
Aluminium sheet and strips	BS 1470
Aluminium extruded tube and hollow sections	BS 1474
Aluminium bars and sections	BS 1476

N.2 STEEL

Steel shall be mild steel of approved commercial quality. Steelwork shall be cleaned and prepared by wire brushing in accordance with SANS 10064 and given one coat of primer as specified before leaving the workshop

N.2.1 Galvanizing of steel

Steelwork described as "galvanized" shall be galvanized by means of the hot-dip process after fabrication. Where welding on site is unavoidable, such welded joints shall be cleaned down and cold galvanized to approval

N.3 STAINLESS STEEL

Stainless steel shall be AISI Type 304 stainless steel and shall be buffed to an even satin finish. Stainless steel screws shall be used for fixing stainless steel

N.4 ALUMINIUM

Aluminium extrusions shall be of 6063-T6 alloy and temper. Aluminium sheet and strips shall be of 1200-H4 alloy and temper.

Joints in all aluminium members shall be formed in an approved manner so that the joints are practically invisible. Screw heads, pins, rivets, etc shall be concealed as far as possible. 300 Series stainless steel screws and bolts shall be used for jointing and fixing aluminium work

The surfaces of all aluminium which are in contact with other materials when fixed shall be suitably insulated with a non-absorbent insulating material to prevent corrosion. All aluminium work shall be suitably protected against damage, deterioration or discolouration caused by mortar droppings, paint, etc by taping with removable tape, covering with temporary casings or by covering with motor oil

N.4.1 Anodizing of aluminium

Aluminium described as "anodized" shall be treated with Grade 25 coating thickness for exterior use or Grade 15 for interior use as specified, to the required finish. All alloys to be anodized shall be suited to anodizing

N.5 BOLTS AND NUTS

Nuts shall be of at least the strength grade appropriate to the grade of bolt or other threaded element with which they are used

N.6 SCREWING OF METALWORK TO STEEL, WOOD, CONCRETE, ETC

Metalwork described as "screwed" to steel, wood, etc or "plugged" to brickwork, concrete, etc shall be fixed at not exceeding 500mm centres, with necessary holes, countersinking, threading, screws, set screws, self-tapping screws and fibre, plastic or metal plugs

N.7 BOLTING OF METALWORK

Where metalwork is described as "bolted" to steel, wood, brickwork, concrete, etc the bolts are measured elsewhere

N.8 WELDING OF METALWORK

All welds shall be cleaned and filed or ground off smooth to approval. All welded joints shall be continuous

N.9 METALWORK GENERALLY

Metalwork shall have all sharp edges ground smooth. Tubular and pipe work shall include running joints. Rails etc described as "continuous" shall be in long lengths with welded joints

N.10 PRESSED STEEL DOORS, FRAMES, ETC

N.10.1 Door frames

Frames shall project not less than 20mm into floor finish. Except where described as galvanized, frames shall be primed as specified before leaving the factory. Frames are to jambs and heads of openings. Frames for single doors shall be provided with two 100mm steel butt hinges and an adjustable striking plate for a mortice lock and frames for double doors shall be provided with four 100mm steel butt hinges. Butt hinges shall be steel butts with loose pins, welded to frames. Where necessary mortar caps shall be welded to frames and back plates shall be welded on behind tappings for screws

N.10.2 Cupboard door frames

Cupboard door frames shall be as described in N.10.1, but with thresholds of unequal channel section, two 100mm steel butt hinges to hanging stiles, two 75mm steel butt hinges to hanging stiles above transoms, necessary striking plates for mortice locks and keeps for barrel bolts

N.10.3 Combination doors and frames

Combination doors and frames shall be manufactured of 1,6mm thick steel plate. Frames shall be as described in N.10.1. Doors shall be standard design and required profile, with a 44mm wide edge all round, vertical reinforcing ribs pressed in and with two reinforcing rails welded on. The door shall be provided with two lever mortice lock with lock box welded to inside. Doors shall be welded to steel butts

N.10.4 Transformer room doors and frames

Transformer room doors and frames shall be manufactured of 1,6mm thick steel plate. Frames shall be as described in N.10.1. Doors shall be of standard design with a 44mm wide edge all round, vertical reinforcing ribs pressed in and with three reinforcing rails welded on. Single doors shall be fitted with a padlock cleat and two 100mm brass pintle hinges and double doors shall be fitted with a padlock cleat, two 150mm bolts and four 100mm brass pintle hinges. Each leaf shall be fitted with a louvered ventilation panel of standard design backed with 6mm mesh galvanized wire vermin proof screen

N.10.5 Sizes

The frame widths given refer to unfinished wall thicknesses

N.10.6 Glazing beads

Where specified, glazing beads shall be 12 x 12mm standard metal glazing beads mitred at angles and countersunk screwed on at not exceeding 300mm centres with self-tapping screws

N.11 STEEL WINDOWS, DOORS, ETC

N.11.1 Windows, doors, etc

All fittings to windows, doors, etc shall be chromium plated. Fixed lights and opening sashes shall be in single squares. Windows etc of single unit construction shall have weather bars at transoms above opening sashes

Composite windows not of single piece construction shall be coupled with standard coupling mullions and transoms that correspond with the window section used

Kicking plates and panels shall be 1,6mm metal plate fixed with standard metal glazing beads mitred at angles and countersunk screwed on at not exceeding 300mm centres with self-tapping screws

Except where described as galvanized, windows, doors, burglar bars, etc shall be primed as specified before leaving the factory

N.11.2 Burglar bars and flyscreens

Where windows are described as fitted with burglar bars or flyscreens, these shall be standard type fitted over opening sashes

N.12 ADJUSTABLE LOUVRE UNITS

Adjustable louvre units shall be suitable for hand or longarm operation

Louvre units shall include glass louvres with polished edges and installation, including holes, screws, rivets, preparation of openings, etc

N.13 ALUMINIUM WINDOWS AND DOORS

The foregoing preambles "N.4 – ALUMINIUM" shall apply to aluminium windows, doors, etc in all respects in so far as they are applicable. Aluminium windows and doors shall be manufactured from extruded aluminium members of 6063T6, 6261-T6 or 6082-T6 alloy and temper

Ancillary members such as sills, flashings, infill panels and the like formed from flat sheet material shall be of an appropriate alloy selected from 1200, 3004 or 5251 complying with BS 1470 of a temper suitable for the method of forming and a composition suitable for anodizing or painting as required

Windows, doors, etc shall be of an approved standard system, manufactured by an approved firm experienced in this type of work, and shall meet with the minimum recommended performance requirements as set out by the Association of Architectural Aluminium Manufacturers of South Africa (AAAMSA) in the latest edition of the Selection Guide

The fittings for all opening sashes shall be substantial and, unless otherwise described, shall be of high quality aluminium alloy finished to match the windows, doors, etc on which they occur. Samples of all fittings shall be supplied to the Principal Agent for approval

Top, side and bottom hung opening sashes shall be hung on two aluminium hinges with 300 Series stainless steel pins, nylon bushes and stainless steel washers. Side hung sashes shall have fasteners and sliding stays, top hung sashes shall have peg stays and bottom hung sashes shall have spring catches and concealed arms

Projected out sashes shall have aluminium fasteners and concealed arms of a non-corrosive material compatible with aluminium

The frames which are to be built into openings in brickwork shall be fitted with the manufacturer's standard type fixing lugs, not less than 20 x 3 x 150mm long, screwed to frame and placed one near each corner and intermediately not more than 450mm apart to sides, top and bottom and where fixed to concrete reveals, wood sub-frames or to preformed openings in brickwork shall have countersunk holes for screws, one near each corner and intermediately not more than 450mm apart to sides, top and bottom

N.13.1 Glazing beads

Where so described, openings and sashes of windows and doors shall be fitted with approved channel section aluminium glazing beads sufficient in size and profile to suit the method of glazing employed, finished to match the windows, doors, etc and neatly mitred. Screws where necessary shall be of aluminium or 300 Series stainless steel and have pan or raised heads finished to match the beads

N.13.2 Finishes

Windows, doors, etc described as “anodized” shall be treated with Grade 25 coating thickness. Windows, doors, etc described as “factory painted” shall have an electrostatically applied oven baked polyester paint coating not less than 25 micrometres thick

N.13.3 General

Aluminium windows, doors, etc shall include glass as described, fixing in position, sealing and protection against damage, deterioration or discolouration by taping with removable tape or covering with temporary casings or motor oil and removing same on completion

N.14 STRONGROOM AND RECORD ROOM DOORS

Strongroom and record room doors shall not be built in as the work proceeds, but shall be fixed later in the openings provided. The Contractor shall ensure that the lock or other important parts of the door are not tampered with. Should any such tampering occur, the Contractor will be held responsible and at the Principal Agent's discretion shall provide a new door or lock and keys at his own expense. The keys shall not be delivered together with the doors to the building site. The Contractor shall arrange for the manufacturer to send the keys direct to the Principal Agent per registered post. If these instructions are not complied with, a new lock and keys shall be provided by the Contractor at his own expense

N.15 STEEL ROLLER SHUTTERS

Roller shutters shall be of approved manufacture comprising curtain, vertical channel guides and top mechanism. The curtain shall be constructed of 1mm thick machine-rolled galvanized interlocking slats with mild steel end locks spot welded to alternate strips. The bottom shall be provided with a galvanized rail riveted on and vertical edges shall slide in galvanized channel guides formed of steel not less than 2,5mm thick bolted to sides of openings

The mechanism shall be covered in a galvanized sheet iron box. The ungalvanized sections shall be primed as specified before leaving the factory

O. PLASTERING

O.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Common cement	SANS 50197-1(Class 32,5N)
Masonry cement	SANS 50413-1(Class 225X)
Limes for use in building	SANS 523 {Slaked (hydrated) limes}
Aggregates from natural sources – Fine aggregates for plaster and mortar	SANS 1090

O.2 PREPARATORY WORK

Surfaces shall be clean and free of oil and thoroughly wetted directly before any plastering or other in situ finishes are commenced. Concrete surfaces shall be slushed with a mixture of one part cement and one part coarse sand or otherwise treated to form a proper key. Preparatory coats shall be thoroughly scored and roughened to form a proper key

O.3 FINISH

All coats of paving and plastering shall be executed in one operation without any blemishes

O.4 SCREEDS

Screeds shall be composed of one part cement and four parts sand

O.5 CEMENT RENDER

Cement render shall be composed of one part cement and three parts sand finished with a steel trowel to a smooth polished surface and cured for at least seven days after laying

Cement render finish shall be divided into panels not exceeding 6m² with V-joints and deep trowel cuts

O.6 GRANOLITHIC

Granolithic shall be composed of one part cement, one part fine sand, two parts coarse sand and one part granite or other approved stone aggregate that will pass through a 5mm sieve, finished with a steel trowel to a smooth polished surface and cured for at least seven days after laying

Coloured granolithic shall be carried out in two coats in one operation and shall be tinted to the required colour with approved colouring pigment mixed into the finishing coat. Under no circumstances is the pigment to be sprinkled on and trowelled in after the granolithic is laid

Granolithic shall be divided into panels not exceeding 6m² with V-joints and deep trowel cuts

O.7 TERRAZZO

Terrazzo shall be applied in two coats. The undercoat shall be composed of one part cement and three parts sand and shall be finished with a wooden float. The finishing coat shall be composed of one part cement and two parts marble or stone aggregate of a colour and size to obtain the required colour and texture and shall be at least 12mm thick, and applied before the undercoat has dried out. The finishing coat shall be compacted by tamping or rolling until superfluous water has been expelled, finished with a steel trowel and cured for at least seven days after laying. The finished surface shall show at least 80% of the aggregate

Surfaces described as "polished" shall be polished by machine using various grades of abrasive and grouting with tinted cement as necessary between polishings

Surfaces described as "polished" shall be polished by machine using various grades of abrasive and grouting with tinted cement as necessary between polishings

Surfaces described as "brushed" shall be brushed with a steel wire brush on the day the terrazzo has been laid to expose the aggregate as required

Where required, brass or other dividing strips shall be embedded in the undercoat to finish flush with the finished surface

Three sample blocks, each size 300 x 300mm, as separately measured shall be prepared for approval by the Principal Agent and kept in an accessible place on the site until the completion of the contract

O.8 SKIRTINGS

Skirtings shall not exceed 25mm thick and shall have a fair edge with arris or rounded external angle at top edge or V-joint to finish flush with plaster and coved or square junction with floor finish

O.9 THICKNESS OF PLASTER

All plaster, other than skim plaster, shall be not less than 10mm and not more than 20mm thick

O.10 CEMENT PLASTER

Cement plaster shall comply with the following table:

1	2	3
Plaster Class	Cement:sand (common cement)	Cement:sand (masonry cement)
I	1:4 or 50kg to 130 litres	1:3 or 50kg to 100 litres
II	1:6 or 50kg to 200 litres	1:5 or 50kg to 170 litres
III	1:9 or 50kg to 300 litres	1:6 or 50kg to 200 litres

O.11 COMPO PLASTER

Compo plaster shall be composed of one part cement, two parts lime and nine parts sand

O.12 GYPSUM SKIM PLASTER

Gypsum skim plaster shall be pure gypsum plaster finished with a steel trowel

O.13 TWO COAT PLASTER WITH GYPSUM FINISH

Two coat plaster with gypsum finish shall comprise an undercoat of Class II cement plaster finished with a wooden float and a finishing coat of gypsum skim plaster

O.14 ROUGH-CAST PLASTER

Rough-cast plaster shall be applied in two coats. The undercoat shall be composed of one part cement and five parts sand finished with a wooden float. The finishing coat shall be composed of one part cement and three parts stone aggregate that will pass through a 4mm sieve. The finishing coat shall be flicked on with a machine before the undercoat has set to obtain an even texture

O.15 FINE ROUGH-CAST PLASTER

Fine rough-cast plaster shall be as for rough-cast plaster but the finishing coat shall be composed of one part cement and three parts coarse sand

O.16 GENERAL

Rates for plastering described as being on vertical surfaces of brickwork or blockwork shall include concrete columns, beams and lintels flush with the face of the wall

P. TILING

P.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Glazed ceramic wall tiles and fittings	SANS 22
Ceramic wall and floor tiles	SANS 1449
Common cement	SANS 50197-1(Class 32,5N)
Masonry cement	SANS 50413-1(Class 22,5X)
Aggregates from natural sources – Fine aggregates for plaster and mortar	SANS 1090
The design and installation of ceramic tiling	SANS 10107

P.2 TILES, MOSAICS, ETC

Tiles, mosaics, etc shall be even in shape and size, free from cracks, twists or blemishes and uniform in colour

P.3 PREPARATORY WORK

Surfaces shall be clean and free of oil and thoroughly wetted directly before any tiling is commenced. Concrete surfaces shall be slushed with a mixture of one part cement and one part coarse sand or otherwise treated to form a proper key

P.4 CERAMIC WALL AND FLOOR TILING

Where tiles are fixed to plaster or screeds with an adhesive, the adhesive shall be as recommended by the manufacturer of the tiles. Joints shall be straight, continuous and flush pointed with an approved grouting compound

P.5 GENERAL

Tiling described as “on walls” is on brick walls or block walls unless otherwise stated and shall include concrete columns, beams and lintels flush with the face of the wall

Q. PLUMBING AND DRAINAGE

Q.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Sheet metal

Sheet zinc	BS 849
Sheet aluminium	BS 1470
Sheet copper	BS 2870

Rainwater systems

Unplasticized poly(vinyl chloride) (PVC-U) components for external rainwater systems	SANS 11

Pipes and fittings

Steel pipes : Pipes suitable for threading and of nominal size not exceeding 150mm	SANS 62
Plain-ended solid drawn copper tubes for Potable water	SANS 460
Malleable cast iron fittings threaded to ISO 7-1	SANS 4
Polyethylene (PE) pipes for water supply – Specifications	SANS 4427
Cast iron fittings for asbestos cement pressure pipes	SANS 546
Vitrified clay sewer pipes and fittings	SANS 559
Reinforced concrete pressure pipes	SANS 676
Concrete non-pressure pipes	SANS 677
Cast iron pipes and pipe fittings for use above ground in drainage installations	SANS 746
Unplasticized poly(vinyl chloride) (PVC-U) sewer and drain pipes and pipe fittings	SANS 791
Fibre-cement pipes, couplings and fittings for sewerage, drainage and low-pressure irrigation	SANS 819
Pitch-impregnated fibre pipes and fittings and jointing	SANS 921
Unplasticized poly (vinyl chloride) (PVC-U) pressure pipe systems	SANS 966-1
Unplasticized poly(vinyl chloride) (PVC-U) soil, waste and vent pipes and pipe fittings	SANS 967
Rubber joint rings (non-cellular)	SANS 974-1
Copper-based fittings for copper tubes	SANS 1067-1&2
Fibre-cement pressure pipes and couplings	SANS 1223
Polypropylene pressure pipes	SANS 1315
Non-metallic waste traps	SANS 1321-1&2
Vent valves for drainage installations	SANS 1532
Heavy duty cast iron pipe fittings for drainage and gas and water supplies	BS 78

Lead pipes	BS 602
Cast iron pressure pipes for use in drainage and gas and water supplies	BS 1211
Stainless steel pipes for use with compression fittings	BS 4127
Sanitary fittings etc	
Stainless steel sinks with draining boards (for domestic use)	SANS 242
Stainless steel wash-hand basins and wash troughs	SANS 906
Stainless steel sinks for institutional use	SANS 907
Stainless steel stall urinals	SANS 924
Acrylic sanitary ware : Baths	SANS 1402-1
Glazed ceramic sanitary ware	SANS 497
WC flushing cisterns	SANS 821
Flush valves for WC flushing cisterns	SANS 1509
Taps, valves etc	
Water taps (metallic bodies)	SANS 226
Water taps (plastic bodies)	SANS 1021
Single control mixer taps	SANS 1480
Float valves	SANS 752
Plastic floats for ball valves	SANS 1006
Functional control valves and safety valves for Domestic hot and cold water supply systems	SANS 198
Cast iron gate valves for waterworks	SANS 664
Automatic shut-off flush valves for water closets and urinals	SANS 1240
Check valves (flanged and wafer types)	SANS 1551-1&2
Fire extinguishers	
Portable refillable fire extinguishers	SANS 1910
Portable rechargeable fire extinguishers : Halogenated hydrocarbon type extinguishers	SANS 1151
Water heaters and fire hose reels	
Fixed electric storage water heaters	SANS 151
Fire hose reels (with semi-rigid hose)	SANS 543
Drainage covers, gratings, etc	
Cast iron surface boxes and manhole and inspection covers and frames	SANS 558
Cast iron gratings for gullies and stormwater drains	SANS 1115
The installation of polyethylene and poly (vinyl chloride) (PVC-U and PVC-M) pipes	SANS 10112
Water supply and drainage for buildings	SANS 10252-1&2

Q.2 GENERAL**Q.2.1 Excavations**

Excavations shall be deemed to be in "earth". Backfilling to excavations shall be executed in 300mm thick layers, watered and compacted. Surplus excavated material shall be spread and levelled over site as directed

Q.2.2 Concrete

Unreinforced concrete shall be Class B prescribed mix concrete and reinforced and precast concrete shall be Class C prescribed mix concrete

Q.2.3 Brickwork

Brickwork shall be of extra hard burnt bricks built in Class I mortar

Q.2.4 Plaster

Plaster shall be 1:3 cement plaster finished smooth with a steel trowel. All angles shall be rounded

Q.2.5 Diameters of pipes etc

Diameters stated for pipes, traps, valves, etc are internal diameters except PVC, polyethylene, stainless steel and copper pipes and traps for which external diameters are stated

Q.3 SHEET METAL WORK**Q.3.1 Galvanized sheet iron**

Galvanized sheet iron shall be rolled steel sheet coated on both sides with Class Z275, unless otherwise specified, zinc coating complying with SANS 3575/4998. Sheets shall be free from white rust

Q.4 EAVES GUTTERS**Q.4.1 Galvanized sheet iron gutters**

Galvanized sheet iron gutters shall have beaded edges and all joints shall be riveted and soldered. Angles shall be strengthened with 50 x 0,6mm galvanized sheet iron strips soldered on over the internal faces of mitres

Gutters shall be fixed with falls to outlets on 30 x 3mm galvanized mild steel brackets, bent to the shape of gutters, with front ends taken up to the underside of beaded edge of gutter and each screwed to roof timbers or bolted to fibre-cement fascias with 6mm galvanized gutter bolts. Gutters shall be bolted to brackets at front with 6mm galvanized gutter bolts, one to each bracket

Brackets shall be positioned at joints of gutters and intermediately at not exceeding 1,25m centres

Q.4.2 Fibre-cement gutters

Fibre-cement gutters shall have spigot and socket joints. Gutters shall be fixed with falls to outlets on standard aluminium alloy brackets, screwed or bolted to roof timbers or fascias

Q.4.3 Unplasticized polyvinyl chloride (UPVC) gutters

Gutters shall be fixed with falls to outlets on brackets as supplied by the manufacturer, screwed or bolted to roof timbers or fascias

Q.4.4 Aluminium gutters

Aluminium gutters shall be roll formed on site to required lengths and profiles from 3003H14-3SH4 alloy strip not less than 0,7mm thick factory coated on both sides with baked enamel and two coats of silicone modified polyester to a total minimum thickness of 20 micrometres. Angles, stopped ends, etc shall be prefabricated units pop riveted to gutters with joints sealed with mastic. The guttering shall be in continuous lengths between angles, stopped ends, etc

Q.5 RAINWATER PIPES

Q.5.1 Galvanized sheet iron pipes

Galvanized sheet iron pipes shall have seams at the back and shall be jointed with soldered slip joints. Pipes shall be fixed to walls etc with galvanized mild steel holderbats spaced at not exceeding 2m centres with tails driven in or cut and pinned in 1:3 cement mortar

Q.5.2 Fibre-cement pipes

Fibre-cement pipes shall have spigot and socket joints. Pipes shall be fixed to walls etc with standard aluminium alloy holderbats with tails driven in or cut and pinned in 1:3 cement mortar

Q.5.3 Unplasticized polyvinyl chloride (UPVC) pipes

Pipes shall be fixed to walls etc with patented UPVC or aluminium clips and holderbats as supplied by the manufacturer of the pipe

Q.5.4 Aluminium pipes

Aluminium pipes and fixing straps shall be formed from 3003H14-3SH4 alloy strip not less than 0,7mm thick factory coated on both sides as described for aluminium gutters. Pipes shall be in continuous lengths with formed angles, offsets, shoes, etc. Pipes shall be fixed to walls etc with 20 x 0,6mm straps at not exceeding 1,5m centres screwed to 25 x 75 x 100mm hardwood chamfered and oiled blocks plugged to walls

Q.6 STORMWATER CHANNELS

In-situ concrete stormwater channels shall be constructed of unreinforced concrete with segmental channel formed in top. Channels shall be laid to falls on a well rammed earth bottom and finished smooth on exposed surfaces

Precast concrete channels shall be of 25 MPa concrete, generally in 1m lengths, finished smooth from the mould on exposed surfaces, laid to falls on a well rammed earth bottom, jointed in 1:3 cement mortar and pointed with keyed joints

Q.7 JOINTS

Joints of pipes not covered by SANS shall be as follows:

Pipes

Fibre-cement, concrete, pitch-impregnated fibre and vitrified clay pipes for use under ground in non-pressure pipe lines

Cast iron for use above ground

Cast iron for use below ground

Galvanized mild steel

Joints between pipes of different materials shall be as follows:

Between cast iron and mild steel

Between cast iron and clay

Between mild steel or copper and clay

Joints

Flexible joints in accordance with the manufacturer's instructions

Spigot and socket joints with tarred rope yarn and caulking compound

or

Plain ended joints with stainless steel couplings with neoprene rubber sleeves

Spigot and socket joints with tarred rope yarn and caulking compound

Joints of screwed galvanized steel sockets or bolted galvanized iron flanges

Screwed joints with plastic jointing tape or hemp

Flanged joints which shall be bolted and provided with rubber gaskets and with flanges screwed to pipes

Spigot and socket joints with tarred rope yarn and caulking compound

Spigot and socket joint with semi-dry cement caulking and 1:2 cement mortar fillet

Spigot and socket joint with either bitumen or semi-dry cement caulking and 1:2 cement mortar fillet

Q.8 FIXING OF PIPES

Pipes shall be fixed as follows:

Q.8.1 Galvanized mild steel (except those stated in Q.8.3)

To walls with galvanized mild steel brackets for pipes not exceeding 80mm diameter and with galvanized cast iron hinged holderbats with brass pins or bolts for pipes exceeding 80mm diameter; both types with tails cut and pinned in 1:3 cement mortar

To woodwork with screw-on type galvanized mild steel holderbats

Q.8.2 Copper and stainless steel

To walls with brass holderbats or screw-on type two-piece spacing clips for pipes not exceeding 75mm diameter and with purpose made holderbats for pipes exceeding 75mm diameter; both types with tails cut and pinned in 1:3 cement mortar

To woodwork with screw-on type brass holderbats

Q.8.3 Cast iron and galvanized mild steel for soil, waste and vent pipes

To walls with hinged cast iron holderbats with brass bolts and with tails cut and pinned in 1:3 cement mortar

To woodwork with screw-on type galvanized mild steel holderbats

Q.8.4 Polyethylene, polypropylene and patented UPVC or unplasticized polyvinyl chloride

To walls, woodwork, etc with aluminium clips and holderbats as supplied by the manufacturer of the pipes

Q.8.5 Fibre-cement

To walls with aluminium alloy holderbats with tails cut and pinned in 1:3 cement mortar

Q.8.6 Pipes fixed to ceilings

Fixed with holderbats and standard or purpose made hangers, with extended hangers for pipes to falls

Q.9 PIPES LAID IN GROUND

Q.9.1 Water pipes etc

Water pipes, gas pipes, etc laid in ground shall be at least 400mm deep from the crown of the pipe to the finished surface

Q.9.2 Drain pipes

Excavations taken out too deep shall be filled in with selected soil and compacted. Backfilling to sides and up to 300mm above plastic pipes shall be free from stone or hard substances which will not pass a 10mm mesh

Q.10 CLEANING EYE LIDS

Cleaning eye lids for drain pipe fittings shall be fixed and sealed as follows:

Pipe fittings	Method of sealing and fixing
Fibre-cement	Sealed with synthetic rubber or bituminous mastic packing and fixed with screws
Vitrified clay	Polypropylene lid sealed with synthetic rubber packing and pressed into position
Polypropylene and unplasticized polyvinyl chloride	Sealed with synthetic rubber packing and screwed on or pressed into position
Cast iron	Sealed with tallow or putty and fixed with non-ferrous metal screws
Galvanized malleable cast iron and cast brass	Sealed with synthetic rubber packing and screwed in

Q.11 CLEANING EYES

Cleaning eyes shall consist of cast iron frames and lids with letters "CE" (or "SO") cast in lids. The lids shall be secured with non-ferrous metal screws. Frames shall be jointed to vertical drain pipes. Cleaning eyes shall be encased in unreinforced concrete taken up to ground level and plastered on exposed surfaces

Q.12 INSPECTION EYE MARKER SLABS

Inspection eye marker slabs shall be 350 x 350 x 50mm thick precast concrete finished smooth from the mould, with letters "IE" (or "IO") formed in top and placed flush in ground or paving

Q.13 GULLEYS

Gulleys shall be built up of traps, vertical piping and gulley heads with loose gratings, all encased in unreinforced concrete to finish flush with gulley head top and taken up to at least 50mm above surrounding finished surfaces. The outer top edge of the concrete encasing shall be splayed and the exposed surfaces plastered

Q.14 DISHED GULLEYS

Dished gulleys shall be built up of traps, vertical piping and gulley heads with loose gratings, all encased in unreinforced concrete and with dished unreinforced concrete hopper size 450 x 450mm overall around gulley head with rounded kerb 50mm wide to front and sides and 25mm wide at back, 100mm high above top of dishing and the hopper plastered on exposed surfaces. Top of hopper shall be taken up to at least 50mm above surrounding finished surfaces

Q.15 SUMPS, CATCHPITS, INSPECTION CHAMBERS, ETC

Q.15.1 Rainwater sumps

Rainwater sumps shall be built with half-brick sides on 100mm thick unreinforced concrete bottom, plastered internally on walls and with 80mm high unreinforced concrete kerb at top rebated for grating or cover and plastered on exposed surfaces

Q.15.2 Stormwater catchpits and inspection chambers

Brick catchpits and inspection chambers shall be built with one-brick sides on 150mm thick unreinforced concrete bottom projecting 100mm beyond walls all round, plastered internally on walls and with 100mm thick reinforced concrete cover slab with opening rebated for frame of grating or cover and plastered on exposed surfaces

Precast concrete catchpits and inspection chambers shall be constructed in accordance with the applicable details shown on Drawing LE-1 of SANS 1200LE. Precast concrete manhole sections and slabs shall comply with SANS 1294 and pipes shall be SC type and in accordance with SANS 677

Q.15.3 Sewer inspection chambers

Brick inspection chambers shall be built as for brick stormwater inspection chambers and with the bottom of the chamber well benched around half round channels, bends, junctions, etc up to sides of chamber in unreinforced concrete finished smooth

Precast concrete inspection chambers shall be constructed in accordance with the applicable details shown on Drawing LD-5 of SANS 1200LD. Precast concrete manhole sections and slabs shall comply with SANS 1294 and the pipes shall be SC type in accordance with SANS 677

Q.15.4 Stormwater drain junction boxes

Junction boxes shall be formed of 150mm thick unreinforced concrete bottom and sides to suit the various sizes of the drain pipes and built after the pipes have been laid, with the sides taken up slightly higher than the highest pipe and finished level on top for and covered with a 75mm thick loose precast concrete slab

Q.15.5 Step irons

Where inspection chambers exceed 1,2m deep, cast iron step irons shall be provided, built into the wall at 300mm centres and staggered regularly in vertical rows spaced at 200mm centres horizontally

Q.16 STOPCOCK AND METER BOXES

Stopcock and meter boxes shall be built with half-brick sides with a cast iron box and lid complying with SANS 558 set in 75mm wide unreinforced concrete kerb for the full depth of the cast iron box and plastered on exposed surfaces

Q.17 VALVE CHAMBERS

Valve chambers shall be built with half-brick sides with 100mm thick unreinforced concrete kerb to top with rebate for cover and frame to finish flush with adjacent paving or finished ground level and plastered on exposed surfaces

Q.18 CAST IRON COVERS, GRATINGS, ETC

All cast iron covers, gratings, frames and surface boxes shall be coated with preservative solution. Frames shall be cast into concrete. Covers, except covers to stormwater drainage or electrical cable inspection chambers, shall be set in grease

Q.19 CONCRETE ENCASING

Concrete encasing for pipes, bends, traps, gulleys, grease traps, etc shall be unreinforced concrete not less than 100mm thick all round

Q.20 SANITARY FITTINGS

Q.20.1 General

Glazed ceramic, acrylic and porcelain enamelled sanitary fittings and component parts shall be white. Accessories for sanitary fittings shall be chromium plated brass

Waste outlets for baths, basins, etc shall comprise chromium plated brass waste union with grating, rubber washers and locknut, fitted with rubber or vulcanite plug on a chromium plated brass chain and stay

Q.20.2 Stainless steel sanitary fittings

Stainless steel sinks and draining boards, basins, wash troughs and urinals shall be AISI Type 304 satin finished stainless steel. All stainless steel fittings shall be treated on the back with a vermin proof sound deadening coating. Sinks, basins and wash troughs shall be provided with 40mm diameter screwed waste outlets

Q.20.3 Precast concrete wash troughs

Reinforced precast concrete wash troughs shall have a sloping front with ribbed rubbing surface and shall be finished smooth on exposed faces with top edges and inner angles rounded. Each compartment shall be fitted with a 40mm diameter waste outlet. Wash troughs shall each be supported on two reinforced precast concrete pedestals finished smooth on exposed faces

Q.20.4 Steel baths

Steel baths shall be porcelain enamelled internally and painted externally and fitted with waste outlet and overflow grating with coupling

Q.20.5 Acrylic resinous baths

Acrylic resinous baths shall be fitted with waste outlet and overflow grating with coupling

Q.20.6 Acrylic resinous wash hand basins

Acrylic resinous wash hand basins and vanity units shall have a smooth high gloss finish, with outlet openings, soap recesses, tap-holes and integral overflow and shall be fitted with waste outlet and overflow grating with coupling

Q.20.7 Glazed ceramic sanitary fittings

Sinks shall be provided with integral weir overflows

Washdown closet pans shall have washdown action and be provided with smooth finished injection moulded polypropylene heavy duty double flap seats fixed with non-ferrous bolts. Urinal channels shall be provided with outlet gratings fitted in bitumen

Q.20.8 Flush and sparge pipes

Flush pipes for high level cisterns shall be of plastic or drawn galvanized steel

Flushpipes for low level cisterns shall be of plastic

Flush and sparge pipes for urinals with high level cisterns shall be of chromium plated copper piping and of the sizes recommended by the manufacturer of the urinal

Q.21 INSTALLATION OF SANITARY FITTINGS

Sanitary fittings shall be installed as follows:

Q.21.1 Precast concrete wash troughs

Precast concrete wash troughs shall be bedded on top of pedestals which shall be bedded on floors in 1:3 cement mortar

Q.21.2 Stainless steel wash troughs and wash hand basins

Stainless steel wash troughs and wash hand basins shall be fixed to walls on a pair of galvanized mild steel galleys brackets bolted to wall with 6mm diameter expanding bolts

Q.21.3 Acrylic resinous wash hand basins

Acrylic resinous wash hand basins shall be fixed to walls on a pair of standard painted cast iron brackets screwed to underside of basin and bolted to wall with 6mm diameter expanding bolts

Q.21.4 Ceramic wash hand basins

Ceramic wash hand basins shall be fixed to walls on a pair of standard painted steel or cast iron brackets bolted to wall with 6mm diameter expanding bolts

Q.21.5 Acrylic resinous baths

Acrylic resinous baths shall be bedded in 1:5 cement mortar on three cross rows of bricks or bedded solid on a layer of dry river sand and fixed to wall with galvanized steel brackets under edges (in the middle of the sides against walls) bolted to wall with 6mm diameter expanding bolts and sealed along top against wall finishes with patent mildew resistant silicone rubber

Q.21.6 Washdown closet pans and cisterns

Washdown closet pans shall be bedded on floors in 1:3 cement mortar. Cisterns shall be fixed to walls with 6mm diameter expanding bolts

Q.21.7 Ceramic urinals

Ceramic stall and slab urinals shall be bedded on floors and against walls in 1:3 cement mortar. Slabs, channels, treads, etc shall be jointed in 1:3 cement mortar and pointed in white cement

Ceramic bowl urinals shall be fixed to walls on standard steel brackets bolted to wall with 6mm diameter expanding bolts. Cisterns shall be fixed to walls on standard brackets bolted to wall with 6mm diameter expanding bolts

Q.21.8 Stainless steel urinals

Stainless steel stall and slab urinals shall be bedded on floors in 1:3 cement mortar and with backs and sides against walls filled in with fine unreinforced concrete. Cisterns shall be fixed as cisterns for ceramic urinals

Q.22 FIRE HOSE REELS

Fire hose reels shall each be fitted with a 30m long hose of internal diameter not less than 19mm with a 4,8mm internal diameter chromium plated brass nozzle

Q.23 FIRE EXTINGUISHERS

All fire extinguishers shall be fully charged

Q.24 TESTS

Sewerage pipe lines, sanitary plumbing including fittings and hot and cold water supply and fire service shall be tested to the approval of the Principal Agent and Local Authority

The Contractor shall provide all testing apparatus, material and labour required for the tests and inspections

R. GLAZING

R.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Glass in building	SANS 50572-1 to 5
Glazing putty for wooden and metal window frames	SANS 680
Silvered glass mirrors for general use	SANS 1236
Safety and security glazing materials for buildings	SANS 1263-1 to 3
Sealing compounds for the building industry, one Component, silicone-rubber based	SANS 1305
The installation of glazing materials in buildings	SANS 10137
Work on glass for glazing	SANS 1817

R.2 PUTTY ETC

Glazing putty shall be Type I for wooden sashes and Type II for steel sashes. Putty for glazing to unpainted hardwood shall be tinted to match the colour of the wood

Back putty shall not exceed 3mm thick. Putty shall not be painted until it has formed a surface crust, and if the putty does not form a surface crust it shall be replaced

Butyl putty shall be used where glass is to be fixed in aluminium sashes with glazing beads

Non-setting compounds shall be used where laminated glass is fixed in sashes with glazing beads

S. PAINTWORK

S.1 MATERIALS AND WORKMANSHIP

Materials and workmanship shall comply with the following standards:

Decorative paint for interior use	SANS 515
Decorative high gloss enamel paints	SANS 630
Primers for wood (for external work)	SANS 678
Primers for wood (for internal work)	SANS 678
Zinc phosphate primer for steel	SANS 1319
Undercoats for paints (except emulsion paint)	SANS 681
Aluminium paint	SANS 682
Varnish for interior use	SANS 887
Emulsion paints	SANS 1586

Materials for paintwork shall be delivered to the site in unopened containers and applied in accordance with the manufacturer's instructions. Materials shall be suitable for application to the surfaces concerned. Undercoats shall be as recommended by the manufacturer of the finishing coats

S.2 PREPARATORY WORK

S.2.1 Plastered surfaces etc

Plastered surfaces shall be thoroughly inspected and, if necessary, washed down and brushed in order to remove any traces of efflorescence and allowed to dry completely before any paint finish is applied. Before any paint is applied, holes, cracks and irregularities in plaster and other surfaces shall be filled with a suitable filler and finished smooth. Unfinished concrete surfaces shall have all projections rubbed off and shall be thoroughly cleaned with a spirits-of-salts solution (1 part concentrated spirits-of-salts to 4 parts water)

S.2.2 Metal surfaces

Metal surfaces shall be sanded, where necessary, washed with a suitable cleaning agent and left smooth

Protective coatings applied by manufacturers to galvanized metal surfaces shall be removed with a suitable agent and the surfaces washed down

Rust, grease and defective factory primers on metal surfaces, as well as pitch on cast iron pipes, shall be removed

S.2.3 Wood surfaces

Knots in woodwork shall be treated with knotting. Minor blemishes shall be filled with a suitable filler. Wood surfaces shall be sanded smooth

S.3 APPLICATION OF PAINT

Primers to wood surfaces shall be applied by brush. Primers to other surfaces may be applied by roller with the approval of the Principal Agent. Undercoats and finishing coats may be applied by brush or roller

Paint shall not be sprayed on except in the case of cellulose and other special paints where spray painting is the accepted method of application

Before subsequent coats of paint are applied the previous coat shall be properly dry and shall be sanded down where necessary

S.4 COLOUR SCHEME

A colour scheme comprising colours and the blending of colours approved by the Principal Agent shall be used for the paintwork. The tints of the undercoats shall closely match the finishing coat but nevertheless differ sufficiently to indicate the number of undercoats. Colour samples of the finishing coats shall be provided in all cases

S.5 GENERAL

Paintwork shall include the preparation of surfaces, filling, stopping, sanding and priming of nail heads and screws. Where windows, sashes, etc are to be painted, the rebates of the openings to be glazed shall be primed

T. PAPERHANGING

T.1 PREPARATORY WORK

Plaster surfaces to be papered shall be dry, thoroughly cleaned down, filled with a suitable filler as necessary to obtain a smooth surface and painted thereafter with a single coat of emulsion paint

Wood surfaces to be papered shall be knotted, stopped and sanded

T.2 PAPERHANGING

Wallpaper shall be hung in vertical long lengths. Vertical joints shall be close-fitted and plumb and the paper shall be tightly fitted to skirtings, ceilings, door frames, windows, etc. Horizontal joints will not be allowed

U. EXTERNAL WORKS

U.1 GENERAL

U.1.1 Excavations

Excavations shall be deemed to be in "earth"

U.2 LANDSCAPING

U.2.1 Topsoil

Topsoil shall vary between sandy loamy soil and sandy clayey soil with an ideal composition of 15% to 25% clay, 10% silt/sludge and 65% to 75% sand, with a minimum ratio of organic material of 2%. All material shall be free of harmful deposits as well as unwanted seeds

U.2.2 Compost

Compost shall be composed of properly decayed organic material, free from harmful deposits, salts, seeds and other waste material and shall have a pH of more than 4 and less than 7

U.2.3 Mulch

Mulch shall be approved organic material free from small particles of bark residue, fungus, disease, etc

U.2.4 Lime

Lime shall be agricultural lime of an approved manufacture

U.2.5 Fertilizer

Fertilizer shall be of the type specified, mixed thoroughly into the soil as prescribed. No fertilizer shall be added more than two weeks prior to planting

U.2.6 Backfilling

Backfilling in plant and tree holes shall be composed of two parts topsoil to one part compost mixed thoroughly together and compacted by foot in 100mm layers. Fertilizer shall only be added if prescribed

U.2.7 Pebbles

Pebbles shall be smooth with a uniform colour and form and ranging in size from 50mm to 75mm diameter. Removal of pebbles from river beds shall be done selectively to avoid any major disruption to the ecology of the river and environment

U.2.8 Plant material

U.2.8.1 General

All plant material (plants, shrubs, trees, etc) shall be obtained from a registered nursery and shall be free from damaged parts, parasites, fungus, other plant diseases or insects. No container-bound plants will be acceptable

U.2.8.2 Trees

The height of trees described in the bills of quantities shall be measured from the top of the root ball to the top of the tree. Where trees are pruned, such prune wounds shall not be more than 25mm in diameter and be sealed with an approved sealing compound

U.2.8.3 Shrubs and small plants

Shrubs and small plants shall meet the requirements for height and spread as specified. Thin or sparsely branched plants shall not be accepted. Branches shall be well spread with ample young branches and the plant as a whole shall be growing well

U.2.8.4 Groundcover

Groundcover shall be dense and healthy and shall comply with the minimum requirements for leaf density as specified

Formal grass shall be planted as runners in 50mm deep drills at 150mm centres unless otherwise described

U.2.9 Cultivation and preparation of planting areas etc

All surface rocks and stones larger than 50mm shall be removed before commencing cultivation and preparation. The entire area shall be ripped and rotavated using approved machinery by breaking up the earth to a depth of 300mm at 600mm centres in both directions, unless otherwise described, and then levelled. Where fertilizer or compost is specified, it shall be worked into the topsoil after ripping and rotavation to a depth of 300mm and finished to final levels

All fertilizer to areas to be grassed shall be strewn on the final layer before final finishing is commenced and worked mechanically into the top 150mm soil

U.2.10 Planting procedure

Holes for shrubs and groundcover shall be as follows:

Shrubs – 500 x 500 x 500mm deep

Groundcover – 300 x 300 x 300mm deep (if not planted in drills)

Holes for trees shall be square, of adequate size to accommodate the root system and suitable for the height of the tree

All plant material shall be watered thoroughly before careful removal from the container and planted in the prescribed planting medium with the top of the soil in the container finishing level with the surrounding area. Water dams size 800mm diameter x 150mm deep and 500mm diameter x 150mm deep shall be formed around trees and shrubs respectively and all planting material shall be watered immediately after planting. Trees, shrubs, etc shall be properly staked or stayed, depending on their size, on the prevailing windy side with patent tree ties

U.2.11 Maintenance

All planted areas shall be maintained for a period of three months after practical completion as defined in the contract with the exception of hydroseeded areas which shall be maintained for 12 months after an acceptable cover has been obtained

This maintenance shall consist of keeping clear of weeds and litter, loosening soil where necessary every two weeks, replacing damaged, diseased or dead plants, pruning, cutting and mowing as necessary and watering so as to keep the plant material in a healthy growing condition

U.3 ROADWORK

U.3.1 Filling

Filling under roads etc shall be of inert material having a maximum plasticity index of 10, free from large stones etc spread, levelled, watered and compacted in layers not exceeding 200mm thick to a density of 98% Mod AASHTO

U.3.2 Preparation of sub-grade

The sub-grade shall be prepared by scarifying for a depth of 150mm and compacting to a density of 98% Mod. AASHTO, including trimming to the correct levels and grades

U.3.3 Base course

The base course shall consist of crusher run stone compacted to a density of 98% Mod. AASHTO and finished to the correct levels and grades

U.3.4 Weed killer

The completed sub-grade shall be treated with an approved total weed killer

U.3.5 Bituminous premix road surfacing

Before spreading the premix material, the base course shall be swept clean and free from all dust, dirt and loose particles, lightly wetted and sprayed with a prime coat of cutback bitumen complying with SANS 308 at the rate of 1 litre/m²

The material shall consist of semi-gap graded crushed stone aggregate having the following grading:

Sieve size (mm)	% By mass passing sieve
13,2	100
4,75	45-60
2,36	42-55
1,18	40-52
0,3	25-45
0,075	5-12

The aggregate shall be mixed with bituminous road tar binder complying with SANS 748 at the rate of 1m³ of stone to 120 litre of emulsion at atmospheric temperature

The binder shall be added to the stone and mixed until the stone is uniformly coated. Thereafter 5% of clean, dry quartzitic sand shall be added and mixed until evenly distributed through the mixture

The premix shall be applied only after the primer has dried out completely and shall be spread immediately after mixing and rolled on the same day

Spreading shall be done evenly over the prepared base course to a loose depth sufficient to ensure the consolidated thickness specified

Rolling shall commence as soon as the binder has set sufficiently, followed after three days by a final rolling

U.3.6 **Precast concrete block road surfacing**

Paving blocks shall be precast concrete blocks complying with SANS 1058

Blocks shall be laid to true levels and grades on and including a 25mm thick layer of river sand with joints exceeding 2mm and not exceeding 6mm wide

After laying, the paving shall be compacted by means of a vibrating plate compactor, with joints between the blocks filled in, after compaction, by sweeping in fine sand

Infill areas at edges of paving constituting less than 25% of a full block unit and of 25mm minimum dimension shall be filled with Class C prescribed mix unreinforced concrete with top surface trowelled smooth to match blocks. Smaller areas shall be filled with 1:4 cement mortar

U.3.7 **Precast concrete kerbs and channels**

Precast concrete kerbs and channels shall comply with SANS 927, generally in 1m lengths and finished smooth from the mould on exposed surfaces. Kerbs and channels shall be bedded on and jointed in 1:3 cement mortar and pointed with keyed joints. Bases to kerbs shall be Class B prescribed mix unreinforced concrete

U.3.8 **Process control tests**

The Contractor shall be responsible for carrying out all necessary process control tests on the density and moisture content of the compacted sub-grade, base course, etc to ensure that the required compaction is being attained

U.4 **FENCING ETC**

U.4.1 **Materials**

Materials and workmanship shall comply with the following specifications and requirements :

Wooden poles, droppers, guardrail posts and spacer blocks	SANS 457-2&3
Zinc-coated fencing wire	SANS 675
Prefabricated concrete components for fencing	SANS 1372
Chain-link fencing and its wire accessories	SANS 1373

	Fasteners	SANS 1700
	Anti-intruder fences	CKS 451
	Metal droppers and standards	CKS 451
U.4.2	Galvanized wire	
	All galvanized wire shall be zinc coated wire with Class B zinc coating. Straining wire shall be 4mm diameter galvanized mild steel wire. Tie wire shall be 1,6mm diameter galvanized mild steel wire	
U.4.3	Plastic coated wire	
	Plastic coated straining wire shall be 3,15mm diameter Class C galvanized mild steel wire plastic coated to an overall diameter of 3,95mm	
	Plastic coated tie wire shall be 1,8mm diameter Class C galvanized mild steel wire plastic coated to an overall diameter of 2,5mm	
U.4.4	Galvanized barbed wire	
	Galvanized barbed wire shall be 2,5mm diameter mild steel double strand reverse twist zinc coated barbed wire with Class A zinc coating	
U.4.5	Galvanized wire mesh	
	Galvanized wire mesh shall be 50mm mesh chain link netting of 2,5mm diameter Class C galvanized mild steel wire	
U.4.6	Plastic coated wire mesh	
	Plastic coated wire mesh shall be 50mm mesh chain link netting of 2,5mm diameter Class C galvanized mild steel wire plastic coated to an overall diameter of 3,25mm	
U.4.7	Galvanized welded wire mesh	
	Galvanized welded wire mesh shall be fabricated from pre-galvanized wires to rectangular pattern welded together at each intersection using a welding method which forms a zinc oxide protective coating at each intersection	
U.4.8	Razor wire	
	Razor wire shall be fabricated from 2,5mm diameter galvanized high tensile steel wire fitted with razor barbs formed of 0,5mm galvanized steel strip clipped on at 37,5mm centres	
U.4.9	Metal droppers and standards	
	Droppers shall be of ridged T-section mild steel with a mass of not less than 0,55kg/m. Standards shall be of I- section mild steel with a mass of not less than 3kg/m or of ridged edge Y-section mild steel with a mass of not less than 2,5kg/m, and shall be driven 600mm deep into the ground	
	Droppers and standards shall have either galvanized, sprayed metal or painted finish as described in the items and in accordance with CKS 451. In addition, those surfaces of standards embedded in the ground shall be coated with bitumen	
U.4.10	Metal posts and stays	
	Posts and stays shall comply with CKS 451 and shall be of black galvanized mild steel tubing as specified	
	Straining posts shall be of 108mm outside diameter x 3mm wall thickness tubing, each with a 300 x 300 x 5mm thick mild steel sole plate and a steel cap welded on	
	Intermediate posts shall be of 50mm outside diameter x 2,5mm wall thickness tubing, each with a 230 x 230 x 5mm thick mild steel sole plate and a steel cap welded on	
	Stays for straining posts shall be of 50mm outside diameter x 2,5mm wall thickness tubing, each with a 230 x 230 x 5mm thick mild steel sole plate welded on and fixed raking with top end flattened, bent, holed and bolted to straining post with and including a 5mm diameter galvanized mild steel bolt with nut and washer	
	Posts and stays shall have either galvanized or painted finish as described in the items and in accordance with CKS 451. In addition, sole plates and portions of posts and stays embedded in ground shall be coated with bitumen	

U.4.11 Timber posts, stays and droppers

Timber posts shall be 125mm diameter, timber stays shall be 100mm diameter and timber droppers shall be 30mm diameter

U.4.12 Prestressed concrete posts and stays

Prestressed concrete posts and stays shall be finished smooth from the mould and uniformly stressed by means of high tensile longitudinal prestressing wires with concrete cover to wires of not less than 20mm

Corner and straining posts shall be 100 x 100mm and intermediate posts and stays shall be 75 x 75mm. Stays shall be fixed raking with top end splayed and glued to posts with a suitable epoxy compound

U.4.13 Bolts, nuts and washers

Straining eye bolts, hinge bolts, bolts, nuts and washers shall be galvanized

U.4.14 Precast concrete fencing

Precast concrete fencing over sloping terrain shall be stepped to suit terrain, including the use of increased lengths of posts as necessary, excavation, etc

U.4.15 Concrete bases

Bases in ground for posts, stays, etc shall be of Class B prescribed mix concrete with tops 100mm below surface of ground

Sizes of concrete bases for posts, stays, etc shall be as follows:

Straining and gate posts	–	450 x 450 x 700mm deep
Intermediate posts	–	300 x 300 x 600mm deep
Stays	–	600 x 300 x 500mm deep

U.4.16 Security overhangs

Where fencing is described as having a security overhang, the posts and standards shall have angular (single arm) extension arms

Extension arms shall be attached to the posts and standards by welding in the case of steel and by spiking in the case of timber

Concrete extension arms shall be cast integrally with the post or standard

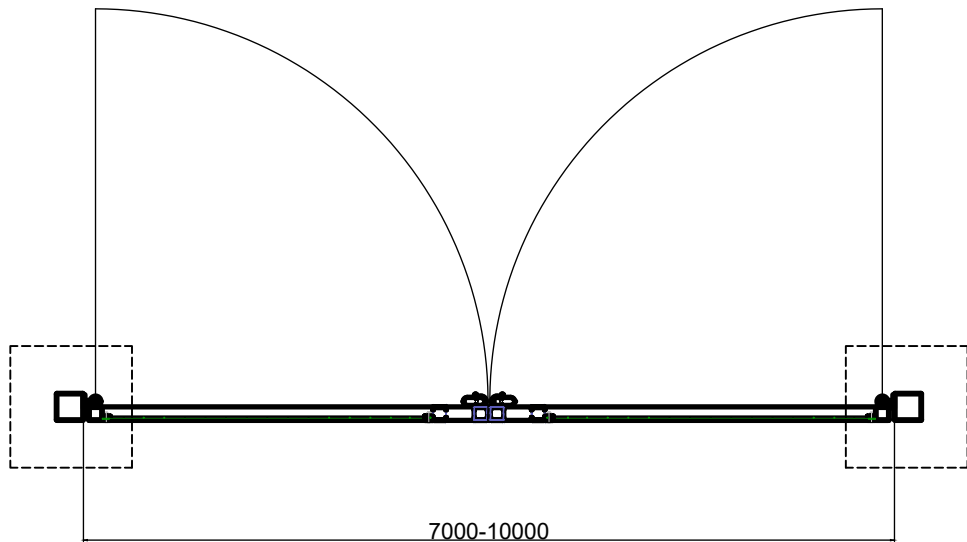
Barbed wire to security overhangs shall be tightly strained and wired at each intersection with extension arms and shall have barbed wire braces at 450mm centres between standards, posts, etc wired onto the barbed wire and the top straining wire

U.4.17 Gates

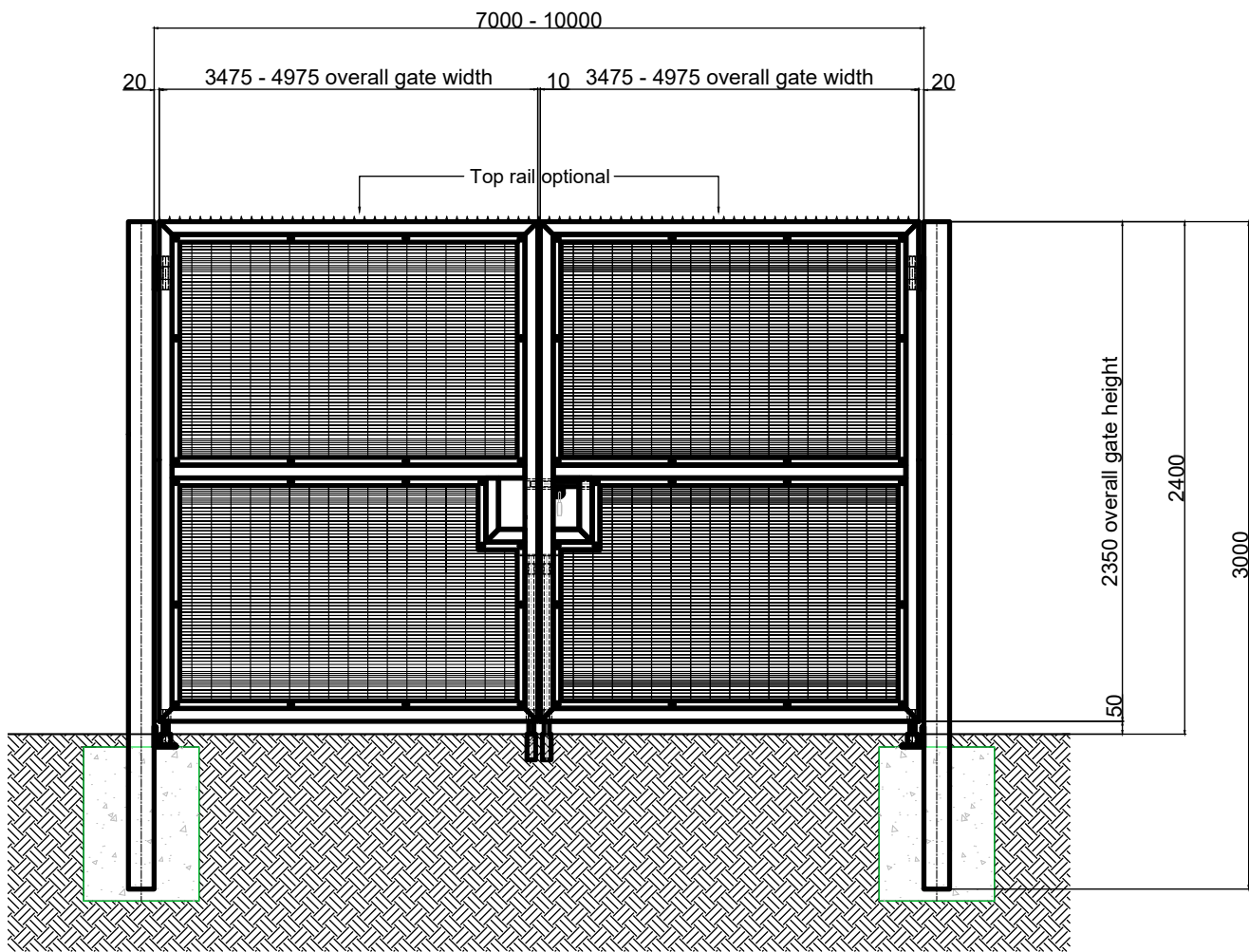
Gates shall be formed of 40mm outside diameter x 2,5mm wall thickness mild steel tubular framework with welded joints, strongly braced as necessary and filled in with wire mesh as described above, properly strained and securely bound to framework with tie wire

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure C: Fence Specification



PLAN LAYOUT



TYPICAL ELEVATION VIEWED FROM OUTSIDE

SPECIFICATIONS

- Gate Construction:
- Gate frame: 38 X 38 x 2MM square tubing.
 - Mesh: Ref 3510 3D
 - Mesh framing: L 50 X 50 x 3mm angle iron.
 - Mesh Clamping flats: Flat 50 x 3 screw fixed to mesh framing flats.
 - Hinges: Each gate leaf shall be equipped with a pair of hinges.
 - Locking devices: The gate assembly shall be fit with two off 20Ø drop bolts and one 16Ø lockable sliding bolt.

- Gate Posts:
- 100 x 100 x 4mm square tubing x 3000mm long.

- Foundations:
- Cast 450mm x 450mm x 600mm deep 15MPa/19 stone at each post.

- Mesh Panels
- Mesh panels shall be ref. 3510 3D, fabricated from high tensile steel with a weld strength of 60% and a tensile strength of 500N/mm2.
 - Horizontal and vertical wires shall have a core diameter of 3.00mm with a tolerance of +- 0,07mm
 - Apertures shall be 76.2mm W x 12.7mm H c/c of wires.
 - Panels are laterally strengthened by incorporation of 43mm deep, V-profiled horizontal stiffener bends.
 - Panel finish size tolerances: width +- 2.0mm and height +-6mm

- Fixings:
- Mesh shall be fixed to gate frame with M8 cup-square bolts, shear-off nuts and flat washers.
 - Fixing Screws & fasteners shall be Grade 304 Stainless Steel.

- Corrosion Protection:
- Mesh Panels: Galvanised and PVC coatings.
 - Posts, Structure, Clamp Plates & Mesh Framing: HD Galvanised.

- Optional Coating:
- Finish colour may be either RAL 6005 Green or RAL 7021 Anthracite.

CVD

TECHNOLOGIES

SECURING WHAT MATTERS

Formally

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REVISIONS

Rev.	Date	Description	Drawn	Checked	Status
drawing title: BETAVIEW 3510 3D - DOUBLE SWING GATE CONSTRUCTION DETAIL - TYPICAL 7m - 10.0m WIDE X 2,4m HIGH					
project:	dwg no:	rev no:	constr:	corr:	width:
TRAN	004	0	DSWG	GEN	7-10.0
height:	product:	profile:	post:	fix with:	config:
2400	3510	3D	S100	FB	-

SCOPE OF WORKS SUPPORTING ANNEXURES:

**Annexure D: Specification For Corrosion Protection - TNPA-
SHEQ PD-Qual-Spec-008**



TRANSNET

SPECIFICATION FOR CORROSION PROTECTION

TNPA-SHEQ PD-QUAL-SPEC-008

Document Number	TNPA-SHEQ PD-QUAL-SPEC-008
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SUMMARY VERSION CONTROL

VERSION NO.	NATURE OF AMENDMENT	PAGE NO.	DATE REVISED
18	Moving from old format to new format		01/08/2023
19	Removing product name collum on all tables	Page 4 and 9	01/09/2024

Note: Only the latest amendments and/or additions are reflected in italics in the body of the document.

DOCUMENTATION SIGN-OFF SHEET

I, the undersigned hereby approve this procedure.

ROLE	CAPACITY/ FUNCTION	SIGNATURE	DATE
Process Owner:	Quality Manager:		01 Sep. 2024
Accepts document for adequacy and practicability. Comments:			

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1. SCOPE

- 1.1 This specification covers Transnet requirements for protective coating of iron and steel structures, electrical motors, gear boxes etc. against corrosion and must be read in conjunction with the main specification as well as the following (latest editions): -

ISO 12944-4 – Types of Surface & Surface preparation

ISO 2409 - Paints and varnishes — Cross-cut test

SANS 1091 for National colour standard (NCS)

2. TYPES OF CORROSION PROTECTION TO BE USED

- 2.1 The coatings specified in this specification are chosen according to ISO 12944-4, as per Table A.1 to ensure adequate protection after 10 years in an environment of frequent salt spray, chemicals and polluted coastal atmosphere. During the 10 years, the normal maintenance painting will be done.
- 2.2 The paint manufacturer shall guarantee the paint for at least 10 years.
- 2.3 Should a tenderer wish to offer coating systems other than those specified, as an alternative, he shall submit full technical details and a list comparing all appropriate details of the alternatives proposed, with the original specified.
- 2.4 Tenderers must ensure that the different coats they offer in their tenders are compatible with each other.
- 2.5 The coating of proprietary items must be done according to Clause 3.
- 2.6 All galvanized components including bolts and nuts but excluding walkway gratings, must be painted with the specified system, unless otherwise approved.

The following coating systems must be used unless otherwise specified in the main specification: -

Substrate	Coat No	Generic Description	Dry Film Thickness (mm)
3CR12 steel	1	Surface tolerant epoxy primer	65-75
	2	Two component recoatable, polyurethane finish (Gloss)	65-75
Galvanized Steel	1	Surface tolerant epoxy primer	65-75
	2	Two component recoatable, polyurethane finish (Gloss)	65-75
Mild steel	1	Two component self-curing inorganic zinc ethyl silicate OR two component zinc rich polyamide cured epoxy primer	65-75
	2	Flexible recoatable high build polyamide cured MIO epoxy	125-150
	3	Two component recoatable, polyurethane finish (Gloss)	65-75

- 2.7 The paint manufacturer's recommendations for the application of the different coating systems, curing time before handling or application of subsequent coats, health and safety recommendations etc. must be carefully adhered to.
- 2.8 Paint contractors must have a quality management system which must be submitted to the Engineer for approval before commencement of the work.

- 2.9 Galvanizing shall be done to ISO 12944-4 heavy duty hot dip galvanizing to a thickness of at least 85µm. Electroplated components in zinc or cadmium are not acceptable.
- 2.10 All mounting bolts, nuts, washers and brackets as well as all fixing bolts, studs nuts and washers, less than 12mm, shall be of stainless steel. Fixing rivets shall be of either stainless steel or brass.
- 2.11 High tensile bolts for friction grip joints must not be galvanized and must be primed and painted after installation. High tensile bolts must be certified.
- 2.12 The full paint system shall be applied to all surfaces except for wear pads, linings etc., which are to be covered with appropriate protection.
- 2.13 For steelwork which will be transported over long distances and erected on site the two pack epoxy primers is preferred.

3. PROPRIETARY ITEMS

- 3.1 Proprietary items such as gearboxes, motors, brakes etc. must either be painted according to this specification or where the coating system is equal to or exceeds this specification sufficient proof of the coating system applied must be provided. Items which are nearly equal to this specification shall be given a finishing coat according to this specification's thicknesses and final colours and to the following procedure: -
 - 3.1.1 A crosscut test must be done to ISO 2409 to determine if the original coating adheres correctly to the substrate.
 - 3.1.2 The original coating shall be rubbed down to remove any smooth finishing to form a suitable key for the finish coat and any damaged areas prepared and patch primed with a suitable primer.
 - 3.1.3 The item must then be detergent washed to remove any foreign matter, taking care that no dust, solvent etc. contaminates any working part of the item.
 - 3.1.4 A test shall be done on the existing coat to ensure that the finish coat will not react with and cause undue dissolving and lifting of the existing coat. This can be done by applying a small quantity of the finishing coat thinners.
 - 3.1.5 Should any undue dissolving or lifting occur, a suitable intermediate or barrier coat must be applied before the finishing coat is applied.
 - 3.1.6 Proprietary items which failed the crosscut test and which generally have inadequate protection shall be dismantled and the full corrosion protection specification applied.

4. SURFACE PREPARATION

- 4.1 All steel surfaces shall be detergent washed and fresh water rinsed to remove all oil, grease and surface contaminates before shot blasting.
- 4.2 Sharp edges shall be radiused and major roughness of welds shall be removed by grinding. Welding spatter and flux shall be removed.
- 4.3 Components manufactured from hot rolled steel sections and steel plate shall be blast cleaned to base metal in accordance with ISO 12944 – 4, grade SA2½ - very thorough blast cleaning, to remove all mill scale, rust, weld spatter etc.
 - 4.3.1 "Sharp" chilled iron shot, chilled iron grit, or granular abrasive slag is to be used to produce a proper degree of surface roughness.
 - 4.3.2 Blast profile shall be determined by micrometer profile gauge, Keane-Tator surface profile comparator or Testex press-o-film.

- 4.3.3 The profile height shall be between 40 and 50µm at any point.
- 4.4 Good quality blast cleaning and spray-painting equipment shall be used. Air used for spraying and blast cleaning shall be free from all traces of oil, water and salinity. Water and oil traps must be fitted to all equipment.
- 4.5 Wheel abrading equipment shall not be used unless an angular profile the same as clause 4.3.3 is achieved.
- 4.6 When wet blasting is done the primer shall be applied before oxidization starts or surface contamination occurs.
- 4.7 Components manufactured from 3CR12 steel shall be lightly abraded. The components shall then be passivated by using a mixture of 10 - 15% nitric acid in water which is rinsed off after 10 - 15 minutes. The surface shall be neutralized to pH 7 before it is coated.
- 4.8 Hot-dip galvanized components, galvanized bolts and nuts etc. shall be lightly abraded with a galvanizing pre-cleaner. The components shall then be washed with detergent and water and washed down with clean water until a water break free surface is achieved. Allow it to dry thoroughly.

5. JOINTS AND MATING SURFACES OF MEMBERS

- 5.1 Mating (faying) surfaces of members which have to be joined by high tensile steel bolts in friction grip shall be cleaned according to Clause 4 and painted with primer only.
- 5.1.1 After being assembled joints so formed shall be seal welded and painted or after the intermediate coat was applied the edges shall be sealed with an approved brand of paintable flexible sealant or mastic (e.g., Butyl rubber, polyurethane sealer or two component epoxy), by means of a suitable caulking gun.
- 5.2 All rivets, bolts, welds, sharp edges etc. must be covered with a "stripe coat" of the primer or intermediate coat specified to ensure the correct dry film thickness on sharp edges, as well as sealing of bolt threads to head etc.
- 5.3 All other mating surfaces must be sealed with an approved brand of flexible Butyl rubber, paintable Silicone, polyurethane sealer or two component epoxy sealer, and joined while still wet. All excess compounds must be completely removed.

6. PAINTING PROCEDURES

- 6.1 Directly before the application of paint, the area to be painted shall be degreased with a suitable degreaser and left to dry.
- 6.2 Paint shall only be applied under the following conditions: -
- 6.2.1 There is adequate light.
- 6.2.2 The steel temperature is between 5 and 50°C and at least 3°C above the dew point of the air.
- 6.2.3 The relative humidity of the air is between the limits specified by the paint supplier.
- 6.2.4 Wind does not interfere with the method used and sand and dust cannot be blown onto wet paint.
- 6.3 Steelwork shall be supported on trestles, at least 900 mm off the ground for painting purposes.
- 6.4 An adequate number of test readings shall be taken per square meter in order to determine the dry film thickness.
- 6.4.1 The paintwork shall be acceptable if the average of the test readings taken falls within or exceeds the ranges given.

- 6.4.2 Paintwork shall not be acceptable if any single test reading is less than the specified minimum thickness.
- 6.5 An ultrasonic or electronic magnetic flux thickness measurement gauge shall be used, but in case of dispute, destructive testing shall be applied. The painted steelwork shall present a clean, neat appearance of uniform colour and gloss as applicable to the paint used. Each coat of paint shall be applied as a continuous, even film of uniform thickness. More than one application of paint may be required to achieve the dry film thicknesses specified or to obliterate the colour of the previous coating.
- 6.6 The use of thinners or solvents at any stage of the work is prohibited, unless specified by the paint manufacturer.
- 6.7 Precautions shall be taken to prevent coatings from being applied to equipment nameplates, instrument glasses, signs etc.

7. COLOUR CODES

Machinery and equipment shall be painted in the following final colours: -

Area	Colour	Code No. [SABS 1091 and International No's]
Mobile equipment (cranes, loaders etc.)		
a) Structure, machinery and electrical houses, operator's cabins, chutes, hoppers etc.	Transnet White	RAL 9016 RAL 7024 (Graphite gray)
b) Undercarriage, travel rubber tyred rims bogies, Industrial buildings, structures conveyor	Transnet dark grey	SABS 1091 GO4 (Blue grey) BS 381C-633
General		
a) Guards	Golden yellow	SABS 1091-B49 RAL 1003
b) Sheaves	Orange	RAL 2008
c) Cable reels (Stainless steel)	Orange	RAL 2008
d) Machine buffers and parts of machine which could constitute a serious hazard	Golden Yellow (High Gloss) with Luminous green stripes in chevron pattern	SABS B49 and Luminous green
e) Any exposed rotating part of machinery, electrical Switchgear (other than starting and stopping devices and emergency stop control), electrical services e.g. conduit and allied fittings	Light Orange (High Gloss)	SABS 1091 B26 BS 381C-557
f) Low voltage switchgear panels	Light grey	SABS 1091-G29
where orange is not aesthetically acceptable		BS 381C-631
g) medium voltage cable trays, switchgear and motors (3,3 kV and up)	Oxford Blue	SABS FO2 BS 381C-105 RAL5003
h) Starting devices, low voltage cable trays and switchgear	Mid Brunswick green (high gloss)	BS 381C-228 SABS1091-EO4 RAL6005
i) Parts of stationary machinery (Electrical, motors, gearboxes, brakes, transformers, etc.)	Light Grey	SABS G29 BS 381C-631

Area	Colour	Code No. [SABS 1091 and International No's]
j) Hand levers, hand wheels, oiling points, handrails on walkways, ladders	Golden Yellow (High Gloss)	SABS 1091 B49 BS 381C-356
k) Stopping devices, grease points, motor fan covers and danger signs (not symbolic safety signs for which see SABS 1186)	Signal red (High Gloss)	SABS 1091 A11 BS 381C-537 RAL3001
l) Walkways (non-slip surfaces) (galvanized gratings not to be painted)	Shop floor green	
m) Informatory signs and notices (not symbolic safety signs for which see SABS 1186)	White on Emerald Green (High Gloss)	White on SABS 1091 E14 BS 381C- 228
Pipelines		
a) Reclaim water piping	Aluminium	
b. Slurry pipelines	Dark admiralty grey	SABS 1091-G12
c. Fire protection piping	Signal red	SABS 1091-A11
d. Wash water drainpipes	Light grey	SABS 1091-G29
e. Instrument air	White with Strong blue band	White and SABS 1091-F11
f. Plant air	White with Flag blue band	White and SABS 1091-FO4
g. Potable water	Grass green	SABS 1091-D14

Colour bands for pipes shall be 75 mm wide for pipe sizes up to 150 mm diameter and 100 mm wide for 150 mm and above. The colour bands shall be applied to the pipe flanges, valves, junctions, walls or structures etc. in such a manner that the pipe may be easily identifiable. On straight sections the maximum spacing shall be 100 x the pipe diameter.

8. FIELD TOUCH-UP PAINTING

- 8.1 Damaged and unpainted areas, fasteners, welds, etc. shall be cleaned by wire brushing with a hand tool or power tool to minimize damage to sound paint. Grinding will not be allowed. Rust spots shall be cleaned to bright metal. Thick edges of old paint abutting bare metal surfaces shall be feathered by scraping and sanding.

8.1.1 Where welding is required on areas already coated with the coating system, the coat should be stepped back for ± 30 mm around the weld area.

- 8.2 The paint shall be applied to match the original coats in accordance with the manufacturer's recommendations for the specific paint system.

Note: Inorganic zinc primers shall not be re-covered with an inorganic primer, but only with an organic zinc primer.

- 8.3 Areas of damaged galvanizing shall be repaired with an approved cold galvanizing product or metal sprayed by the wire spraying process with Zinc, and then touched up with the specific paint system.

9. GENERAL

- 9.1 All walkways, floors, maintenance platforms etc. must be painted with a durable, nonskid coating of the appropriate colour.
- 9.2 Exposed machined surfaces must be coated with a strippable corrosion inhibitor (e.g., Tectyl).
- 9.3 Where different materials will be in contact with each other, and galvanic corrosion can occur the contact areas of the materials must be isolated from each other, or the joints made waterproof to prevent ingress of moisture.
- 9.4 All components must be designed with corrosion prevention in mind and specifically the following: -
- 9.4.1 No entrapment of dirt, product, moisture etc.
 - 9.4.2 No areas must be inaccessible for maintenance such as too narrow gaps etc.
 - 9.4.3 Large flat areas rather than complicated shapes and profiles.
 - 9.4.4 No sharp corners and discontinuous welds.
- 9.5 Parts of equipment which are exposed to high temperatures must be coated with the following system: -

Coat No	Generic Description	Dry Film Thickness (mm)
1	Two component self-curing inorganic zinc ethyl silicate	65-75
2	Single component high temperature moisture curing silicone with aluminium flakes	40

10. MAINTENANCE PAINTING OF STRUCTURES

- 10.1 Areas which are only lightly corroded must be cleaned by means of high-pressure water blasting or wire brushing by power tool and the following system applied: -

Coat No	Generic Description	Dry Film Thickness (mm)
1	Surface tolerant two pack epoxy primer with aluminium pigments	125-150
2	Same as first coat OR micaceous iron oxide (MIO) epoxy	125-150
3	Two component recoatable, polyurethane finish (Gloss)	65-75

- 10.2 Alternatively, the Noxyde paint system can be used, consisting of two to three coats of water based Noxyde paint to achieve a DFT of 350 to 400 microns. Where the Noxyde system is used on areas other than slightly corroded structural areas, the following additional requirements must be observed:

10.2.1 Very smooth surfaces (e.g., 3CR12, stainless steel or hot-dip galvanized components, bolts, nuts and fittings, and HT bolts): Parts must be thoroughly degreased using OptiDegreaser, washed down with potable water, and immediately when dry, a single coat of OptiPrimeAqua applied.

10.2.2 Paintable flexible sealant/mastic: Only sealant approved by the paint manufacturer may be used, and an initial coat of OptiPrimeAqua applied over it before the further coats of Noxyde are applied.

10.2.3 Bolted/riveted connections: After blasting or and/or cleaning as required, apply a coat of OptiPrimeAqua and an additional stripe coat of Noxyde, in contrasting colour, to all bolt/nut and plate edges and crevices.

- 10.3 The adhesion of old coatings must be verified by doing a crosscut adhesion test on selected areas.
- 10.4 The compatibility of the new paint system on the old coating must be tested and guaranteed in writing by the paint supplier.
- 10.5 The work and coating system must be guaranteed for a minimum of 12 months.
- 10.6 All heavily corroded areas must be shot blasted to minimum SA2 and the three-coat system indicated in clause 2.6 applied.
- 10.7 Areas where the old coating is still sound need only be high pressure cleaned with a suitable solvent and coated with one of the primers suggested in clause 10.3 (as tie coat) and then with one of the topcoats suggested in clause 2.6 to get the appropriate colour and finish. The minimum dry film thickness of this tie coat must be 75 microns and topcoat must be 50 microns, but the previous coating colour shall be completely obliterated to present a uniform colour.

Note: Inorganic zinc primers shall not be re-covered with an inorganic primer, but only with an organic zinc primer.

- 10.8 Repairs to the insides of all the enclosed sections of the booms as well as the insides of the crane legs, sill beams, cross beams, pylon cross bracing members etc. shall be done as above but the topcoat need not be applied.

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure E: Specification for the supply, delivery, offloading, installation and commissioning of diesel driven standby generator sets

**SPECIFICATION FOR THE SUPPLY, DELIVERY, OFFLOADING AND INSTALLATION
AND COMMISSIONING OF DIESEL DRIVEN STANDBY GENERATOR SETS**

REVISIONS		
REV	DATE	APPROVED
01	30/05/2017	SM

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SECTION A

STANDARD SPECIFICATION

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GENERAL STANDBY PLANT SPECIFICATION – TECHNICAL

A1 GENERAL:

This section of the specification covers the standards for the design, manufacture, delivery to site, off-loading on site, commissioning, testing and handling over in full working order the standby plant and ancillary equipment necessary to comply with the specified requirements.

A2 PLANT:

- 2.1. General: The diesel generator plant and ancillary equipment offered shall be capable, at any time and under any ambient conditions likely to occur at site, of meeting the load requirements stated in Section B7.
- 2.2. Operation: The diesel generator plant and ancillary equipment normally operate as an automatic mains failure installation and shall be capable of delivery rated output to the essential loads detailed in Section B7. The diesel generator plant and ancillary equipment will not be required to be synchronised with the mains.

A3 SITE RATING:

All plants offered shall be capable of providing the required and specified outputs at site conditions but, for comparative purposes, tenders shall also state the sea level ratings of their plants.

The general plant and ancillary equipment shall normally operate as an automatic mains failure installation and shall be capable of delivering rated output in accordance with A DIN 8270/6271 (continuous rating with 10% overload capability for one hour continuous in eighteen hours) to the essential loads.

A4 DELIVERY REQUIREMENTS:

Nil

A5 TENDERING INFORMATION REQUIRED:

- 5.1 General: Tenderers shall submit with their tender's full technical details of all engines, generators, machines, equipment and ancillary equipment offered, together with any relevant descriptive leaflets, illustrations, standard drawings and documents. In addition, the schedule of technical information shall be completed in full and submitted with the tender.

Failure to provide any of the above requested information may lead to disqualification of tenders.

- 5.2 Drawings: Tenderers shall submit with their tender dimensioned drawings showing the general layout of the offered plant and all buildings and structural details required for its installation and operation.

Within one month of the receipt of order the successful tenderer shall submit three prints of drawings for approval. The drawings shall include the layout and schematic of all electrical panels and boards; schematic of the complete electrical systems, battery and automatic battery chargers; schematic of the fuel system; dimensioned layout of the complete plant including all piping, cabling, etc., and any other drawings the Engineer may require for the approval of the proposed installation.

At the time of hand-over of the plant the successful tenderer shall provide and mount suitable wall frames, with clear Perspex front, with "as installed" prints of the above specified schematic and general layout drawings.

- 5.3 All items to be included: Tenderers will be deemed to have included all items for the proper operation of the standby plant, notwithstanding that such items may not be referred to in the specification unless he qualifies his tender accordingly. In such instances he shall submit a quotation at the time of tendering for the items omitted onto the inner canopy door.

A6 CIVIL WORK:

The contractor shall notify the Engineer and the main contractor of the

position and sizes of any holes, sleeves, recesses, chases, etc., that will be required in good time to enable these to be provided during the course of construction in order that no unnecessary expense may be incurred.

The cost of the above and of all such cutting away and making good will form part of this contract.

The contractor will be held responsible for the sizes and positions of holes, sleeves, recesses, chases, etc., required.

A7 REGULATIONS AND BY-LAWS:

The whole of the work shall be carried out in strict accordance with the Power Supply Authority's regulations and current edition and addenda of the SANS 10142-1 "Code of Practice for Wiring of Premises". The requirements of the Mines Works and Machinery Regulations and the "Machinery and Occupational Safety Act" and of any Local Municipal Regulations and By-laws or such other relevant Regulations or By-laws which have the force of law shall be compiled with. The onus will be on the contractor to ensure that all such regulations or requirements are complied with. Should any compliance entail a modification of the Specification the matter shall be referred to the Engineer before or at the time of tendering. No claims for extras arising out of the need to comply with Regulations or By-laws will be considered.

A8 TESTING AND COMMISSIONING:

- 8.1 General: Any instruments or equipment required for testing shall be provided by the successful Tenderer.

Notwithstanding the carrying out of any tests at the manufacture's works or the submission of any test certificates, the supplier will in no way be relieved of his responsibility for the successful and efficient operation of the Standby plant and ancillary equipment on site or of his liability for its conforming to any relevant laws.

- 8.2 Inspection and Test by the Engineer: The Engineer shall be entitled at all reasonable times during the currency of the contract to inspect, examine and test any of the work, material, equipment and workmanship of the Sub-

contractor works, at the Contractor's premises or at the premises of any outside suppliers of equipment for the Sub-contract works.

The contractor shall provide such attendance and assistance as may be required for such inspections or tests.

- 8.3 Commissioning: The final commissioning of the standby plant shall be carried out in the presence of the Engineer. All lubricating oils used during the commissioning shall be drained after commissioning of the plant in the presence of the Engineer and replaced with the new lubricating oils on handover. Commissioning shall be carried out by the manufacturer upon successful installation of the generator by the competent electrical contractor approved by the engineer on site. The standby plant shall be load tested with SABS calibrated resistor banks that are rated to the load capacity of the standby plant. The test will be carried out in the presence of the engineer.
- 8.4 Fuel Oil: The contractor shall supply all fuel oil used during commissioning and testing and shall hand-over the standby plants with full fuel and oil tanks – (Bulk and Day tanks).
- 8.5 Handbook and Maintenance Instructions:
At the time of handover, the contractor shall provide 4 copies of:
- (i) All the drawings referred to in Clause 5.2.
 - (ii) A fully comprehensive operations handbook with maintenance instructions.
 - (iii) A list of spare parts complete with names and addresses of the supplier.

All the above information shall be collected and bound in loose leaf hard-covered binders suitably numbered and indexed. The front covers shall clearly state the job name, contractor's name, address and telephone numbers (normal business, after hours and emergency).

- (iv) Logbook: At the time of commissioning the successful tenderer shall provide a logbook, duly approved by the Engineer. The logbook shall be placed on a suitably sized shelf unit or in a suitable metal box mounted in the prominent position on the inside of the canopy door.

A9 GUARANTEE AND MAINTENANCE:

- 9.1 General: The Sub-Contractor shall guarantee and maintain the contract works for a period of twelve months after hand over. During this period the contract works shall be maintained as set out in Clause 9.3 by the contractor and any defective material, equipment or workmanship (excepting only proven wilful or accidental damage, or fair wear and tear) shall be made good without inconvenience to the client at the contractor's expense and to the satisfaction of the Engineer. The guarantee period will only commence upon successful commissioning and handover of the equipment in proper working order to the client.
- 9.2 Making Good: When called upon by the Engineer the contractor shall make good on site and shall bear all expenses incidental thereto including making good work by others which may arise out of removal or reinstallation of equipment.

The contractor may delegate such making good to an approved party. All work arising from the implementation of the guarantee or maintenance of equipment shall be carried out at a time which will be indicated by the Engineer.

If any defects are not remedied within a reasonable time the Engineer may proceed to do the work at the contractor's risk expense, but without prejudice to any other rights which the Client may have against the contractor.

- 9.3 Maintenance: At quarterly intervals during the maintenance period of twelve months, the contractor shall adjust and maintain the Standby Plant and its ancillary equipment in proper working order. As a minimum requirement the contractor shall:
- (i) Check and top-up if necessary the fluid levels in the cooling systems, engine sumps, and batteries.
 - (ii) Test run the standby plant and ancillary equipment for a period of 30 minutes.

- (iii) Wipe down the standby plant and ancillary equipment and report any evidence of any fluid leaks or other defects
- (iv) Check batteries.

The cost of such inspections, maintenance, adjustments, repairs, etc. shall be included in the tenderer price but the cost of renewing any parts which may become worn through fair wear and tear, or damaged beyond the control of the contractor (provided this is not due to unsuitable design) shall be excluded.

If during the guarantee and maintenance period the standby plants are not in working order for any reason for which the contractor can be held responsible then the contractor will be notified and immediate steps shall be taken by him to remedy the defects. Should the standby plants defects be so frequent as to become objectionable or should the equipment otherwise prove unsatisfactory during the guarantee period of twelve months the contractor shall, if called upon by the engineer and at his own expense, replace the whole or such parts thereof as the Engineer may deem necessary with equipment to be specified by the Engineer.

Approval of the equipment installed shall be considered as provisional only and shall not invalidate the client's rights as indicated above.

A10 DIESEL ENGINES:

- 10.1 General: The engines shall be of reciprocating, compression ignition four stroke, liquid fuel type with a running speed not exceeding 1500 rpm. The engine shall be capable of delivering the specified output continuously at the stated site conditions and shall do this without overheating. The engine and radiator shall comply with BS 5513 or A DIN 6271 as amended, and where applicable shall be built together with the brushless alternator and shall be close coupled via a flexible coupling mounted on a steel base frame (duplex or simplex) with resilient anti-vibration mountings.

The skid base shall be suitable for installation direct onto the reinforced concrete floor. A torsional vibration analysis test certificate must be supplied

after installation. The engines shall be fully derated for site conditions in accordance with BS 5514 or DIN 6270/6271 as amended.

- 10.2 Starting: The engine shall be easily started from cold, under summer as well as winter conditions, and shall be capable of supplying the specified loads immediately change-over occurs. The total time taken for the diesel generator plant to achieve stabilised running from the start shall not exceed 10 seconds. Thermostatically controlled water jacket heaters shall be fitted and full details of such equipment shall be submitted with the tender.
- 10.3 Starter Method: The engine shall be fitted with a direct current electric starting motor rated for operation from a battery of not less than 12 volts.
- 10.4 Starters and Control Batteries: The starter and control battery shall be a gel type maintenance free, automotive battery. It shall be adequately rated to provide three automatic starts immediately followed by three manual starts without any appreciable permanent voltage drop but the voltage drop during cranking shall not exceeded 25% of the nominal battery voltage. Only reputable approved "maintenance free" gel type batteries shall be supplied.

The battery shall be placed on suitable plastic lined or coated battery stand which shall stand in a suitable acid resistant tray resting on the standby plant room floor. The battery shall be connected to the starter motor with suitably rated and insulated flexible cables and the battery terminals shall be greased to minimised chemical attack. Note that neither the positive nor the negative terminals of the battery or starter shall be earthed.

- 10.5 Battery Charging Equipment: The charging equipment shall be connected so that the battery is normally charged from the mains, but is also charged under mains failure conditions from the diesel generator plant via an inhibitor relay to prevent dual charging. The charging equipment shall include a suitable ammeter and protection equipment.

The trickle charging equipment shall be incorporated in the standby plant switchboard and shall be of the two stage type (ie. booster and trickle charging).

- 10.6 Cooling System: The engine shall be either water cooled or air cooled and full details of the cooling system shall be included with tenderers. Although the plant is used for standby purposes it must be appreciated that the engines shall be continuously rated (refer to Clause 3) and cooling system shall be designed accordingly.

Where specified elsewhere suitable ducting shall be provided and fitted between the radiator and the ventilation air outlet louver. In the case of air cooled engines suitable ducting shall be provided between the room air intake louver and the cooling air intake of the engine.

The ducting shall incorporate a suitable flexible section to minimise vibration transmission.

Whether water cooled or air cooled engines are offered, a suitable engine driven or independently driven fan shall be provided for adequate engine and standby plant room ventilation when the plant is operating. A protective device shall be fitted to the engine to prevent operation at excessive engine temperatures.

- 10.7 Lubrication: Lubrication of the main bearings and other moving parts shall be by force feed system. A pressure sensitive device shall be fitted to prevent operation of the engine at low engine oil pressure.

The engine shall be handed over with the first fill of new oil.

- 10.8 Fuel System: The fuel system shall comprise the following:

- (i) Fuel Tank (Day Tank): The plant shall be equipped with either a floor mounted tank of sufficient capacity for at least 18 hours running all the engines at full-load. The fuel tank shall be fitted with the following items:
 - (a) Sludge trap (dished bottom) with drain valve and cleaning access and drip pan.
 - (b) Easily removable, dust proof lid.
 - (c) Fuel level indicator other than a sight glass to provide "Full", "Fill" and "Low" indication.
 - (d) Outlet valve positioned 50mm above tank bottom.

- (e) Injector leak-off return fitting
- (f) Low fuel alarm float switch to operate an alarm enunciator device specified subsequently.
- (ii) Fuel Tank (Bulk Tank): This shall be an underground type as specified in Section C.
- (iii) Fuel Piping: All necessary interconnecting fuel piping shall be provided and installed by the Sub-Contractor. All piping shall be zinc free corrosion protected and colour coded in accordance with the SABS code.
- (iv) Injection Equipment: The fuel injection equipment shall be suitable for trouble-free operation with commercial brands of diesel fuel normally available in South Africa.
- (v) Hand Pump: The Sub-Contractor shall supply and install on the day tank, a hand pump with the delivery pipe permanently connected to the fuel tank and with a flexible suction pipe to fill the fuel tank from drums of diesel fuel.

All fuel used during commissioning etc., shall be supplied by the Sub-Contractor. The engine shall be handed over with the bulk tank full.

10.9 Ventilation Air Louvre's: Ventilation louvers shall be supplied as part of the 3CR12 Stainless steel IP55 enclosure. Detail of the ventilation louvers' must be given with the tender.

10.10 Exhaust Gas System: An exhaust gas system shall be provided. The exhaust pipes shall be flexibly fitted to the engines and shall discharge outside the weather protected enclosure at a point to be approved by the Engineer. The exhaust gas system shall be adequate size and gauge, taking due account of the possible route, and the materials to be used shall be approved by the Engineer.

Within the plant enclosure and in all areas where the exhaust pipe are within reach of any person they shall be lagged with an approved material, and clad with 0,5mm thick sheet material sleeves. The exhaust pipes shall

be neatly supported on suitable brackets with expansion joints and spring supports. Silencers shall be provided with the exhaust pipes.

- 10.11 Governor: The speed of each engine shall be controlled by a governor. Class "A1" governing, in accordance with BS5514, as amended, shall be provided together with an external means of adjustments of the nominal speed setting by +/- 5% at all loads between zero and rated load.
- 10.12 Flywheel: A flywheel shall be provided to ensure that cyclic irregularity of the engine shall be within the limits specified in BS5514 or DIN 6270/6271 as amended.
- 10.13 Engine Mounted Instruments: An instrument panel with anti-vibration mountings incorporating the following instruments with suitable limit markings shall be provided on each engine:
- a. A water temperature gauge.
 - b. A lubrication oil pressure gauge.
 - c. A mechanical driven running hour meter (smallest unit indicated to be one hour).
 - d. An engine speed indicator.
- 10.14 Accessories: The engine shall be complete with all accessories, intake air filter, operation and instruction manual, spare parts list etc.

A11 BRUSHLESS ALTERATIONS:

- 11.1 General: The alternators shall be of the self excited brushless type with enclosed ventilated drip proof housing, and shall be capable of continuously delivering the output to meet the load requirements stated in Section B7. The alternators shall be generally constructed and rated in accordance with BS 5000, as amended and shall be capable of supplying a 10% overload for the period stated therein.
- 11.2 Regulations and Response: The alternator shall be self-regulated and shall

incorporate a self contained automatic voltage regulator. The voltage regulator shall not exceed $\pm 2,5\%$, from no load to full load, including cold to hot variations at any power factor between 0,8 lagging and unity and inclusive of speed variations within the limits stated in Clause B10.11

Upon application of full load at a power factor of 0,8 lagging the alternator voltage shall recover to within 2,5% of the steady state value within approximately 300 milliseconds.

Upon application of any load specified the transient maximum voltage dip shall not exceed 20% of the nominal voltage when measured at the generator terminals.

- 11.3 Bearings and Coupling: The brushless alternator shall be of the two bearings type directly coupled to the engine by means of a bell housing or flanged adaptor ring in such a manner as to ensure permanent alignment of the alternator and the engine. The engine vibrations and irregularities in excess of those detailed in BS 5514 or A DIN 6270/6271 as amended, shall not be transmitted to the alternator. Single bearing type shall only must be approved prior to tender and a torsional test must be supplied prior to supply.

A12 STANDBY PLANT SWITCHBOARD:

- 12.1 General: The standby plant switchboard shall be manufactured from 3CR12 stainless steel in either a metal clad cubicle pattern mounted on the wall or floor. The board steelwork shall be degreased, treated with a rust preventative, primed and finished with two coats of electrical orange powder coated paint.

The board, suitably labelled, shall be fitted with all the equipment necessary for control, protection, automatic operation and proper functioning of the complete plant and it shall be fully wired to suitably accessible terminals and terminal strips. However, no terminals shall be provided for the incoming and outgoing mains.

All control wiring shall be done in 1mm coloured PVC conductors throughout. All wiring terminations must be numbered and ferruled with

non-deteriorating ferrules. All wiring terminals must be by means of either OBA or 2BA terminals or by means of crimped lugs or directly into a socket where the wire is crimped lugs or directly into a socket where the wire is crimped by a screw which is so fixed that it will not become loose due to vibration or any other cause.

An approved gland plate and earthbar shall also be provided and fitted inside the board.

A mimic diagram of the feeders, breakers and change-over breakers shall be painted onto the front panel of the switchboard.

12.2 Equipment on Standby Plant Switchboard:

Note: The prospective fault level at this board shall be as state in Section B7.

Equipment Installed:

1 x TP Mains isolators with two operating positions labelled "off" and "on" rated as specified in Section B7. The main incoming cables or busbar shall be terminated to this point.

1 x TP Generators ACB, with two operating positions labelled "off" and "on", mounted adjacent to the Mains Isolator. The ACB shall be rated to suit the generator offered and shall have both adjustable thermal and instantaneous overload elements. Provide a label: "In case of emergency isolate both switches" below these two switches. Auxiliary contacts shall be fitted to meet the operational alarm requirements.

1 x Sets of TP automatic change over on-load circuit isolators with motor operated mechanisms suitably rated and with appropriate auxiliary and control contacts. The electrical and mechanical interlocking arrangements of these changeover breakers shall be to the approval of the Engineer. A key switch shall be with two positions "Standby" and "Direct" with the key retained in the direct position. It shall be possible, by the operation of this switch, to operate the changeover breakers, and thereby provide a direct bypass function without control of the normal automatic circuitry.

1 x On load main bypass switch on enable the mains to be connected directly to the load.

1 x Flush mounted 100 x 100mm dial voltmeter, sealed 0-400 volts, complete with a set of HRC fuses or MCBs.

1 x Flush mounted 7 position voltmeter selector switch with positions engraved as follows: "Red-White", "White-Blue", "Blue-Red", "Off", "Red-Neutral", "White-Neutral", "Blue-Neutral".

1 x Flush mounted 100 x 100mm dial vibrating reed frequency meter, scaled 47-50-53 Hertz.

1 x Set per incomer of HRC fuses or MCBs for the frequency meter and generator voltage sensing unit.

3 x Flush mounted 100 x 100 dial ammeters (with a set of appropriate ratio CTs) suitably scaled for the generator rating and with suppressed overload scale.

1 x "English Electric" Test terminal block with suitable CTs.

1 x Automatic control panel for the protection, supervision and operation of the diesel generator set. Solid state printed circuitry shall be used wherever possible and the control panel shall incorporate the equipment and features specified hereunder. DC connections and AC connections shall be made of separate terminal strips.

This control panel shall include the following:

- (a) Automatic starting device to give three automatic start attempts of 10 seconds each, with 10 second intervals between attempts and lockout after the third start failure. Lockout shall initiate an alarm device specified subsequently.
- (b) Mains voltage sensing units on each incomer, initiation on mains failure. This shall be adjustable from 0-10 seconds and connected to the mains via a MCB. This shall start the plant in the event of a voltage drop on any one

or combination of phases of more than 20% of the nominal voltage.

- (c) A separate time delay unit shall be provided to ensure that after restoration of the mains supply, the diesel plant will continue to supply load for an adjustable time of thirty seconds in order to ensure that the mains supply has stabilised before the essential loads are reconnected to the mains.
- (d) For water cooled engines only an off load stop delay timer shall be provided to enable the set to run for a further 5 minutes before shutting down.
- (e) Generator voltage sensing unit connected to the generator output to trip the generator change over breakers in the event of a voltage drop on any one or combination of phases of more than 20% of the nominal voltage. Provide an alarm annunciator device as specified subsequently.
- (f) Status selector switch labelled "off", "auto" and "test without load" with contacts to meet the operational requirements.
- (g) A set of alarm annunciator and/or drop trip devices. Each annunciator device shall have a resettable alarm giving visual indication of the specific fault, with a test facility or other approved arrangement. Any alarm condition shall illuminate a common alarm lamp which shall only be cancelled when the fault condition has been rectified and restored to normal and the appropriate alarm has been reset.

The following alarm annunciator and/or trip devices shall be installed.

	Alarm	Trip
High Engine (Temperature)	X	X*
Low Engine (Temperature) (water jacket)	X	
Alternator under voltage	X	X
Start sequence failure	X	
Low Fuel Level	X	

Low Oil Level X

*(At higher temperature than the alarm)

- (h) Automatic starters for any ventilation fans, circulating water pumps etc. that may be required. All starters shall operate automatically as soon as the standby generator has started.

A13 PLANT OPERATION:

- 13.1 Normal: For normal operation as an automatic mains failure plant the mains isolator shall be set to the "on" position, the bypass key switch shall be set to set the "standby" position, the generator ACB shall be set to the "on" position, and the status selector switch shall be set to the "auto" position.

Under these condition the plant, after an adjustable delay, shall start automatically to the event of a mains failure, the automatic changeover breakers shall operate and the essential loads shall be applied. When the mains supply has been restored the plant shall continue to operate on load thirty seconds after which the, load will be reconnected to the mains and, in the case of water cooled engines, after a further five minutes delay the plant shall automatically shut down.

- 13.2 Testing, etc: For operation during routine maintenance and testing, etc, the following conditions arise:

- (a) With the status switch set to "test without load" (and the main isolator, bypass key switch and generator ACB are set to "on", "Direct" and "on" respectively) the plant shall start automatically, the automatic change-over breakers shall not operate and the load will not be applied. When the status selector switch is returned to the "auto" position the plant shall automatically and immediately shut down without running through the time delay sequence referred to in Clause 13.1. Should the mains supply fail whilst the status selector switch is in the "test" position, the plant shall be loaded by returning the status selector switch to the "auto" position and the bypass key switch to the "standby" position. Thereafter the plant shall continue to operate on load until the mains are restored after which the plant

shall automatically shut down in Clause 13.1.

- (b) If the status selector switch is set to the "test without load" position while the bypass switch is in "standby" position and the mains isolator and generator ACB are both in the "on" position, the plant shall start automatically, the automatic change-over breakers shall not operate and the load will not be applied. When the status selector switch is returned to the "auto" position the plant shall automatically and immediately shut down. Should the mains supply fail whilst the status selector switch is in the "test" position the plant shall be loaded by returning the status selector switch to the "auto" position. Thereafter the plant continue to operate on load until the mains are restored after which the plant shall automatically shut down as in Clause 13.1.
- (c) With the status selector switch set to "test without load" and the generator ACB set to the "off" position (while the mains isolator is in the "on" position and the bypass switch is in either the "standby" or the "direct" position) the plant shall start automatically, but the frequency meter will not operate. Under mains failure conditions the generator ACB will have to be set to the "on" position, the status selector switch to the "auto" position and the bypass switch to the "standby" position for the plant to be loaded.
- (d) If the status selector switch is set to the "off" position, whilst the mains isolator, bypass switch and generator ACB are set to "on", "standby" and "on" respectively, the mains change-over breakers shall be de-energised and the essential loads will not receive any supply. When the status selector switch is returned to the "auto" position the mains change-over breakers shall immediately operate without running through the time delay sequence referred to in Clause 13.1.
- (e) When the status selector switch is set to the "off" position the plant shall be inoperable, irrespective of the position of the bypass switch. All alarms shall not operate under this condition, but the battery charger shall still remain operational. Under mains failure conditions the essential loads will not receive any supply.

- (f) When the mains isolator or the bypass switch or the generator ACB or the status selector switch are moved away from their normal positions an alarm indication shall be given. This alarm shall indicate that the position of one or more of the isolator ACB or switches is incompatible with the operation of the plant as an automatic mains failure installation.

A14 WARNING NOTICES:

Clearly legible and indelible notices made of non-corrodible and non-deteriorating material, preferably plastic, shall be worded and mounted in conspicuous positions on the diesel engine and standby plant switchboard. These two notices shall read as follows:

DANGER

THIS ENGINE WILL START WITHOUT NOTICE. TURN STATUS SELECTOR SWITCH ON CONTROL PANEL TO "OFF" POSITION BEFORE WORKING ON THE PLANT.

GEVAAR

HIERDIE ENJIN SAL SONDER WAARSKUWING BEGIN LOOP. DRAAI STATUS KEUSESKEKELAAR OP BEHEERPANEEL NA "AF" POSISIE VOORDAT AAN DIE MASJIEN GEWERK WORD.

A15 ELECTRICAL:

- (1) General: Tenderers shall allow for all cables, wiring, installation and connections in the standby plant enclosure between the diesel generating plant and the standby plant switchboard. General purpose PVC/ECC/SWA/PVC cables to SABS 150/1970 shall be used throughout, and, where necessary, shall be adequately supported on both horizontal and vertical runs of cable by means of galvanised perforated metal cable trays adequately supported by means of substantial angle iron brackets or other approved means, bearing in mind the number and weight of the cables to be supported.

Where necessary tenderers shall suitably derate cables for proximity of lay, etc. and tenderers shall note that there is not provision for laying cables in cable trenches.

The neutral point of the generator shall be solidly connected, by means of an appropriate size of insulated earth conductor, to the earthbar mounted on busbar insulators in the standby plant switchboard. All plant, ancillary equipment and steelwork in the standby plant room shall be suitably bonded together with an appropriate size of bare copper tape which shall also be connected to the earthbar.

The Sub-Contractor shall ensure that the mains and generator phase rotations are identical.

SECTION B

DETAIL SPECIFICATION

SCOPE OF CONTRACT, SPECIAL CONDITIONS, ELECTRICAL LOADS AND COMMISSIONING

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B1. SCOPE OF CONTRACT:

The Contract shall be for the manufacture, supply, delivery, offload, installation testing, commissioning and handing over in proper working order of Diesel Driven Standby Generating Plants as specified in Clause B7.

B2. SITE LOCATION AND CONDITIONS:

The sites are located in four different areas as listed below, however it does not exonerate the tender from contacting the engineer prior to delivery of the equipment:

Berth B100, Port of Ngqura, Port Elizabeth

The plant shall be located on a concrete plinth and craineage for offload must be allowed for.

The plant shall be rated to suit the local conditions of the various areas as stipulated above.

B3. APPROVAL AND SUBSTITUTION OF MATERIALS:

Where materials or articles are specified in the Detailed Specification, it is to indicate the quality and type of materials or articles required. Where the term "or equal and approved" and "or other approved" is used in conjunction therewith, it shall mean that no substitution will be permitted unless written authority has been obtained from the Engineer before tenders close.

Approval by the Engineer shall not relieve the Contractor of any of his obligations under the Contract, the guarantee, or compliance with the requirements of the Authorities having jurisdiction.

B4. SPECIALIST FIRMS:

Tenderers are to note that only firms specialising in Standby Generating Plant and with local branches for back-up service will be considered. Tenderers may be

required to produce proof of previous contracts completed.

B5. PLANT ROOMS:

Plant rooms are to be constructed by the sub contractor. Tenderers are to ensure that the plants are sized to fit the areas provided with sufficient space around the units for maintenance and inspection purposes. Details of any deviations from the details provided are to be highlighted at time of tender.

B6. PLANT ROOMS VENTILATION:

Tenderers are to ensure that the ventilation requirements for the inlet and exhaust air are suitable for the plant offered. Any additional information is to be clearly stated at time of tender.

All louvers are to be supplied by the Standby Generator Contractor for installation by contractor. The exhaust louvers are to be constructed as to allow the removal of the machine through the clear opening if so required at a future date. All necessary ducting shall be provided between the radiator and the exhaust louvers.

B7. STANDBY PLANT REQUIREMENTS:

This offer shall be for the supply, delivery to site, offloading and commissioning as follows:

- 7.1.1 1 x Standby Diesel Generator Plant 500 kVA at 0,9 PF continuous 400/230v 3PH 50Hz
- 7.1.2 The standby diesel generator must have a 500 kVA 400V, Equal or similar approved to Marrelli alternator capable of developing over 288 kW.
- 7.1.3 The standby diesel generator must have a Turbo Charged air cooled diesel engine.
- 7.1.4 A radiator louver and Sound Attenuation in the form of a sound attenuated 3CR12 canopy mounted on a common steel base plate with anti vibration mountings

- 7.1.5 Fuel Tank - Day Tanks for the set preferably located in the base frame. Tank to be manufactured from a minimum of grade 304 stainless steel and powder coated black.
- 7.1.6 1200A automatic mains failure panel consisting of 25kA circuit breakers, Main circuit breaker and all controls as specified. The panel must have an equal or similar approved to Deep Sea Controller electronic engine management and control unit.
- 7.1.7 The control panel must have a change over control set.
- 7.1.8 The control panel must have a battery charger.
- 7.1.9 All cables between plants and control panel.
- 7.1.10 Exhaust System to be manufactured from a minimum of grade 304 stainless steel
- 7.1.11 The Control Systems must include facilities to down load data.
- 7.1.12 The control panel and mains failure unit shall be installed in an orange powder coated, stainless steel enclosure (grade 3CR12). The enclosure shall have an IP rating of 54, have lockable doors and shall be floor mounted.

B8. BASE FRAME, FUEL STORAGE AND HANDLING:

The Standby Generator shall have a powder coated hot dipped galvanised steel bolted base frame. Suitable anti-vibration mountings between the generator set and its base frame or between the generating set's base frame and its support structure shall be provided.

The contractor shall supply and install fuel tanks as detailed below as well as the pumps, sensors of fuel level for automatic operation, pipe work, fittings and valves required for the storage and handling of the fuel for the Standby Diesel Generators. The whole installation shall comply with the Code of Practice for the Storage and handling of liquid fuel issued by the South African Bureau of

Standards and with the local Authority requirements.

DAY TANK: This shall consist of a suitably sized tank installed in the position shown on the drawings. The filling shall be by an automatically controlled pump. A return pipe double in size of the feeder pipe is to be installed to avoid overflow in the event of automatic pump malfunction.

B9. CHANGEOVER SYSTEM:

GENERAL: The changeover switching of the essential loads between normal and standby power will be affected in the AMF Panels.

The switching of the standby power may be in sequence with a maximum delay of 10 seconds. The proposed sequence is to be submitted to the Engineer for approval.

CHANGEOVER: Each changeover will consist of 2 suitably rated TP motor operated ACB's with the appropriate auxiliary contacts supplied and wired to a terminal block by the Main LV Board Manufacturer.

The Standby Contractor shall liaise with the Main LV Board Manufacturer to ensure that the changeover installation suits the Standby Plant Operation.

CONTROL CIRCUITRY: The control and operation of the changeover system shall be from the Standby Plant. The Standby Contractor shall supply, install and connect all the wiring for control and sensing purposes between the Standby Plant and the LV Main Distribution Board. Tenderers are advised that three sets of mains sensing wiring are required.

B10 AUTOMATIC MAINS FAIL CONSOLE:

All equipment necessary for the operation, control, protection, supervision as well as synchronising and automatic load balancing of the Standby Plant shall be included in a self-standing Control Console Unit.

Solid state printed circuitry with plug-in modules for easy maintenance and repair shall be used wherever possible.

The following are the basic items to be incorporated in each generator section of the control console.

Automatic Mains Failure Control Unit: This unit shall contain all components required for the sensing of the normal supply voltage, the automatic and manual starting/stopping operation as well as automatic load changeover operations.

"OFF" - "AUTO" - "MANUAL" "TEST" Mode Selector Switch : This shall provide the following facilities:

- (i) "OFF" position : set will be entirely inoperative and isolated.
- (ii) "AUTO" position : set will automatically start/stop depending on the status of the mains supply.
- (iii) "MANUAL" position : set will start manually (push button) for maintenance allowing mains supply to load but will not transfer the load in the event of power failure.
- (iv) "TEST" position : set will start automatically bypassing the automatic control to test the starting sequence and alarm circuitry without switching onto the standby busbars. However, in the event of power failure the generator has to take the load.

Alarm/Shut Down System for Faulty Conditions : This system is to be battery operated and shall consist of a set of alarm annunciators and shutdown devices with test facilities. Any faulty condition in the system shall cause a luminous alarm with clear indication of the specific fault. The luminous alarm must persist until the faulty condition is rectified. An acoustic alarm shall also be activated but it will be possible to cancel it by a "cancel" push button. Certain faulty conditions as listed below shall cause the automatic shutdown of the generator when the fault reaches preset (adjustable) values. The following alarm annunciators and "shutdown" devices are to be supplied

Fault/Conditions	Alarm	Shutdown
High Engine Temperature	X	X
Low Oil Pressure	X	X
Overspeed	X	X

Underspeed	X	X
Low Radiator Water Level	X	X
High A C. Volts	X	X
Low AC. Volts	X	X
Emergency Stop		X
Start Failure	X	X
Fuel Bulk Tank Low Level	X	X
Jacket Heater Faulty		X
Fuel Day Tank Low Level	X	

Warning Indications:

Set not in Auto	Flashing L.E.D.
Manual Start	Flashing L.E.D.
Manual Stop	Flashing L.E.D.
Mains available	L. E. D.
Load on Mains	L. E. D.
Alternator Available	L. E. D.
Load on Alternator	L. E. D.
Battery Charge Failure	L. E. D.
Lamp test facilities are to be included in the system	

Programming Controller:

This shall allow the following parameters of the system to be programmable on site:

Mains low volt sense level

Mains high volt sense level

Alternator low volt sense level

Alternator high volt sense level

Start Delay 0.5 - 60 sec

Crank delay 0.5 - 30 sec

Run up delay 0.5 - 30 sec

Run up timer 0.5 - 30 min

Mains return timer 0.5 - 30 min

Load transfer delay 0.5 - 60 sec

Engine under speed 0001 - 4900 RPM

Engine over speed 0001 - 4900 RPM

Number of start attempts 1 - 20

Low battery level 08.0 - 50.0 V

High engine temperature sensor N/O - N/C

Low oil pressure sensor N/O - N/C

Low fuel sensor N/O - N/C

Manual stop sensor N/O - N/C

Manual start sensor N/O - N/C

Emergency stop sensor N/O - N/C

Low water level sensor N/O - N/C

The controller shall be protected against lightning hazards, power surges, mains borne and other noise interference to prevent malfunctioning of the system. The suppressor shall be as "Powertech Kleen-Line" or other approved.

Logging of Events: All events relating to the status of the generator set shall be logged with date time in a non volatile memory (which can retain information for a period of 60 days in the absence of power to the controller-).

The user must be able to obtain a hard copy of these events on site which are

based on the above system configuration i.e.

Mains available	Date	Time
Mains phase low	Date	Time
Start attempts	1	
Alternator on load	Date	Time
Mains on load	Date	Time
Unit switched off	Date	Time
Unit mode - manual	Date	Time
Emergency stop	Date	Time
All fault conditions etc.	Date	Time

Automatic Frequency Controller: This shall be of the solid state type and it will consist of a device to compare the busbar frequency with the alternator's and control the engine governor actuator accordingly. After paralleling the frequency controller will be over-riden by the load balancing unit. The frequency controller is to be within Class AO (1 %).

Synchroniser Unit: This unit shall monitor phase angle and voltage of the associated alternator against those of the standby busbars and provide an output signal to switch the alternator's ACB on the busbars when the above parameters are within preset limits.

Load Balancing Unit: This unit shall monitor and compare the load on the standby busbars and the output of the associated alternator. By controlling the governor actuator of the associated engine the unit will automatically equalize. the load of the two generator sets.

Reverse Power Relay : In the event of the reverse power flow this relay will isolate the set from system.

Battery Charger : This shall be of the solid state type with fully automatic voltage and current control.

Metering : The following components are to be mounted in the top panel of the console.

3 X KI.D.I. 0-1500A Ammeters

- 1 X C, - 500V Voltmeter
- 1 X Voltmeter Selector Switch with off, phase to phase and phase to neutral positions. (7 positions)
- 1 X 47 - 50 - 53Hz frequency meter
- 1 X 0 - 30V DC Voltmeter (battery)
- 1 X 0 - 10A DC Ammeter (battery)
- 1 X Running hour meter
- 1 X Synchronoscope
- 1 X Manual start push button
- 1 X Emergency stop push button "latching type"
- 1 X Manual speed actuator for manual synchronizing

All above components are to be flush mounted. The meters must be 96mm square as Elima or Gosen manufacture or other approved.

B11. EXHAUST GAS SYSTEM:

The Standby Generator Contractor shall supply and install the exhaust gas system for the diesel engines. The piping shall be made of Grade 304 stainless steel and shall extend 2 000m outside the plant room.

All pipes and bends to be thermo-insulated.

B12 ACCEPTANCE OF LOAD:

The time from the initiating of the starting operation of the first engine and the switching of the total essential load to standby supply shall not exceed 15 seconds. The contractor must make use of resistance banks such that the client can verify that the supplied machine can handle the desired load and is as stipulated on the name plate.

This shall be set at time of Commissioning.

B13. FEEDER CABLES:

The cables between the Generators and the Main LV Board shall form part of this contract.

Cognisance must be taken into account of the number of cables and the Generator Main Board shall be constructed with sufficient space to accommodate the termination of these cables.

B14. CABLING WIRING AND PIPING:

General: With the exception of the above, all cabling, wiring, piping, cable trays, etc. required to interconnect the various components of the system including those installed in the Main LV Board shall be supplied and installed under this Contract.

Auxiliary Services - Electrical Installation: The electrical installation related to the auxiliary services (battery chargers, jacket heaters, fuel pumps, etc) is part of this contract. The required db shall be supplied and installed in the Control Console (common section). This board is to be fed by a suitable PVC SWA cable from the essential section of the Main LV Board where a suitable MCB shall be provided.

Earthing: All items of equipment are to be earthed with suitable copper conductors.

B15. MANUAL OPERATION:

It must be possible to manually operate the plant by switching the generator set from automatic to manual control. In the manual control mode the automatic apparatuses for frequency control, synchronizing, load balancing, etc. shall be isolated and it shall be possible to manually carry out their functions.

The changeover switches for this facility are to be installed in the AMF Panel.

B16. SOUND ATTENUATION:

Tenderers shall allow to supply and install both inlet and outlet sound attenuators ensuring a noise level not more than 65 dba at 7m.

B17. GUARANTEE AND MAINTANANCE:

Refer to Clause A9.

B18. DRAWINGS:

The Standby Generating Contractor's attention is drawn to Clause A5.2 and all drawings are to be submitted timorously for approval prior to manufacture.

B19. SITE LIAISON:

Tenderers shall allow in their Tender for regular Site Visits and liaison with the Main Contractor and Engineer to ensure all builders work is fully in accordance with their requirements.

B20. ADDITIONAL INFORMATION

The tenderer shall supply the following additional information:

- Availability and value of Spares Holding
- Backup Support Provided (Service Centres, Technicians etc)
- Warranty Details (12 Month on-site warranty required)
- Maintenance Contracts Available
- Full brochures/specifications of all the standby generators to be offered.
- All other details to support the offer

SECTION C
TECHNICAL DATA SHEET
SCHEDULE OF TECHNICAL INFORMATION
TO BE COMPLETED BY CONTRACTOR

DIESEL STANDBY PLANT OR DIESEL PRIME MOVERS

Engine and Ancillary Equipment:

- 1 Manufacturer
- 2 Place of Manufacture.....
- 3 Manufacturer's Engine Model No.
- 4 Name of Engine Agencies in RSA
- 5 Continuous sea level rating after reduction for fan and/or ancillaries
.....kW at.....oC
- 6 Continuous site net rating at specified conditions
.....kW at.....oC
- 7 Percentage of rated load that may be applied at start up?
- 8 Balance of load to be applied after?
- 9 Nominal speed rpm
- 10 Number and arrangement of the cylinders.....
- 11 State V angle.....
- 12 Recommended fuel.....
- 13 Fuel Tank Capacities:

- (a) Day Tank.....l
- 14 Fuel Consumption:
 - (a) Full Load.....grams/kW/hr and.....1/hr
 - (b) 3/4 Full Load..... grams/kW/hr and.....1/hr
 - (c) 1/2 Full Load grams/kW/hr and.....1/hr
- 15 Air quantity required for adequate cooling of engine and generator at site conditions m³/h
- 16 Recommended gross cross-section area of ventilation air outlet louvers from standby plant room m³/h
- 17 Air quantity required for combustion at full load at Site atmospheric conditions m³/h
- 18 Recommended gross cross-sectional area of ventilation and combustion air inlet louvres into standby plantroom.....m
- 19 Recommended Make and Model No. of outlet air louvres.....
- 20 Velocity of air flow from outlet louvres m/s
- 21 Is a turbocharger fitted?
- 22 Is a jacket water heater fitted?
- 23 If so, make and type of jacket water heater fitted.....
- 24 Rating of jacket water heater
- 25 Method of protection against high engine temperature
- 26 Method of protection against low engine oil pressure.....
- 27 Range of mechanically driven running hours indicator (smallest unit shown on dial to be one hour)

- 28 Make and type of coupling between engine- and generator.....
- 29 Is a torsional analysis carried out?
- 30 Is engine fitted with individual cylinder heads?
- 31 State type and class of engine governor.....
- 32 State material used in cylinder head and crankcase construction.....
- 33 Number of valves per cylinder head?
- 34 Model of fuel injection chamber.....
- 35 Guaranteed unlimited light load.....
- 36 Type of exhaust valve material.....
- 37 Type of bearings.....
- 38 Is it necessary to shut down engine to change lubricating oil and fuel oil filters?
- 39 Recommended interval, in engine running hours, for:
 - (a) Air filter oil change.....hrs
 - (b) Oil filter element change.....hrs
 - (c) Lubricating oil change.....hrs
 - (d) Decarbonising and top overhaul hrs
- B. Generator and Ancillary Equipment:
 - 1 Manufacturer.....

- 2 Country of Origin.....
 - 3 Manufacturer's Generator Model No.
 - 4 Continuous sea level rating at 0.8 PF lagging.....
 - 5 Continuous site rating at 0.8 PF lagging
- C. Standby Plant Switchboard:
- 1 Manufacturer.....
 - 2 Is board floor, wall mounted or set mounted?
 - 3 Make and rating of Mains Isolator.....
 - 4 Make and rating of Generating ACB
 - 5 Make and rating of Changeover Breakers.....
 - 6 Make of By-pass switch
- D. Control Console:
- 1 Manufacturer.....
- E. Starter and Control Battery:
- 1 Manufacturer.....
 - 2 Country of Origin.....
 - 3 Manufacturer's Battery Type No.
 - 4 Ampere hours of battery (10 hours rating) Ah
 - 5 Ampere hours of battery (1 hour rating) Ah

6 Battery voltage (as supplied across starter motor) V

F. Dimensions and Masses:

1 Engine Generator and Skid Base Unit:

This shall include the radiator but shall exclude radiator ducting, exhaust gas pipework, etc.

- (a) Overall length.....m
- (b) Overall width.....m
- (c) Overall height.....m
- (d) Mass in operating condition with full oil sump and radiator.....kg

2 Day Fuel Tank for Plant

- (a) Width m
- (b) Depth.....m
- (c) Height m
- (d) Mass of full fuel tank.....kg
- (e) Volume.....l

3. Delivery Periods:

- (a) Diesel/Alternator Set.....
- (b) Electrical Control Panel.....
- (c) Underground Fuel Tank.....
- (d) Sound Attenuation Equipment.....

APPENDIX 1

STATEMENT OF COMPLIANCE (TO BE COMPLETED BY TENDERER)

This tender complies with specification TPD-009-STANDBYPLANTSPEC in all respects.

SIGNATURE : _____ DATE : _____

This tender complies generally with specification TPD-009-STANDBYPLANTSPEC but differs from it on the following points.

SIGNATURE : _____ DATE : _____

**Transnet Group Capital
KWAZULU-NATAL**

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure F: Specification for the supply, delivery, offloading, installation and commissioning of an uninterrupted power supply (UPS) system

**SPECIFICATION FOR THE SUPPLY, DELIVERY, INSTALLATION AND
COMMISSIONING OF AN UNITERRUPTIBLE POWER SUPPLY (UPS) SYSTEM**

REVISIONS		
REV	DATE	APPROVED
00	May 2016	S.Sewdayal

INDEX

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15.	SPARE PARTS
16.	ADDITIONAL INFORMATION
Appendix 1	Schedule of Requirements
Appendix 2	Details of Tenderers Offer
Appendix 3	Statement of Compliance (To be completed by tenderer)

1. SCOPE

This specification is for the supply, delivery, installation and commissioning of an uninterruptible power supply (UPS) system consisting of rectifier/charger, inverter, fully automatic static switch, manual bypass switch, batteries and remote alarm panel.

2. STANDARDS AND SPECIFICATION

2.1 The following standards and specifications are applicable and tenderers must ensure that all the UPS complies with the requirements laid down in such standards and specifications: -

SANS 10111	Engineering drawings
SANS 10142	Code of Practice for Wiring of Premises
SANS 1507	Electric Cables with extruded solid dielectric insulation for fixed installations, 300/500 kV to 1900/3300V
SANS 1574	Electric Cables Flexible cords and flexible cables to 600/1000V
SANS 1474	Uninterruptible power systems
SANS 1091	Colour standards for paint.

2.2 The maintenance work shall comply with the latest editions of the relevant South African Bureau of Standards or British Standards or International Electro technical Commission for Scientific and Industrial Research Publications and Reports.

2.3 Users of this specification must ensure that they are in possession of the latest issues of the above-mentioned standards

3. TECHNICAL INFORMATION REQUIRED

Refer to clause 16

4. ENVIRONMENTAL CONDITIONS

The UPS shall be rated for continuous operation under the following conditions:

Altitude	:	-20 to 0 metres below sea level
Ambient temperature	:	0 deg.C to +40 deg.C
Relative humidity	:	As high as 95%
Lighting conditions	:	Severe with a maximum ground density of 11 flashes per square kilometre per annum
Exposure conditions	:	Salt laden industrial atmosphere damp.

5. DRAWINGS AND MANUALS

5.1 Certified drawings, instruction and maintenance manuals (3 sets) shall be supplied within 30 days of final product shipment by the tenderer. Final drawings shall be submitted by the

contractor in DXF format and AutoCAD 14 at no extra charge. Documentation must be submitted in WORD97 or later format.

5.2 Tenderers shall submit with their tenders a schematic diagram showing:

- Input circuit breakers
- System busbars
- Rectifiers
- Batteries
- Inverters
- Electronic switches
- Bypass circuit
- Detour circuit
- Fuse protection
- Output circuit breakers
- Oscillator
- Power supply circuits to oscillator, alarms, controls, etc.
- Battery isolator
- Relative phase displacement of the rectifier transformers.

6. INFORMATION AND METHOD OF TENDERING

6.1 Tendering shall be in accordance with Transnet Projects Tender Form.

6.2 Tenderers shall submit their main offers in accordance with the requirements of this specification. Deviations from the requirements of this specification, which are of a minor nature and do not depart materially, will be considered at the discretion of Transnet Projects. The acceptance of alternative tenders will be considered only if a main tender is submitted as part of the tender document.

6.3 All documents forming part of the tender shall be firmly bound. No loose documents will be considered. Failure to comply with the above requirements may preclude a tender from consideration.

6.4 All tender documents shall be presented in a clear format with index, uniquely numbered pages and cross-referenced. The total number of pages shall be clearly stated in the index.

6.5 Type test reports/certificates shall be issued or certified by the SABS or other test authority recognised by the SABS. This recognition shall accompany the tender. Failure to comply with the above requirements may preclude a tender from consideration

7. TECHNICAL REQUIREMENTS

System Requirements (The required input and output voltages are contained in the detailed specification)

7.1 Input to the UPS

Input voltage:	400/231V $\pm$ 10% or 231V $\pm$ 5%
Frequency:	50Hz $\pm$ 4%
System:	1 phase 2 wire or 3 phase 4 wire with operative earth conductor, supplied from local low voltage network or standby generator set. Refer to detailed specification.
Power factor:	Not less than 0,8 lagging.

Max starting current: 10 times full load current for not more than $\frac{1}{2}$ a cycle with rectifier soft starting facility.

7.2 Output to Load

Rating: Refer to detail specification.
Output voltage: Refer to detail specification.
Frequency: 50 Hz $\pm$ 0,5 Hz.
System: 1 phase 2 wire or 3 phase 4 wire with operative earth conductor. Refer to detailed specification.
Voltage regulator: $\pm$ 10% maximum deviation of steady state voltage recovering to within 5% in less than 50ms and to within 1% less in that 100ms.
Frequency stability: Normally automatically synchronised to mains frequency if the latter is within 50 Hz $\pm$ 2% (adjustable window) Runs free at 50 Hz $\pm$ 0,5 Hz at any load when mains is out of limits.
Harmonic content: Less than 4% total distortion.
Amplitude modulation: Less than 2%

7.3 Overall Performance

Efficiency (overall): 80 - 85%

- 7.3.1 The equipment shall be designed for the maximum operating efficiency. The efficiency shall be determined when the system is delivering full load at 0,8 power factor, with the batteries fully charged. The load required by the auxiliary equipment (controls, alarms, etc), electronic switches and cabinet fan shall be included in the determination of the overall efficiency. A typical test report clearly indicating how the efficiencies were calculated, shall be submitted with the tender.

7.4 Ambient Operating Conditions

Refer to Clause 5

7.5 System Description

The system shall consist of a static UPS complete with the following components:

- Rectifier/charger.
- Inverter.
- Battery.
- Automatic electronic no-break bypass circuit and switch.
- Separate manual bypass switch.
- Protective devices and measuring equipment.
- The required controls and necessary equipment.
- A self-monitoring system with digital readout by means of which all critical functions can be checked.

- 7.5.1 The system shall be capable of providing an uninterrupted supply to the load with the output characteristics as specified for a minimum period as reflected in the detailed specification during a total mains failure (i.e. normal mains and standby generator supply failure). The batteries shall be rated at an AC load power factor of 0,8 lagging.

- 7.5.2 The complete system, including all controls shall be designed in such a way that the failure of any one vital central component will NOT cause a complete system failure. If necessary such a failure must be avoided by connecting the load directly to the mains by means of the bypass switch.
- 7.5.3 The UPS shall operate satisfactorily synchronous with the mains supply even under severe conditions of up to 100% unbalanced load.
- 7.5.4 The UPS shall be amply rated to carry the stated full load current. The UPS shall furthermore be capable of withstanding the following overloads:
- 7.5.4.1 Static Overloads: 100% of full load continuously.
125% of full load for 5 minutes.
150% of full load for 2 minutes.
165% of full load for 1 second with inductive decay after initial equipment switch on surge current.
- 7.5.4.2 Dynamic Overload: 300% for less than 5 msec.
1000% for less than 1 msec.
- 7.5.4.3 All component parts, cables and other connections shall be amply rated to withstand the overloads stated and maintain the input voltage at the load within the tolerances stated.
- 7.5.4.4 It shall be the responsibility of the successful tenderer to ensure satisfactory operation of the complete system for the load to be supplied. It is, therefore, essential that the tenderer acquaint himself fully with typical load conditions before the tender closing date.
- 7.6 Screening: All cabinets containing thyristors shall be adequately screened and earthed to prevent direct radio frequency radiation.

7.7 Inverter Oscillator

- 7.7.1 The inverter shall contain an oscillator capable of operating and maintaining the inverter output frequency as specified. The inverter oscillator shall be capable of frequency synchronisation and phase locking to the mains (or standby generator) power source frequency. When operating as a slave to the mains or standby power and a failure occurs in the slaving signal, the inverter oscillator shall automatically revert to a free running state and maintain the specified limits. All changes in output frequency to free run or synchronise shall be gradual to suit the load requirements.

7.8 Rectifier

The UPS shall have its own rectifier and rectifier transformer which shall operate satisfactorily from the mains or standby supply.

- 7.8.1 The rectifier shall be of the solid state type providing full wave rectification of the input voltage suitably regulated to suit the input requirements of the inverter. Where necessary, a high grade DC filter shall be utilised to limit the output ripple to within acceptable levels for the inverter input. Current limiting features shall be provided to protect the rectifier. The current limiting settings shall be variable for final adjustment on site.
- 7.8.2 Voltage free contacts shall be provided for the malfunction alarms of the rectifier.
- 7.8.3 An input monitoring circuit shall be provided for the rectifier. This circuit shall switch off the

rectifier when the r.m.s. value or frequency of the input voltage falls below present values.

- 7.8.4 The necessary protection circuitry shall be provided to switch off the rectifier if any one of the rectifier phases should fail, thus presenting an unbalanced load to the incoming supply.
- 7.8.5 The output of the rectifier shall be connected in parallel to the battery and inverter.
- 7.8.6 The rectifier shall have over temperature protection. Temperature sensing probes shall be placed on the thyristor housing, thyristor mounting, or on the heat sink close to the thyristor. The sensing of the off coming air temperature alone is not acceptable.
- 7.8.7 Tenderers shall take into account the possible effects of harmonics that may be present on the input supply due to non-sinusoidal waveforms at the rectifier input, phase commutation, the effect of reactance during phase commutation etc. The input voltage monitoring circuits of the rectifiers shall be adequately filtered and buffered to ensure reliable load control and to prevent continuous on-off switching of the rectifiers. For three phase units each of the three rectifier transformers shall have a different primary to secondary phase displacement in order to minimise the harmonics generated by the rectifiers for units above 200 kVA.

7.9 Inverter

- 7.9.1 The inverter shall be adequately protected against any excessive overload or short circuits that occur in the load. Reactive current limiting or other methods shall be employed to render the thyristors short circuit proof. The successful tenderer shall replace any thyristors or any inverter components at his own expense if these should be damaged.
- 7.9.2 The necessary feedback and control circuits shall be incorporated to ensure satisfactory operation separately or in synchronisation with the mains supply under all conditions of dynamic load variations, stated overloads, severe unbalanced conditions and high operating temperatures. The thyristor bridge shall contain the necessary auxiliary circuitry to ensure satisfactory operation.
- 7.9.3 The output of the inverter shall be connected in parallel with the thyristor switch output.
- 7.9.4 Each inverter shall have over temperature protection similar to the over temperature protection for the rectifier.
- 7.9.5 A discharge device shall be provided across the D.C. input to the inverter, which will discharge any capacitors in the inverter module when it is switched off.

7.10 Battery charger

- 7.10.1 The battery charger shall be a solid state, constant voltage type providing full wave rectification of the input voltage with the output regulated to an accuracy as specified. A high grade D.C. filter shall be utilised to limit the output ripple to the stated tolerance. Current limiting features shall be provided. The value of the current limit setting, shall be in accordance with the maximum allowable charging current that the batteries can withstand.
- 7.10.2 The maintained voltage on float charge shall be such as to give maximum life to the batteries whilst maintaining the maximum charge conservation and minimising gas formation and water loss. The optimum float charge voltage shall be specified by the battery manufacturer but is expected to be approximately 2, 23 volts per cell. The voltage shall be kept within $\pm 0, 5\%$ of the nominal value for all loads from no load to the full rated battery charger current when supplying the full output with batteries discharged.

- 7.10.3 The rectifier shall be equipped with 2 independent over voltage shutdown contacts for maximum charger security.
- 7.10.4 The battery charger shall be designed to charge the batteries to 90% of its fully charged capacity within 14 hours and to 100% capacity within 20 hours.
- 7.10.5 The battery charger shall be capable of boost charging the batteries to 2,6 volt per cell. The boost facility shall be manually operated.
- 7.10.6 The battery charger shall be provided with a current limiting circuit. The current limit setting shall be variable for easy adjustment on site.
- 7.10.7 The necessary voltage free contacts for the alarms and battery charger failures shall be allowed for in the tender price.
- 7.10.8 The battery charger shall have over temperature protection similar to the protection specified for the rectifier.
- 7.10.9 On UPS systems above 200kVA, the battery charger shall have circuitry to inhibit the charging of batteries from the standby generator. This circuitry shall be activated by normally open contacts on the generator control panel. The interconnecting cables will be supplied and installed as part of this contract.

7.11 Battery

- 7.11.1 The battery capacity shall be sufficient to provide full load for the specified time. The capacity shall be rated at a maximum specific gravity of 1,245 at 25 C and correctly filled.
- 7.11.2 Tenderers shall state the discharge capacity of the battery after 10 hours of charge and the battery voltage at its terminals under various conditions. The inverter shall switch off on low battery voltage.
- 7.11.3 The battery cells shall be of the maintenance free type.
- 7.11.4 The batteries shall give satisfactory service for a minimum period of 3 years. Tenderers shall state the maximum expected lifetime of the batteries and motivate their statement, and provide a statement by the battery manufacturer supporting this and stating that the charger offered is suitable for the battery.
- 7.11.5 The cells must be mounted in a matching steel cabinet or in the same cabinet as the control equipment. The vented type cells should be mounted on wooden stands, consecutively, numbered with positive and negative terminals clearly marked in a ventilated battery cabinet.
- 7.11.6 The batteries shall be complete with cell inter-connectors and row inter-connectors. The output terminals shall be robust and adequately dimensioned for the output cable terminations.
- 7.11.7 The inter-connectors between cells and shall be made in a manner giving the lowest volt drop and maximum resistance to corrosion. All connections to cells must consist of flexible cable to avoid mechanical stress at the cell terminals. All cabling for the battery shall be installed on PVC cable trays and fitted to the satisfaction of the engineer.
- 7.11.8 The tenderer shall describe the method of removal and replacement of a faulty cell.

- 7.11.9 The battery shall be complete with a battery fuse isolator capable of breaking the full load current drawn by the inverter. These battery fuse isolators shall be installed in the inverter unit room or cabinet.
- 7.11.10 Terminal posts should be effective for the expected lifetime of the battery and should be effective even if the cell is overfilled.
- 7.11.11 The battery may be resistance grounded through 5000 ohm to 10000 ohm for the purpose of ground fault.
- 7.11.12 Tenderers shall submit full details with dimensioned drawings of the batteries offered. Tenderers shall also submit the calculations and motivations complete with curves supporting the selection of a specific battery cell.

7.12 Automatic by-pass and static switch

- 7.12.1 An integral automatic bypass switch shall be provided to transfer the critical load without break to the mains should the UPS unit fail. The latter unit shall simultaneously be disconnected from the critical load bus. This transfer shall, however, be inhibited if the mains is out of synchronism with the UPS output. Retransfer to the UPS output shall be on a manual or automatic command.
- 7.12.2 The static switch shall be rated to supply the full load continuously. The static switch must be capable of supplying 1000% for 5 cycles in order to clear any type of load fault. If the inverter output becomes unavailable or goes out of tolerance, the static switch must transfer the load to mains without interruption. The static switch should automatically retransfer the load back to the inverter if the voltage returns to within tolerance. The static switch should prevent "hunting" and after trying unsuccessfully to switch a maximum of three times the static switch should be inhibited from further switching.
- 7.12.3 The bypass switch must have a cover fitted screwed to the panel so as to make the operating of this switch impossible without having first removed the cover.
- 7.12.4 The bypass switch cover must also have the following words etched in white with a red background mounted on or adjacent the cover: CAUTION : BYPASS SWITCH ONLY : ONLY TO BE OPERATED BY QUALIFIED PERSONNEL

7.13 Protection

- 7.13.1 The UPS shall have surge protection fitted. Tenderers shall state what level and type of surge protection is fitted. The AC input shall also be protected by a circuit breaker on the following input circuitry:
- Reserve (static switch) input
 - Rectifier/Charger input

7.14 Instrumentation and controls

- 7.14.1 All the required instrumentation as indicated on the drawings shall be provided.
- 7.14.2 The unit should be equipped with a Mimic Panel with LED Status indications of:
- Mains power
 - Rectifier status

- DC link status
- Inverter status
- Static switch condition
- Reserve supply
- Output switch position
- Battery switch position
- Bypass switch position

7.14.3 The unit shall include a LCD display with the following features:

- True RMS phase voltages, line voltages and currents of mains input, reserve supply and UPS output
- All DC parameters
- Unique customer configurable identifier
- Real time clock
- Active alarm indication
- Comprehensive password protection
- Interactive keypad, allowing UPS control and easy scrolling through menus
- One thousand event log file (only accessible through the serial port)
- Audible alarm
- Full networking features (using UPS Interfacing software and a SNMP UPS network adapter)
- Remote alarm panel (optional)
- Software configurable alarm relays
- Full serial and modem communication capability
- Remote monitoring of UPS service history and alarms, via GSM modem (using SIM card)
- Monitoring by dial in software (using GSM modem and SIM card)

7.14.4 The front panel alarms shall be clearly and adequately marked in English. A single line mimic layout of the switchgear shall be provided on the front of the cubicles providing a graphic display of the circuitry of the equipment involved.

7.14.5 Facilities shall be provided for controlling the rectifier, switching the inverter on, switching the inverter output to the synchronous motor/alternator and controlling the bypass thyristor switch circuit.

7.14.6 All control switching of the rectifier and inverter as well as the bypass operation shall be pushbutton initiated.

7.15 Alarms

7.15.1 All alarms shall be of the tell-tale type with memory features e.g. a flashing light indicates a fault coupled with an audible alarm. The pressing of the appropriate button shall cancel the audible alarm and allow the alarm lamp to burn continuously until the fault is removed.

7.15.2 The following minimum alarm conditions shall be monitored on the equipment:

- Normal
- Mains failure
- Inverter failure

- Shutdown imminent
- Load on mains
- Overload
- Charger fails

7.15.3 Where required a remote panel must be supplied and installed. The alarms indicated must duplicate all the alarms indicated on the UPS control panel. In addition a buzzer must be provided. Any alarm occurring must sound the buzzer to draw attention. An alarm accept pushbutton to silence the buzzer must be provided.

7.15.4 Provision shall be made on all the alarms mentioned above to be remotely monitored. Normally open contacts shall be supplied at the converter for each alarm for this purpose. The contacts shall close under an alarm condition.

7.16 Construction of cubicles and switchboards

7.16.1 Converter equipment shall be housed in totally enclosed, free standing, floor mounted cubicles, designed to provide adequate ventilation for the equipment. All cubicles shall be rigid with suitably braced doors providing front access and shall be vermin proof.

7.16.2 All equipment shall be mounted on the metal framework suitably arranged to provide safe operation and ease of access. Fuses and switchgear in particular should be safely accessible even under load conditions.

7.16.3 All power bridges, filters and other major components both in the inverter and rectifier, shall be completely withdrawable to facilitate rapid repair and/or replacement. The method of withdrawal shall be such that a complete module can be extracted in the operating condition so that checks and measurements may be made while in operation and access to all components facilitated.

7.16.4 All electronic printed circuit cards shall be of a good quality and shall be easy and simple to interchange.

7.16.5 All auxiliary power supplies shall be duplicated and shall be connected so as to operate in parallel redundancy. At least two primary sources of power shall be provided for each of the power supplies in the system.

7.16.6 Flexible wires shall not be soldered directly onto terminals but shall have a crimped tab, which is soldered onto a terminal or post. The wire wrapping technique shall be employed for electronic circuits where possible.

7.16.7 All input and output power cables shall be terminated using approved cable glands, onto a cable gland support bracket. The cable conductors shall terminate at the connecting busbars or shall be connected directly to the appropriate switchgear. All power cables shall be properly numbered with wrap around cable markers with punched figures to identify cables at each termination point.

7.17. Ventilation

7.17.1 All equipment racks shall be positioned in logical fashion, in a configuration which will ensure proper ventilation

- 7.17.2 Each cubicle containing heat-generating equipment (thyristors, transformers electronic circuitry, filters, etc) shall have extraction ventilation fans mounted on the top of the cubicle to assist air circulation. These fans shall be fed from the output distribution panel of the uninterrupted power supply.

8. SERVICES AND RESPONSIBILITY FOR WORK

- 8.1 Builders work such as, cutting of holes for cabling, installing cable ladder etc. shall be carried out by the Contractor. Transnet will only be responsible for structural alterations if required.
- 8.2 The tenderer shall be responsible for the complete installation of the UPS together with relevant electrical controls, power circuitry and interconnecting cables. All materials used, including workmanship, shall be of the highest quality, and carried out to the full satisfaction of Transnet.
- 8.3 The tenderer shall be responsible the rigging and positioning of the UPS into the building.
- 8.4 The tenderer must exercise care so as to not damage the UPS and the building when rigging into position and during transportation.

9. QUALITY ASSURANCE

- 9.1 All inspection and testing procedures shall be developed and controlled under the guidelines of the seller's quality system. This system must be registered to ISO 9001 which is regularly reviewed and audited by a third party registrar.
- 9.2 All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.
- 9.3 All sub-assemblies shall be inspected and/or tested for conformance to vendor's engineering and quality assurance specifications.

10. TESTS TO BE PERFORMED

The following functional checks and tests shall be performed on site. For tests in the manufacture's premises the engineer shall be notified four weeks in advance in order that a representative can be sent to witness these tests.

10.1 Battery tests

- 10.1.1 The output voltage of the battery unit (i.e. all the cells making up one battery) shall be tested with the incoming supply removed.
- 10.1.2 The full rated load for the battery shall then be connected to it. The voltage shall be measured at 5 minute intervals for the duration discharge period.
- 10.1.3 The batteries shall be left to recharge. The voltage shall be checked after 14 hours with the load and incoming supply removed as well as with the load connected but incoming supply removed.
- 10.1.4 When fully recharged, the voltage and specific gravity of every cell shall be measured with

the incoming supply removed.

- 10.1.5 The circulating A.C. current through and the A.C. voltage across the batteries shall be measured when the rectifiers are on with the battery discharged and fully charged.

10.2 Oscillator tests

- 10.2.1 Frequency within tolerances at all loads.
- 10.2.2 Parallel redundancy.
- 10.2.3 Auto automatic synchronisation for connection of the synchronous motor/alternator to mains via the thyristor switch.
- 10.2.4 An electronic frequency counter shall be used to measure the frequency.

10.3 Rectifier tests

- 10.3.1 Output voltage of rectifiers at no load and full load with batteries charged and not charged.
- 10.3.2 Current limit, both for mains failure and return to mains.
- 10.3.3 Switch off value mains input monitor.
- 10.3.4 Sequential switch on for return to mains.
- 10.3.5 Soft start circuits.

10.4 General

- 10.4.1 Ammeters will not be acceptable to prove the above items. A wave analyser and a recording oscilloscope will be required. Photographs shall be taken of the oscillograms by the contractor in the presence of the engineer.
- 10.4.2 The overall efficiency of the complete uninterrupted power supply shall be proved to be within the specified limit at full load and at no load.
- 10.4.3 The overcurrent protection mechanisms of the A.C.B. shall be proved by current injection (either primary or secondary)
- 10.4.4 The bypass and detour circuits shall be proved.
- 10.4.5 All alarms, indications and control functions shall be proved.
- 10.4.6 The test instruments provided shall in all cases be of high quality and suitable to be able to adequately assess the quantities being measured and the equipment being tested. All instruments shall be calibrated by a testing laboratory approved by the National Calibration Service of the CSIR. The test equipment remains the property of the successful tenderer.
- 10.4.7 At the completion of the tests, a full test report shall be submitted by the contractor to the engineer in triplicate.
- 10.4.8 Continuously adjustable dummy loads of a rating suitable to comprehensively test the UPS shall be provided by the contractor as well as any temporary cables required for the

connection of the dummy load to the UPS on site.

- 10.4.9 Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.
- 10.4.10 Warning labels and nameplates must be present, legible and clearly visible to advise personnel of all possible hazards.
- 10.4.11 Isolation barriers must be in place to protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
- 10.4.12 Operation of mechanical and electrical interlocks will be tested on site after installation of the unit.

11. EARTHING

- 11.1 The main earth bar must be connected to the insulated earth bar of the UPS via a removable copper link bar.
- 11.2 All UPS boards must have insulated earth bars, separately earthed to a clean stainless steel earth spike by means of 70mm² insulated earth to obtain less than one ohm at the UPS board.

12. COMMISSIONING AND ACCEPTANCE

- 12.1 After completion, the whole installation will be inspected by Transnet Group Capital and commissioned by the Contractor.
- 12.2 The Contractor shall make good to the satisfaction of Transnet Group Capital, any deficiencies, which may arise during inspection and commissioning.
- 12.3 Only after the whole of the installation has been tested and commissioned by the Contractor, and passed as satisfactory by the engineer, will it be accepted by Transnet Group Capital.

13. GUARANTEE AND MAINTENANCE

- 13.1 The successful tenderer will be required to guarantee and maintain the complete plant and installation (as called for in this project specification) for a period of 12 months after date of acceptance of the installation by Transnet.
- 13.2 If during this period the plant is not in working order, or not working satisfactorily owing to faulty material, design or workmanship, the Contractor will be notified and immediate steps shall be taken by him to rectify the defects and/or replace the affected parts on site at his own expense.
- 13.3 The Contractor shall maintain the plant in good working condition for the full twelfth month period to the final delivery of the installation. However, should the Contractor fail to hand over the plant in good working order on the expiry of the specified twelfth months, the Contractor shall be responsible for further monthly maintenance until final delivery is taken.
- 13.4 During this period the contractor will undertake to arrange that the plant be inspected at regular intervals (whatever number of visits the contractor deems necessary to fully maintain

the equipment) by a qualified member of his staff who shall: -

- Check the mechanical soundness of all parts
- Check and adjust all the output and control values of the system (voltage, frequency, control voltages, etc.)
- Take control measurements on the major system components and record these measurements.
- Replace all defective components.
- Service batteries.
- Check ventilation of UPS equipment.
- Clean all equipment and/or rooms as required.
- Provide 24 hour standby maintenance and repair service at all times, including statutory holidays.

- 13.5 At each visit, which shall be arranged in advance with the client's representative, a record of maintenance carried out shall be kept. The time and date of visits shall be entered in a logbook, which shall be kept in the plant room.

14. GENERAL

- 14.1 The contractor shall supply and install a metal cabinet next to the UPS cabinet. The metal cabinet shall have lockable doors and shall be adequately sized to house all operating and maintenance instructions, drawings, spares, tools, etc
- 14.2 A schematic diagram of the complete system shall be mounted in a suitable place next to the UPS system. The diagram shall be installed in an A1 sized aluminium frame with a glass front.

15. SPARE PARTS

- 15.1 Recommended spare parts list and prices shall be supplied with the tenderers bid. Also, the address of the manufacturer's closest parts stocking location in South Africa and a required spares list.

16. ADDITIONAL INFORMATION

The tenderer shall supply the following additional information together with the tender document:

- The information requested in the schedule of information.
- Tenderers shall complete a clause by clause statement of compliance with this specification and provide full technical specifications of the equipment offered. Failure to comply with this requirement may preclude a tenderer from consideration.
- If alternative systems are offered, a clear description of the operating characteristics and special features of the equipment along with a motivation for offering the alternative.
- Descriptive and illustrated brochures and other information pertaining to the inverter and ventilation equipment and switchgear.
- The proposed layout as stated.
- Arrangement of batteries.
- A sample test report as stated.
- The circuit diagram requested.

- All other details to support the offer
- Maintenance and repair service facilities in the Republic of South Africa
- Tenderers shall submit a list of successful installations completed in the Republic of South Africa.

ANNEXURE No.1

1. SCOPE

- 1.1 This specification covers the supply, delivery, offloading, installation and commissioning of an uninterruptable power supply.

2 GENERAL

- 2.1 This specification is for the supply, delivery, offloading, installation and commissioning of a **XXX** kVA uninterruptable power supply at Berth B100, in the port of Ngqura only.

3 UNINTERRUPTABLE POWER SUPPLY (UPS) REQUIREMENTS

- 3.1. The UPS system shall consist of components as detailed in the general technical specification.
- 3.2 The UPS shall be rated at **XXX kVA** at the power factor detailed in the general technical specification.
- 3.3 The input and output UPS system voltage shall be **XXX ± 10%**.
- 3.4 The input and output electrical service connection to the UPS shall be **XXX** with operative earth conductor, supplied from the local distribution board that will be located in the same room as the UPS.
- 3.5 The UPS shall be designed for use under the standardized ambient conditions as detailed in the general technical specification.
- 3.6 The cabinet housing the UPS components and the adjacent spares cabinet shall have an ingress protection rating of **XXX** and shall be manufactured from **XXX**, powder coated **XXX** as defined in SANS 1091.
- 3.7 The batteries used in the UPS shall be maintenance free with a minimum lifespan of **XXX** years.
- 3.8 The batteries shall provide a **backup period of XXX** minutes at full UPS output power.
- 3.9 Ventilation within the UPS cabinet shall be designed as detailed in the general technical specification
- 3.10 The incoming and outgoing cable terminations shall be suitable for a **XXX** mm² three-core PVC copper cable.

4 TESTS

- 4.1 The tests for the components to be supplied shall be carried out in accordance with the general technical specification.

5 MARKING/LABELLING/DOCUMENTATION

- 5.1 All markings/Labeling and documentation shall be done in accordance to the general technical specification.

6 GUARANTEE

- 6.1 The contractor shall guarantee all equipment supplied for a period of 12 months after the date of installation and acceptance or 18 months from the date of delivery whichever occurs first.
- 6.2 The conditions for rectifying defective work shall be laid down in the General Conditions of Contract.

SIGNATURE OF TENDERER

DATE

ANNEXURE No.2

DETAILS OF TENDERER'S OFFER

1. SYSTEM PARAMETERS

No	DETAILS	TENDERERS OFFER	
1.1	Net output power of inverter system	kVA	
1.2	Power factor for which the system is rated	Lagging	
1.3	Nominal input voltage	Volts	
1.4	Maximum input voltage tolerated	Volts	
1.5	Minimum input voltage tolerated	Volts	
1.6	Maximum input frequency deviation tolerated	Hz	
1.7	Maximum and minimum input power factor at rated KVA	kVA	
1.8	Maximum harmonic input tolerated for successful operation	%	
1.9	Nominal output voltage	Volts	
1.10	Steady state output voltage regulation	Volts	
1.11	Dynamic output voltage regulation:		
1.11.1	Step load of 25% between 10% and 100% of full load	%	
1.11.2	150% overload for 1 sec	%	
1.11.3	Input voltage step variation of $\pm 15\%$	%	
1.12	Time for voltage recovery to steady state:		
1.12.1	25% step load	ms	
1.12.2	100% step load	ms	
1.12.3	150% step load for 1 sec and then returned to 100%	ms	
1.13	Relative output phase angles at 100% unbalanced load (in degrees)	Degrees	
1.14	Maximum harmonic content of output voltage	%	
1.15	Overload capacity		
1.15.1	One hour	%	
1.15.2	One minute	%	
1.15.3	Ten seconds	%	
1.15.4	One second	%	

1.15.5	Five m sec	%		
1.15.6	One m sec	%		
1.16	Total input required with batteries charged for rated full load	KVA		
1.17	Total input required at full load and battery discharged	KVA		
1.18	Allowable temperature rise across equipment at input air temperature of:			
1.18.1	25 °C	°C		
1.18.2	30 °C	°C		
1.18.3	32 °C	°C		
1.18.4	35 °C	°C		
1.18.5	40 °C	°C		
1.19	Heat dissipation under normal full load Running conditions:			
1.19.1	Converter	KW		
1.19.2	Battery	KW		
1.20	Efficiency of the complete UPS system		<u>1.0p.f.</u>	<u>0.8p.f</u>
1.20.1	Full load		%	%
1.20.2	80% load		%	%
1.20.3	75% load		%	%
1.20.4	65% load		%	%
1.20.5	50% load		%	%
1.20.6	40% load		%	%
1.21	R.M.S. value of the A.C. <u>current</u> component through the batteries for:			
1.21.1	Discharged battery	Amp		
1.21.2	Charged battery	Amp		
1.22	R.M.S. value of the A.C. <u>voltage</u> component through the batteries for:			
1.22.1	Discharged battery	Volts		
1.22.2	Charged battery	Volts		
1.23	Total number of cubicles			
1.24	Total floor space required	m ²		
1.25	Dimensions of cubicle in mm	W		
1.25.1		H		
1.25.2		L		

2. BATTERY CHARGER

No	DETAILS	TENDERERS OFFER	
2.1	Type		
2.2	Output voltage for trickle charge	Volts	
2.3	Steady state regulation of output voltage trickle to full load	±%	
2.4	Output voltage for input voltage fluctuation		
2.4.1	± 10%	%	
2.4.2	± 15%	%	
2.5	Ripple content (%)	%	
2.6	Current limit value	Amp	
2.7	Input voltage at which battery charger switches off		
2.7.1	Maximum	Volts	
2.7.2	Minimum	Volts	
2.8	Maximum switch on inrush current	Ampere	
2.9	Battery charger overload protection (type)		
2.10	Efficiency	%	
2.11	How is the effect of harmonics on input voltage minimised?		

3. OSCILLATOR

3.1	Type of oscillator (RC, crystal, etc.)	
3.2	Stability:	
3.2.1	With oscillator supply fluctuation	± %
3.2.2	Temperature variation	± °C
3.2.3	Number of power supplies in parallel redundancy	
3.3	Number of batteries from which oscillator is fed	
3.4	Minimum time synchronise to mains frequency	sec

4. INVERTER

4.1	Maximum continuous power output (kVA)	KVA
4.2	Nominal output voltage	Volts
4.3	Maximum harmonic content	%
4.4	Nominal input voltage:	
4.4.1	Maximum	Volts

4.4.2	Nominal	Volts
4.4.3	Minimum	Volts
4.5	Input current at full load	Ampere
4.6	Input power factor at full load	Lagging
4.7	Efficiency at full load	%
4.8	Overload protection	

5. STATIC SWITCH

5.1	Minimum power factor at which the switch will operate satisfactorily	
5.2	How does the switch derive an operating signal	
5.3	Maximum break time for switchover	ms

6. BATTERIES

6.1	Manufacturer	
6.2	Country of origin	
6.3	Type	
6.4	Type No	
6.5	Total number of cells	
6.6	Number of cells per inverter	
6.7	Battery voltage (float conditions)	Volts
6.8	Battery voltage (Boost charge)	Volts
6.9.1	Capacity (rated for time required)	Ah at
6.9.2		Hrs
6.10	Battery time offered under load conditions specified in the general technical specification	Minutes
6.11	Maximum output current	Ampere
6.12	Cell voltage under float conditions	Volts
6.13	Cell conditions under boost conditions	Volts
6.14	Cell voltage at start of discharge and full inverter load	Volts
6.15	Cell voltage at end of discharge period	Volts
6.16	Expected lifetime of batteries	Years

6.17	Time to charge to 90% capacity	Hrs
6.18	Total time to charge to 100% capacity	Hrs
6.19	Material of supporting framework	
6.20	Finish of framework	
6.21.1	Dimensions of each cell	W
6.21.2		H
6.21.3		L
6.22	Design of positive plate of cell	
6.23	Rating of fused isolator	Ampere
6.24	Cell configuration	

ANNEXURE No.3

**STATEMENT OF COMPLIANCE
(TO BE COMPLETED BY TENDERER)**

This tender complies with specification TPD: 011-UPSSPEC in all respects.

SIGNATURE: _____ DATE: _____

This tender complies generally with specification TPD: 011-UPSSPEC but differs from it on the following points.

SIGNATURE: _____ DATE: _____

**Transnet Group Capital
Engineering**

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure G: Technical specification for low voltage distribution boards



SPECIFICATION FOR LOW VOLTAGE DISTRIBUTION BOARDS

This specification covers Transnet Projects requirements for low voltage distribution boards

REVISIONS		
REV	DATE	APPROVED
0	MARCH 2012	



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23.	PAINTING
24.	ADDITIONS AND MODIFICATIONS TO EXISTING DISTRIBUTION BOARDS
25.	INSPECTION
26.	TESTS
27.	GUARANTEE
28.	SPARES



1. SCOPE

1.1. This specification covers Transnet Projects requirements regarding the design, supply, manufacture, population, works testing, delivery to site, site erection, site testing and commissioning of low voltage Distribution Switchboards consisting of fuse switches incorporating high rupturing capacity cartridge fuse links, air circuit breakers, moulded case circuit breakers and auxiliary equipment. The tenderer is required to familiarise themselves with all applicable Standards and Codes of Practice listed herein, and to ensure compliance in the execution of any work in terms of this document.

2. REFERENCES

2.1. The following publications (latest edition) are referred to herein:-

2.1.1. SOUTH AFRICAN BUREAU OF STANDARDS

Codes of Practice

SANS 064	The preparation of steel surfaces for coating
SANS 10111	Engineering Drawings.
SANS 10142	Wiring of premises Part 1: Low voltage installations
SANS 10313	Protection against lightning - Physical damage to structures and life hazard

Specifications

SANS 60947	Low-voltage switchgear and control gear
SANS 156	Moulded-case circuit breakers
SANS 60269	Low-voltage fuses
SANS 1091	National colour standards for paint
SANS 1195	Busbars
SANS 1274	Coating applied by the powder coating process
SANS 1973-1	Low-voltage switchgear and control gear 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 control gear assemblies Part 3: Safety of assemblies with a rated prospective short-circuit current of up to and including 10 kA
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 1507	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
SABS ISO 9000	Quality management systems -- Fundamentals and vocabulary
SANS 1019	Standard voltages, currents and insulation levels for electricity supply
SANS 170	Fasteners

International Electrotechnical Commission

BS 3938	Current Transformers
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems.
IEC 60051	Direct acting indicating analogue electrical measuring instruments and their accessories

3. SERVICE CONDITIONS

3.1 The equipment shall be designed and rated for continuous operation under the following conditions:-

**3.1.1 Ambient/Environment Conditions:**

- 3.1.1.1 Ambient temperature- 5°C to +40°C (daily average +35 °C).
- 3.1.1.2 Relative humidity- As high as 95%
- 3.1.1.3 Lightning conditions- Severe, with a maximum lightning ground flash density of eleven (11) flashes per km² per annum.
- 3.1.1.4 Atmosphere- Salt laden and corrosive industrial atmosphere

3.1.2 Electrical Conditions:

- 3.1.2.1 The system of supply shall be three phase, 4 wire, 50 Hz alternating current with solidly earthed neutral at a nominal voltage of 400 / 231 Volts.
- 3.1.2.2 The voltage may vary within the range of 95% to 105% of the nominal and all equipment installed shall be suitably rated.
- 3.1.2.3 All equipment shall be adequately rated for prospective fault level ratings.

4 DRAWINGS AND INSTRUCTION MANUALS

- 4.1 All drawings shall be in accordance with SANS 10111 – Engineering Drawings.
- 4.2 The successful tenderer shall supply the following instruction manuals, all of which shall be included in the tender price and be to the satisfaction of Transnet Capital Projects.
 - 4.2.1 THREE (3) sets of detailed drawings and instruction manuals, with illustrations where necessary and 2 sets of prints of the "As Built" General Arrangement drawings and the schematic and wiring diagrams to facilitate erection and adjustment of the switchgear.
 - 4.2.2 A full set of electronic media including all information requested above.
 - 4.2.3 These instruction manuals and drawings shall be supplied as soon as possible after placing of the order, but before delivery of the equipment.

5. STANDARD OF WORK, EQUIPMENT & MATERIALS

- 5.1. The distribution board shall conform to the requirements of the latest edition and amendments of SANS 10142-1 Code of Practice for the Wiring of Premises Part 1: Low voltage installations and any additional requirements thereto, described in this specification.
- 5.2. All equipment and material used shall be of high quality and the work shall be of a high standard of workmanship carried out by qualified staff under proper supervision by experienced and competent officers.
- 5.3. If any special tools are required for the maintenance of the switchboard, the tenderer shall supply three (3) sets at delivery of the switchboard to site.



6. DISTRIBUTION BOARDS

6.1. The distribution board shall comply with SANS 60439-1

6.1.1. The form of separation will be specified in the project specific documentation.

6.2. The degree of protection shall be to IEC Publication 144/EN60529 and shall conform to the following:

- Inside Substations and MCC Rooms: IP42
- Other Locations: IP65

6.3. The distribution board shall consist of either a framework of substantial steel sections covered with heavy gauge steel plates or of folded sheet steel sections, forming a robust construction.

6.4. Particular attention shall be given to the ventilation of panels, to eliminate build-up of excessive heat caused by the sun or internal heat generation. All necessary precautions shall be taken to ensure that the temperature of the air in any portion of the assembly does not rise more than 15°C above ambient air temperature

6.5. Every board shall be fitted with a suitable gasket incorporated into the frame to ensure that the arrangement is in accordance with the required degree of protection. Sealing strips and gaskets shall be made of durable, non-hardening rubber, neoprene or other synthetic material, suitably fixed to the door or frame to ensure that the seal does not become dislodged during normal operation.

6.6. Where possible the lock and door catch shall comprise of a combination unit. Door latching and delatching operations shall be smooth and quick, whilst ensuring proper compression of the sealing gaskets. Repeated opening and closing of the hinged doors and operations of the door locks and catches shall not cause chipping or scratching of the painted surfaces or any other blemishes to the finished boards

6.7. Lifting lugs shall be provided for floor standing enclosures and as needed for wall mounted enclosures.

6.8. The board shall have a separate latches hinged or removable front cover secured to the board by means of suitable captive type screws or bolts. When the cover is removed/ opened, easy access to that compartments components and wiring shall be possible.

6.8.1. The control units shall be mounted flush with the front cover so that only the operating handles protrude.

6.8.2. Large removable panels shall be supplied with handles for easy handling.

6.8.3. No possibility should exist for panels to come into contact with live parts.

6.9. Due care shall be taken to ensure that the live side of the MAIN SWITCH is suitably protected so that no live conductors are exposed when the panel door is opened or the panel cover is removed.

6.10. The board shall be equipped with a set of 3 phase and neutral copper busbars. The 3 phase busbars shall be continuously rated for the full load of the incoming supply switch. The neutral shall be 100% of the phase busbars. Earth bar shall be rated to fault current and touch voltage.



- 6.11. All busbars shall be designed, manufactured, marked and tested in accordance with SANS1195.
- 6.12. Busbar rating shall be 2A/mm^2 up to 630A and 1.6A/mm^2 thereafter.
- 6.13. Busbar temperature shall not exceed a 40°C temperature rise.
- 6.14. The busbars shall be adequately braced and supported. The busbars shall be covered with a sufficient number of layers of high quality insulating tape or heat shrinkable sleeving and finished in standard colours.
- 6.15. Where busbar joints and terminations have not been covered, a kit shall be provided for covering during installation.
- 6.16. Alternatively, busbars shall be suitable enclosed in a busbar chamber or behind a protective barrier for protection against inadvertent contact with "live" busbars with access panels removed.
- 6.17. Inter-connectors between the busbars and control units shall be by means of fully insulated, adequately rated conductors firmly bolted to the busbar and secured to the appropriate terminals of the control units using crimped-on terminal lugs. Solid flat conductors shall be used if the rating exceeds 400 A or if the fault current exceeds 25kA rating. No conductor of less than 16mm^2 shall be used between busbars and control units. All conductors shall be suitably rated for the fault level.
- 6.18. The other terminals of the incoming and outgoing panel units shall be connected by means of conductors conforming to clause 6.17, i.e. they shall be robust, insulated, easily accessible terminals, of adequate size, conveniently located in the distribution board near the incoming and outgoing cable entries but with sufficient clearance and space to enable the incoming and outgoing cables to be connected to their corresponding terminals without difficulty or strain.
- 6.19. All the outgoing connections of MCCB'S greater than 400A 3 phase shall be done by means of copper bus bars, securely clamped using approved busbar clamping insulators, fixed to a robust metal section of adequate size, conveniently located in the rear of the distribution board to enable the incoming cables to be terminated in the back of the distribution board cubical behind each respective MCCB. This is to allow for the easy termination of the larger incoming cables, with sufficient clearance and space to enable the outgoing cables to be connected to their corresponding busbar terminals without difficulty or strain to the MCCB's. Each MCCB up to 250A shall be fitted with extended terminal complete with phase barriers as supplied by circuit breaker supplier.
- 6.20. Outgoing cable tails that connect to the busbars in clause 6.19 shall have securing places to enable the cable to be secured with nylon type cable fasteners in an approved manner.
- 6.21. The busbars that protrude into the back compartment of the distribution board shall be covered with a perspex type barrier and shall have danger signs on each section.
- 6.22. Removable gland plates shall be provided. These gland plates shall be of adequate thickness or construction for the cables to be terminated without distortion of the gland plate, and shall not be less than 2mm mild steel (zinc passivated). Gland Plates shall not be mounted less than 300mm above ground floor level, alternatively a base frame of suitable depth may be provided.
- 6.23. Distribution board cases shall be of such dimensions that adequate space is available for manoeuvring and connecting the incoming and outgoing cables.



- 6.24. All cable entries shall be from the bottom of the distribution board unless stated otherwise.
- 6.25. Glands shall not be less than 300mm above floor level. Unless otherwise stated.
- 6.26. The terminals of all incoming and outgoing cables shall be firmly connected to the terminals on the lugs or ferrules, unless they are of a type that will grip the cable without splaying the strands of the conductor.
- 6.27. A substantial earthing terminal shall be firmly attached to the metal work of the distribution board and connected to an earth bar of cross sectional area not less than 50% of the phase bars, running the full length of the distribution board to which all earthing conductors of the incoming and outgoing circuits shall be firmly connected.
- 6.28. A removable link shall be provided in the Neutral busbar to ensure that the neutral busbar can be split in two sections for testing purposes. The link shall be secured in position with a bolt and nut arrangement.
- 6.29. The distribution board manufacturer shall allow for at least 30% capacity for the installation of additional switchgear in the distribution boards.
- 6.30. Each distribution board shall be fitted with the following labels as needed in suitable positions:
- Live busbars
 - Flash signs
 - Main label (always required)
 - Voltage rating
 - Current rating
 - Fault level and time
 - IP rating
 - Job number
 - Reference number
 - Date of manufacture
 - Form of separation
 - Fed from
 - Each feeder/starter to be labelled
- 6.31. Each distribution board shall be supplied with a test certificate. This certificate shall include all items as indicated in annexure 1 of SANS 1973-1 and annexure E of SANS 1973-3.

7. ARC DETECTION SYSTEM

- 7.1. All switchgears shall be equipped with an efficient and reliable arc detection system designed according to IEC 61508 with a safety level meeting at least SIL 2.
- 7.2. The system shall consist of one or more arc monitoring units and light detectors.

7.2.1. Arc detection system:

Arc detection system shall not be activated by interfering influences such as portable lamps, electro-magnetic fields, vibration or touching. In case of an arc occurring in the switchgear it shall be possible to identify where and when the arc has occurred. This information should be accessible without opening the switchgear door and stored even if power is lost to the system. The HMI shall not affect the IP degree of the cabinet.



7.2.2. Arc monitoring unit and light detector:

The arc detection system shall use light as the main condition for tripping. Detectors shall cover each bus-bar section, respective circuit breaker and in any other areas where the designer of the switch gear considers or finds it as a potential risk for an arc. The detectors shall be made of optical fibre in order to avoid EMC disturbances. Without any extra calibration from the user the system shall not react for a light intensity lower than 3000 lux in order to avoid nuisance tripping. The light intensity shall also be constant regardless the length of the detector.

7.3. The trip signal shall be sent within less than 2 ms to the circuit breaker in an event of an arc

7.4. The arc monitoring unit shall provide at least three high speed solid state tripping outputs to the circuit breaker.

7.5. It shall be possible to configure the detectors to trip different breakers depending on which detector detects the arc.

7.6. The system shall have the possibility to mount up to 30 detectors in the space of the main unit in order to avoid space issues if the system would be extended.

8. FUSE SWITCHES

8.1. Fuse switches shall comply with SANS 152 and SANS 60947 – 3.

8.2. Fuse switches shall be enclosed, triple pole, quick break and dustproof.

8.3. Fuse switch handle shall have an IP rating of IP65 and the handle shall be defeatable to override the door interlock.

8.4. Fuse switches shall be of the double break type and the fuses shall be completely isolated when the switches are in the "OFF" position.

8.5. Fuse switch and handle shall have a test position. It will be possible to have an auxiliary for only indication test position.

8.6. The switches shall be interlocked to prevent the opening of the front covers unless the switches are in the "OFF" position and the closing of the switches with the covers open. The switches shall be lockable in the "OFF" position.

8.7. Fuse Switches shall have a lever or rotary action with a positive spring controlled opening and closing action for making or breaking the circuit under load conditions. Fuse carrier and base contacts shall be designed to give permanent high contact pressure and shall be designed to facilitate location of blown fuses without removal of the carrier. Fuse carriers and bases shall be of the highest grade phenolic mouldings to BS 771 and shall be non-flammable and nonhygroscopic, with a hard gloss black finish.

8.8. It shall be possible to install the fuse switch in any position without derating.

9. FUSE LINKS

9.1. HRC Fuse Links shall be of the high rupturing capacity type, compliant with SANS IEC 60269 – 1:2006. Fuse links shall incorporate a visual indication device to facilitate location of blown fuses and shall be designed to clip into the fuse carrier contacts without the use of fixing screws.



9.2. Breaking capacity of all fuse links shall be not less than Category of duty AC.50 at 415 Volts (SANS IEC 60269 - 1:2006). The Fusing factor of the fuses shall not exceed 1.5 (SANS IEC 60269 Class Q1).

9.3. Fuse current ratings shall be indicated on engraved 20 x 12mm white-black-white trifoliate labels in 4mm letters. The labels are to be fitted at the fuse bases and shall not be obscured by wiring.

9.4. Fifty- percent spare fuses of each size shall be provided in suitable cubicle on the switchboard. The door of this cubicle shall be suitably identified.

10. AIR CIRCUIT BREAKERS (ACB) SHALL CONFORM TO THE FOLLOWING CHARACTERISTICS.

10.1. Functional characteristics:

10.1.1. Air circuit breakers for use on the incoming supply side of the distribution board shall comply with SANS 60947.

10.1.2. The circuit breakers shall have a continuous enclosed current rating as indicated on the relevant drawings with a minimum Icu (ultimate breaking capacity) of 42kA at 415 volts. The circuit breakers shall be tested for category P.2, unless specified otherwise.

10.1.3. The circuit breakers shall have an Ics (service capacity) rating equal to the Icu (ultimate breaking capacity) rating.

10.1.4. The circuit breakers shall have an Icw (withstand current) of 1 sec and 3 sec. The 1 sec Icw rating shall be equal to the Icu rating.

10.1.5. The air circuit breakers shall be of the enclosed, ventilated, independent manual spring, draw-out type with a rated service voltage of 690 volts and a rated insulation voltage of 1000 volts and be equipped for shunt tripping from a 115 V DC battery supply. The shunt tripping facility shall be wired so that the ACB shall trip when it's associated high voltage transformer circuit breaker trips.

10.1.6. The circuit-breakers shall have a rated impulse withstand voltage of 12 kV.

10.1.7. The rated uninterrupted current shall be between 100 and 6300 A with the possibility of set trip threshold of L protection from 40A.

10.1.8. Different versions of circuit-breakers shall be available, divided into their category of use: A (current-limiting) and B (selective).

10.1.9. Different versions shall be available with rated ultimate breaking capacity from 42 to 150 kA at 440 V AC and from 42 to 100 kA at 690 V AC for circuit-breakers in category B and with 130 kA at 415 V AC, 85 kA at 690 V AC for circuit-breakers in category A.

10.1.10. The mechanical life shall be at least 12000 operations with a frequency of 60 operations/hour without the need for maintenance of the contacts and arcing chambers

10.1.11. The electrical life at a voltage of 440 V AC shall be (with a frequency of at least 10 operations/hour and without the need for maintenance of the contacts and arcing chambers):



- at least 9000 operations up to 2000 A
 - at least 5000 operations up to 3200 A
- These values are intended to be valid only for category B circuit-breakers.

10.2. Environmental characteristics

- 10.2.1. Operating temperature: -25 °C...+70 °C (-13 °F...158 °F) and storage temperature: -40
- 10.2.2. Altitude: operation without derating shall be up to 2000 metres above sea level. (6600 ft), and with derating up to 5000 metres above sea level. (16500 ft).
- 10.2.3. Suitability for use in a hot-humid environment. With regard to this, the circuit-breakers shall undergo a tropicalisation process which makes them suitable for use in a hot-humid environment, as established by the prescriptions of the main shipping registers and in accordance with the international IEC 60068-2-30 Standards.

10.3. Construction characteristics

- 10.3.1. All the models shall be available in the 3 and 4 pole versions both in the fixed (with rear horizontal, rear vertical and front terminals) and withdrawable (with rear horizontal, rear vertical, front and front terminals) versions.
- 10.3.2. There shall be total segregation between power and front shield, using double insulation where suitable so as to guarantee maximum operator safety.
- 10.3.3. Total segregation between the phases shall be guaranteed for safety reasons without need of phase barriers up to 1000V.
- 10.3.4. It shall be possible to inspect easily the arcing chambers easily and to check main contact wear with the circuit-breaker racked-out, by removing the arcing chambers.
- 10.3.5. All the circuit-breakers in the range shall have the same height and depth with the aim of standardising the supporting structures of the switchgear and the switchgear itself as far as possible.
- 10.3.6. IP30 degree of protection shall be guaranteed on the front part and IP20 on the rest of the circuit-breaker (excluding the terminals), with the possibility of having IP54 degree of protection (NEMA 3/3s/13) on the front, using the transparent cover which completely protects the front, but still leaves the panel underneath and the protection unit fully visible with the relative indications.
- 10.3.7. The whole range of air circuit-breakers shall be fitted with electronic protection releases. It shall be allowed the inter-changeability of protection releases from skilled personnel.

10.4. Special points for withdrawable versions:

- 10.4.1. The circuit-breakers in the withdrawable version shall be fitted with anti-racking-in locks to prevent racking a moving part into a fixed part with a different rated current.
- 10.4.2. In the case of the withdrawable version, the presence of a device shall prevent racking-out and racking-in with the apparatus closed.

**10.5. Accessories**

The following accessories shall be common to the whole range standard:

10.5.1. Electrical accessories:

- 10.5.1.1. Shunt opening/closing release.
- 10.5.1.2. Control and monitoring Test Unit - allows continuity of the different versions of the shunt opening releases to be checked;
- 10.5.1.3. Undervoltage release;
- 10.5.1.4. Time delay device for undervoltage release - allows release trip delay with established and adjustable times;
- 10.5.1.5. Geared motor for the automatic charging of the closing springs;
- 10.5.1.6. Mechanical and electrical signalling of overcurrent release trip;
- 10.5.1.7. Trip reset release;
- 10.5.1.8. Auxiliary contacts which allow signalling of the circuit-breaker state;
- 10.5.1.9. Current transformer for the neutral conductor outside the circuit-breaker;
- 10.5.1.10. Homopolar toroid for the main power supply earth conductor (star centre of the transformer).

10.5.2. Mechanical accessories:

- 10.5.2.1. Interlocks between 2 circuit-breakers or among three circuit-breakers can be used horizontally, vertically or in "L" position using different types of flexible cables:
- 10.5.2.2. Standard version (with maximum distance between two circuit breakers: up to 1200 mm if horizontally interlocked while up to 750mm if vertically interlocked).
- 10.5.2.3. Extended version (with distance between two circuit breakers: from 1200mm up to 1600 mm if horizontally interlocked while from 750 up to 1000 if vertically interlocked).
- 10.5.2.4. Mechanical locks to control enabling racking-in/out operations available also with interlocks. IP54 transparent front protection (NEMA 3/3S/13).

10.6. Protection Release**10.6.1. Basic Protection Functions**

- 10.6.1.1. The release shall not require auxiliary power supplies since the power is taken from the current transformers.
- 10.6.1.2. The signals supplied by the release shall not operate with power supply supplied by internal batteries.



- 10.6.1.3. The protection against overload (L) with characteristic $t=k/I^2$ shall always have setting ranges with timing adjustable up to 144s with $I=3I_n$.
- 10.6.1.4. The protection of neutral shall be set at 50%, 100%, 200% and OFF of the phase currents without changing any component.
- 10.6.1.5. All the protection functions except protection against overload shall be excludable.

10.6.2. Measurement Functions

- 10.6.2.1. The release shall always be able to provide measurement of the currents and voltages in the three phases, in the neutral and of earth fault (ammeter function), both in self-supply and with an auxiliary power supply. Measurement function shall be active, even without external supply, starting from 140 A of single-phase current, independently from the circuit-breaker size. Accuracy of the ammeter measurement chain (current sensor plus ammeter) shall equal or better than 1.5% in the 30% - 120% current interval of I_n .
- 10.6.2.2. The release shall not normally require auxiliary power supplies since the power is taken from the current transformers. For measurements and programming at very low currents, a power supply at 24 V DC shall be available. As alternative the release shall be able to receive power supply directly from busbars or terminals, up to line voltage equal to 690 V AC.
- 10.6.2.3. The release shall be able to acquire the waveforms of electrical values with a sampling frequency selectable from 600 to 4.800 Hz and sampling interval from 3 s to 27 s. Acquisition shall be frozen after a trip or a configurable event. Acquisition data shall be retrieved from an external device (personal computer or similar) for fault analysis purposes. The release shall show voltage measurements on display, with a precision equal or higher than 1%.
- 10.6.2.4. Measurement functions that shall be available:
 - Current measurements
 - Voltage measurements
 - Power measurements
 - Power factor measurements.
 - Measurements of frequency and peak factor
 - Energy measurements
 - Historical measurements
 - The last 10 trips information
 - Complete trip information on display without batteries
 - Data logger included as standard

10.7. Advanced Protections Functions

- 10.7.1. Thermal memory for functions L (overload protection) and S (short circuit protection).
- 10.7.2. Protection against over-temperature. It shall be possible to signal the presence of anomalous temperatures on the release by means of two LEDs (Warning and Alarm) and, if decided during the unit configuration phase, when the temperature is over 85 °C, to simultaneously control circuit-breaker opening.
- 10.7.3. Protection against missing and unbalanced phase (U) with characteristic $t=k$ shall be possible.



- 10.7.4. Load control protection (K).
- 10.7.5. Undervoltage protection (UV)
- 10.7.6. Overvoltage protection (OV)
- 10.7.7. Residual voltage protection (RV)
- 10.7.8. Underfrequency protection (UF)
- 10.7.9. Overfrequency protection (OF)
- 10.7.10. Protection against reversal of active power (RP)

10.8. User Interface and Signalling LEDs

- 10.8.1. An alarm shall indicate by means of LEDs located on the release the disconnection of opening solenoid and current transformers. A trip shall also occur, after a short time delay, when the disconnection is detected.
- 10.8.2. The release shall allow parameterisation by means of keys and a LCD graphic display.
- 10.8.3. Access to control and configuration of the unit by means of a password (edit MODE).
- 10.8.4. The signals given by the permanent indicators shall guarantee maximum reliability.
- 10.8.5. Indication shall be available directly on display on request of the user for not less than 48 hours even without an auxiliary voltage and batteries and also be given in the case of re-losing on a fault. After 48 hours of inactivity the information shall be retrievable by external devices. Indication shall contain at least the protection tripped.
- 10.8.6. It shall be possible to read the current values and information on the last 10 measures (current values, protection tripped) at any time through external devices, some of which can transmit data via bluetooth;
- 10.8.7. In the event of CB tripped, shall be indicated the type of protective function that intervened.
- 10.8.8. Each alarm or warning alarm shall be clearly shown on the display, when it is active.
- 10.8.9. On the protection release two (2) led's shall be present.
- 10.8.10. Warning LED shall be in place indicating at least the following:
 - Presence of one or more phases with current values in the $0.9 \cdot I_n < I < 1.05 \cdot I_n$ range
 - Presence, between two or three phases, of unbalance higher than the value programmed during configuration
 - The first temperature threshold of $T=70\text{ }^{\circ}\text{C}$ has been exceeded
 - Contact wear $> 80\%$
 - Harmonic distortion
 - Out of range frequency
 - Breaker status error
 - Warning threshold override



- 10.8.11. Alarm LED shall be in place indicating at least following:
- Presence of one or more phases under overload with current values $I > 1,3 \cdot I_n$ (Overload Protection - L under timing)
 - Timing in progress for protection function S (Selective short circuit protection)
 - Timing in progress for protection function G (Earth fault protection)
 - The second temperature threshold of $T=85^\circ\text{C}$ has been exceeded
 - Contact wear 100%.
 - Timing in progress for protection function D;
 - Timing in progress for protection function UV(Under Voltage), OV(Over Voltage), RV (Residual Voltage);
 - Timing in progress for protection function RP(Reversal of Active Power);
 - Timing in progress for protection function
 - Timing in case of unbalance between the phases higher than the value set during configuration with trip set to ON;
 - Current Sensors disconnected;
 - Opening solenoid (Trip Coil) disconnected
- 10.8.12. The communication function shall be implemented on the release by means of:
- An internal bus, with interface RS485;
 - An external bus, with Modbus RS485 protocol 2-Wire Twisted Pair, 19.2 kbit/s max.
- 10.8.13. There shall be the possibility of setting the release in remote and in local operating mode, and with the latter it shall not be possible to carry out data transmission from the system to the release. It shall be possible to automatically set the local mode by means of an external contact. An 24VDC auxiliary supply shall be used.
- 10.8.14. The protection release shall be able to send to the system these data:
Protection parameters set, phase and neutral currents, state of the circuit-breaker (open closed), position of the circuit-breaker (connected-isolated), state of the springs (charged discharged), number of circuit-breaker mechanical operations, total and for each protection number of trips, last interrupted current, contact wear, state of the protection functions (pre alarm function. L, timing function. L, S,G...), overtemperature protection function, state of internal communication bus.
- 10.8.15. The system shall transmit to the protection release the following data: protection parameters, circuit-breaker opening and closing commands, reset for tripping of some protection functions.
- 10.8.16. Adjustable inverse definite minimum time (IDMT) overcurrent release facilities are required in addition to the instantaneous fault trip for the air circuit breakers.

11. MOULDED CASE CIRCUIT BREAKERS (MCCB) SHALL CONFORM TO THE FOLLOWING CHARACTERISTICS.

11.1. Functional Characteristics

- 11.1.1. AC rated service voltage for currents over 160 A: 690 V AC (50-60 Hz).
- 11.1.2. DC rated service voltage: 500 V DC for currents of 160 A and 750 V DC for currents over 160A.
- 11.1.3. Rated uninterrupted current for 1000 V AC or DC applications: 800 A (three and four poles).



- 11.1.4. Minimum rated insulation voltage for currents equal or over 160 A: 8 kV.
- 11.1.5. Rated insulation voltage for currents equal or over 160 A: 800 V AC.
- 11.1.6. Rated uninterrupted current between 160 and 3200 A with trip units settings starting from 1A.
- 11.1.7. According to IEC 60947-2 (§ 4.4) starting from 400 A the circuit breakers shall be category B
- 11.1.8. MCCBs shall be available with different ultimate short breaking capacities between 16kA and 200kA @ 380/415 V AC.
- 11.1.9. Both line up and line down supplying shall be possible without decreasing MCCBs performances or functionality
- 11.1.10. For rated uninterrupted currents up to 160 A, the MCCB limiting features shall be enough to assure its conformity to IEC 60439-1 (§ 8.2.3.1) once installed into a type AS or ANS switchboard as general breakers. This shall be valid up to the MCCB's rated uninterrupted current (limiting versions are excluded).
- 11.1.11. A test bottom for the correct functionality checking (moving contacts opening) shall be place in front of the breaker.

11.2. Ambient Characteristics

- 11.2.1. Operating temperature: -25 °C. +70 °C (ambient temperature)
- 11.2.2. Storage temperature: -40 °C .. +70 °C (ambient temperature)
- 11.2.3. Reference temperature for setting the thermal element of the thermomagnetic trip unit: +40 °C
- 11.2.4. Maximum relative humidity: 98%
- 11.2.5. Maximum altitude: 2000 m above sea level, 5000 m above sea level with derating suitability for being used in hot-humid places. With regard to this, the circuit-breakers shall undergo a tropicalization process to make them suitable for use in hot-humid places, as established in the prescriptions of the major naval registers and in compliance with the International IEC 60068-2-30 Standards.
- 11.2.6. Circuit-breakers fitted with electronic trip units shall comply with the prescriptions of the International Standards on electromagnetic compatibility.

11.3. Construction Characteristics

- 11.3.1. The range of moulded case circuit-breakers shall cover a range of rated uninterrupted currents from 160 to 3200 A
- 11.3.2. By means of the double insulation technique, moulded case circuit-breakers shall guarantee complete separation between the power circuits and the auxiliary circuits.
- 11.3.3. Moulded case circuit-breakers shall have an operating lever which always indicates the exact position of the circuit-breaker contacts (positive operation), by means of safe and reliable signals (I= closed, O= open, yellow-green line= open due to trip unit).
- 11.3.4. The operating mechanism shall be designed to operate all poles of the circuit breaker simultaneously for making, breaking and tripping.



- 11.3.5. Moulded case circuit-breakers shall be suitable for isolation in compliance with § 7.2.7 of the IEC 60947-2 Standard. This indication shall be clearly and indelibly marked on the circuit-breaker (in accordance with § 5.2 of IEC 60947-2) and in a position where it is visible with the circuit-breaker installed.
- 11.3.6. Moulded case circuit-breakers shall be available in the three-pole and four-pole version both in the fixed, and in any possible plug-in or withdrawable versions.
- 11.3.7. Circuit-breakers in the plug-in version starting from 250 A shall be available. In the case of a plug-in or withdrawable version, the presence of a device shall prevent racking-in or racking-out with the apparatus closed.
- 11.3.8. In the withdrawable version, racking-out with the door closed shall be possible.
- 11.3.9. The same depth and installation on a DIN EN 50022 rail shall be guaranteed up to the rated setting of 250 A inclusive. The same depth shall be guaranteed. This characteristic shall allow the switchboard and their support structures to be standardized.
- 11.3.10. Moulded case circuit-breakers with rated uninterrupted current up to 250 A shall have a 45 mm high face which makes them suitable for installation on modular panels.
- 11.3.11. All the installation positions shall be possible without jeopardizing the function of the apparatus. Starting from 630 A up to 1600 A the withdrawable version shall be mounted and operated horizontally.
- 11.3.12. For the front parts of the circuit-breakers the degree of protection of at least IP20 (excluding the terminals) shall be guaranteed, IP30 when they are installed in switchboards, and up to IP54 for circuit-breakers installed in a switchboard fitted with transmitted rotary handle and special accessory.

11.4. Protection Trip Units

- 11.4.1. Moulded case circuit-breakers shall be equipped with interchangeable trip units. From 160 A up to 800 A it shall be possible to choose between a thermomagnetic and an electronic protection. For the sizes higher than 800 A, the trip unit shall only be electronic. The trip unit shall be integrated in the volume of the apparatus.
- 11.4.2. From the 250 A size circuit-breakers, the trip unit shall be interchangeable. Trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings

11.5. Thermomagnetic Overcurrent Trip Units

- 11.5.1. Thermomagnetic trip units shall be fitted with protection threshold against overload (whose thermal element shall consist of a bimetal) and with protection threshold against short circuit.
- 11.5.2. The protection threshold against overload shall be continuously adjustable starting from 0.7 times the rated current of the trip unit and up to its rated value.
- 11.5.3. The reference temperature for setting the thermal element of the protection trip unit is 40°C.
- 11.5.4. The temperature performance of the trip unit shall be indicated as the temperature varies.



- 11.5.5. The protection threshold against short-circuit shall be either the fixed or adjustable type with continuity from 5 and up to 10 times the rated current of the trip unit. In the four-pole version, the neutral pole shall always be protected. For current values equal to or higher than 125 A, protection of the neutral pole shall, at choice, be at 100% or at 50% of the rated current of the trip unit. Vice versa, for current values of less than 125 A, protection of the neutral pole shall always be 100%.
- 11.5.6. For circuit-breakers with rated uninterrupted current of 160 A, 250 A, 400 A and 500A, a thermomagnetic trip unit shall be available for generator protection with adjustable thermal threshold, starting from $0.7 \times I_n$, and fixed magnetic threshold at $3 \times I_n$ or adjustable magnetic threshold from 2.5 to $5 \times I_n$. Suitability for use in direct current.

11.6. Magnetic only overcurrent trip units

- 11.6.1. The overcurrent trip units with magnetic only threshold shall be suitable for protection against short-circuit.
- 11.6.2. The adjustable magnetic only trip units (suitable for motor protection) shall only be available in the three-pole version, whereas those with fixed threshold shall also be available in the four-pole version.
- 11.6.3. The adjustable magnetic only trip units shall be available for circuit-breakers up to 320 A. Suitability for use in direct current.

11.7. Electronic Overcurrent Release Trip Units

- 11.7.1. The electronic overcurrent trip units shall be self-supplied and shall be able to guarantee correct operation of the protection functions even in the presence of a single phase supplied with a current value equal to 20% of the phase current. They shall be unaffected by electromagnetic interference in compliance with the EMC directive on the matter.
- 11.7.2. The basic version shall be fitted with protection functions against overload (function L) and against short-circuit. The latter function can either be of the instantaneous type (function I) or, alternatively, with intentional delay selective short circuit protection (function S). The function of protection against short circuit shall be excludable.
- 11.7.3. A basic version shall also be provided with only the protection threshold against instantaneous short-circuit which cannot be excluded.
- 11.7.4. The complete version shall be fitted with protection threshold against overload (function L), against instantaneous short-circuit (function I) and with intentional delay (function S) and also with protection threshold against earth fault (function G). All the protection functions except for protection against overload shall be excludable.
- 11.7.5. The advanced version shall be suited for zone selectivity protection for the S and G protection functions. An integrated ammeter and many other additional features are provided over and above the protection functions. All the protection functions except for protection against overload shall be excludable.
- 11.7.6. The advanced version shall be suited for zone selectivity protection for the S and G protection functions. An integrated ammeter and many other additional features are provided over and above the protection functions. All the protection functions except for protection against overload shall be excludable.



- 11.7.7. A version dedicated to ultra rapid short-circuit protection (with a detection time less than 5 ms) combined with zone selectivity shall be available.
- 11.7.8. An advanced version dedicated to motor protection shall be available with protection functions against overload (function L), against instantaneous short circuit (function I), against unbalanced or missing phase (function U) and against rotor block (function R).
- 11.7.9. A version dedicated to generator protection shall be available (up to 160A), with protection functions against overload (function L), against instantaneous short circuit (function I) and with intentional delay (function S). The S and I protection functions are not an alternative to each other. All these functions are imposed by the major naval registers.
- 11.7.10. All the advanced trip units shall be available with thermal memory.
- 11.7.11. All the protection functions shall be characterized by threshold and time tolerances according to the International Standards.
- 11.7.12. The trip unit shall allow parameterization of the trip thresholds and timing locally or remotely; in the case of any anomalies in remote parameterization, the protection shall automatically use the series of parameters set manually on the front of the circuit breaker.
- 11.7.13. On the advanced version, access to information and programming shall be allowed by a keyboard and graphic liquid crystal display.
- 11.7.14. Alarm signals for the protection functions will be available by means of LEDs located on the trip unit (complete version) and/or on the display (advanced version).
- 11.7.15. The size of the current sensors shall be a minimum of 10 A to a maximum of 3200 A so as to cover the widest possible current range.
- 11.7.16. Interchangeable rating-plugs shall be available starting from 400 A.
- 11.7.17. The four-pole circuit-breaker shall always be supplied with the neutral protected at 100% up to 125A excluded, and for higher values with protection selected between 50% and 100% of the rated current of the trip unit. Starting from 630A setting of the neutral at 150% and 200% shall be possible.
- 11.7.18. The current sensors for external neutral shall be optional.
- 11.7.19. Moulded Case Circuit breakers equipped with electronic releases shall be available a dedicated function to verify the correct connection between the trip unit, current sensor and trip coil. Eventual anomalies shall be signalled by a red led flashing.
- 11.8. Accessories for electronic trip units shall be available, such as the test unit for checking functioning of the tripping coil of the electronic trip unit, a trip signalling unit of the protections, a test and configuration unit which allows the electronic trip unit protections to be tested and configured, an actuation unit which allows circuit-breaker opening and closing by means of a motor operator mounted on it, a battery unit which allows trip unit testing when the circuit-breaker and an external unit for wireless communication.



- 11.8.1. For both the complete and the advanced version a measurement module shall be available, in order to gauge the plant functioning parameters, such as phase and phase to phase voltages, powers and energies. On the advanced version all the available measurements can be displayed on the LCD. Furthermore, for the electronic trip units for motor protection, there shall also be a contactor control unit available.
- 11.8.2. The advanced version will be provided with a data logger function that automatically records and stores the instantaneous values of all the currents and voltages. Data shall be easily downloaded to any personal computer for elaboration. The data logger function freezes the recording whenever a trip occurs, so that a detailed analysis of faults can be easily performed. The sampling rate shall be adjustable up to 4800Hz, with total sampling time up to 27 s (@ 600Hz sampling rate). Tracking of up to 64 events shall be possible.

11.9. Protections

The minimum performances of the protection functions of the electronic protection trip unit for distribution, where present, shall be:

- 11.9.1. Function L: adjustable trip threshold $I1 = (0.4-1) \times I_n$, trip curves for the basic version with time settings from 3 to 12 seconds – 2 different trip curves - (at 6 times the set threshold), whereas for the advanced version with time settings from 3 to 18 seconds – 4 different trip curves - (at 6 times the set threshold). For the advanced version, L function according to IEC 60255-3 shall be available. *Cannot be excluded.*
- 11.9.2. Function S: adjustable trip threshold $I2 = (1-10) \times I_n$, trip curves for the basic version with time settings from 0.1 to 0.25 seconds – 2 different trip curves – (at 8 times the rated current of the trip unit), whereas for the advanced version with time settings from 0.05 to 0.5 seconds – 4 different trip curves with inverse short time with definite time characteristic or curves with definite time – (at 6 times the rated current of the trip unit). For circuit breakers from 250 A to 630 A, in the advanced version, $I2 = (0.6-10) \times I_n$. *Can be excluded.*
- 11.9.3. Function I: adjustable trip threshold $I3 = (1-10) \times I_n$ for the basic version (instantaneous trip), whereas for the advanced version $I3 = (1.5-15) \times I_n$ (instantaneous trip). *Can be excluded.*
- 11.9.4. Function G: adjustable trip threshold $I4 = (0.2-1) \times I_n$ with trip time settings from 0.1 to 0.8 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.5. Function U: adjustable trip threshold $I6 = (2\% \dots 90\%) \times I1$ with trip time settings from 0.5 to 60 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.6. Function OT: fixed at 85 °C (with instantaneous trip). *Can be excluded.*
- 11.9.7. Function UV: adjustable trip threshold $U8 = (0.5-0.95) \times U_n$ with trip time settings from 0.1 to 5 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.8. Function OV: adjustable trip threshold $U9 = (1.05-1.2) \times U_n$ with trip time settings from 0.1 to 5 s with curve with inverse short time and definite time characteristic. *Can be excluded.*



- 11.9.9. Function RV: adjustable trip threshold $U_{10} = (0.1-0.4) \times U_n$ with trip time settings from 0.5 to 30 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.10. Function RP: adjustable trip threshold $P_{11} = (-0.3...-0.1) \times P_n$ with trip time settings from 0.5 to 25 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.11. Function UF: adjustable trip threshold $f_{12} = (0.9-0.99) \times f_n$ with trip time settings from 0.5 to 3sec with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.12. Function OF: adjustable trip threshold $f_{13} = (1.01-1.10) \times f_n$ with trip time settings from 0.5 to 3 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.13. The minimum performances of the protection functions of the electronic protection trip unit for motor protection shall be:
- Function L: adjustable trip threshold $I_1 = (0.4-1) \times I_n$, trip curves in class 10A, 10, 20 and 30 or 3E, 5E, 10E e 20E in compliance with the IEC 60947-4-1 Standard, with temperature compensation and sensitivity to missing/unbalanced phase. *Cannot be excluded.*
 - Function R: adjustable trip threshold $I_5 = (3-10) \times I_1 + \text{OFF}$, with 4 different trip curves with definite time with time settings $t_5 = 1...10$ s. Automatic exclusion of the function during the motor starting phase, and automatically reactivated after this. *Can be excluded.*
 - Function I: adjustable trip threshold $I_3 = (6-13) \times I_n$ (instantaneous trip) with recognition of the motor starting phase.
 - Function U: adjustable trip threshold $I_6 = (0.4-0.9) \times I_1$ e $t_6 = 4$ s. *Can be excluded.*
 - Possibility of contactor control for trip of functions L and R.
 - Possibility of connection to a PTC (temperature probe) inserted in the motor.

11.10. Dialogue

For circuit-breakers from 250 A to 1600 A dialogue shall be available, making the following functions possible:

- 11.10.1. Remote setting of the protection function parameters, unit configuration and communication.
- 11.10.2. Transmission of measurements, states and alarms from circuit-breaker to system transmission of events to the system.
- 11.10.3. Dialogue units able to support different standard market protocols shall be available:
- 11.10.3.1. Modbus RTU protocol, EIA RS485 physical transmission means, speed 9.6...19,2 Kbit/s, bus architecture.
- 11.10.3.2. Profibus DP protocol, RS485 physical transmission, speed 9.6...19,2 Kbit/s, bus architecture.



- 11.10.3.3. Device Net protocol, RS485 physical transmission, speed 9.6...19,2 Kbit/s, bus architecture. Wireless bluetooth protocol.
- 11.10.3.4. The dialogue unit shall make all the parameterization and measurement information of the protection unit available on the field bus, as well as the state of the circuit-breaker (open/closed, racked-in/racked-out) and of the related trip units. Shall be providing a tool able to analyse all these data by PC.

11.11. Accessories

11.11.1. Electrical Accessories

- 11.11.1.1. Internal Accessories has to be the same up to 250A as well from 250A to 1000A.
- 11.11.1.2. Auxiliary contacts: these shall allow the state of the circuit-breaker (open or closed; contact on change-over) and trip unit to be known. Auxiliary contacts for use at 250 V AC/DC, 400V AC and 24 V DC (digital contacts) shall be available.
- 11.11.1.3. Releases: the shunt opening and under-voltage releases shall be available with different power supply voltages both in AC and DC.
- 11.11.1.4. With circuit-breakers up to 250 A the electrical accessories shall be available both in the pre-cabled version and with 1m long un-cabled cables.
- 11.11.1.5. The addition of the electrical accessories shall not increase the volume of the circuit breakers.

11.11.2. Mechanical Accessories

- 11.11.2.1. Terminals: different types of terminals (both front and rear) shall be available for all the sizes, suitable for connection with copper, copper-aluminium cable and bus bar connections.
- 11.11.2.2. Up to the 160 A size, the circuit-breakers can be fitted with different types of terminals combined in different ways (higher of one type, lower of a different type). Terminal covers and phase separators shall also be available.
- 11.11.2.3. Multi-cable terminals shall be available for circuit-breakers for the 250-320-400-630 A size. Support for fixing onto DIN rail: supports for fixing onto DIN EN 50022 rail shall be available up to the rated current of 250 A inclusive.
- 11.11.2.4. Mechanical interlocks: mechanical interlocks shall be available for the whole series of circuit-breakers; the interlock can be of the front type for circuit-breakers with rated current up to 250 A. It shall be possible to interlock circuit-breakers of different sizes at least up to 250 A and between 250A and 630 A.
- 11.11.2.5. Rotary handle: a rotary handle operating mechanism both in the direct and transmitted version shall be available for the whole range of circuit-breakers, both padlockable in the open position and fitted, on request, with the following accessories: early contact for under-voltage release, compartment door lock and key lock in open position.
- 11.11.2.6. The whole range of moulded case circuit-breakers shall be fitted with motor operator (according to the rated current of the circuit-breaker, this can either be of the solenoid type, or with stored energy) for remote operation of the circuit-breaker.

**11.12. Residual Current Release****11.12.1. General Aspects**

- 11.12.1.1. The residual current releases used in low voltage installations shall be designed, constructed and tested in compliance with the International Standards and in particular with:
 - 11.12.1.1.1. IEC 60947-2 appendix B and ANNEX M
 - 11.12.1.1.2. IEC 60255-4 and IEC 61000: for protection against unwarranted trips
 - 11.12.1.1.3. IEC 60755 for insensitivity to the continuous current components
- 11.12.1.2. It shall be possible to install the residual current releases in installations with line-to-line voltage up to 690 V.
- 11.12.1.3. They shall be able to be used in close connection with circuit-breakers and/or switch disconnectors.
- 11.12.1.4. Shall be guaranteed the normal operating up to -25°C

11.13. Construction Characteristics

- 11.13.1. It shall be possible to combine the range of residual current releases with all the circuit breakers making up the range of moulded case circuit-breakers so as to cover the whole current range of MCCBs.
- 11.13.2. It shall be possible to combine the residual current releases with circuit-breakers in fixed, plug-in and withdrawable version.
- 11.13.3. Their installation on a DIN rail shall be possible.
- 11.13.4. Control of correct operation shall be possible according to the prescriptions of the reference Standards, by means of a test pushbutton on the front of the apparatus.
- 11.13.5. Residual current releases shall be available both in the three-pole up to 250A and in the four-pole version.
- 11.13.6. Dedicated residual current releases shall be available up to 1600 A
- 11.13.7. Type B residual current protection shall be available
- 11.13.8. It shall be possible to select the maximum threshold of sensitivity to the residual current fault frequency (3 steps: 400 700 1000 Hz).

11.14. Electrical Characteristics and Performances

- 11.14.1. Up to the rated current of 250 A, the service voltage shall be between 85 and 500 V AC line-to-line (operation up to 50 V phase-neutral). Trip thresholds I_{dn} starting from 0.03A and up to 10 A shall also be available for the advanced version which shall also allow selection of the trip times (for the basic version, the trip shall be of the instantaneous type).
- 11.14.2. A contact signalling pre-alarm shall be available in the advanced version and the availability of an input for remote opening.



- 11.14.3. There shall be type A versions for alternating pulsed current, S selective and E for emergency stop of the residual current release.
- 11.14.4. The release shall be self-supplied and the power supply can come either from above or below.
- 11.14.5. Compliance with the International Standards on the matter of electromagnetic compatibility.
- 11.14.6. There shall be a switchboard residual current unit with voltage varying between 80 and 500 V AC and between 48 and 125 V DC. There shall be availability of several adjustment ranges from 0.03 to 30 A, with trip times from instantaneous to 5 s and pre-alarm threshold adjustment.
- 11.14.7. The toroidal transformers can either be closed (from 60 to 180 mm in diameter) or open (from 110 to 230 mm in diameter).

12. MINIATURE CIRCUIT BREAKERS SHALL CONFORM TO THE FOLLOWING CHARACTERISTICS.

12.1. Functional Characteristics (1 to 63 Amps)

- 12.1.1. Miniature Circuit Breaker for cable protection according to:
DIN VDE 0641 Teil 11,
EN 60898, IEC 60947-2, EN 60947-2,
UL1077/C22.2 No.235, UL489/C22.2 No.5
- 12.1.2. Rated short-circuit capacity I_{cn} shall be: 6/10/25 kA unless otherwise indicated.

12.2. Tripping Characteristics/curves shall be as follows

B: In 6/10/13/16/20/25/32/40/50/63 A
 C: In 0,5/1/1,6/2/3/4/6/8/10/13/16/20/25/32/40/50/63 A
 K: In 0,2/0,5/1/1,6/2/3/4/6/8/10/13/16/20/25/32/40/50/63 A
 Z: In 0,5/1/1,6/2/3/4/6/8/10/16/20/25/32/40/50/63 A
Number of poles: 1/2/3/4/1+NA/3+NA
Energy Limiting Class: 3
Rated Voltage U_n :
 Single-pole: 230/400 VAC
 Multi-pole: 400VAC
Max. Operating Voltage U_{Bmax} DC:
 Single Pole: 72 VDC
 Double Pole: 125 VDC
 Suitable for isolation acc. IEC 60898-1

12.3. Environmental Characteristics

- 12.3.1. Operating temperature: -25 °C...+70 °C and storage temperature: -40 °C...+70 °C.
- 12.3.2. Altitude: operation without derating up to 2000 m (6600 ft), and with derating up to 4000 m.
- 12.3.3. Suitability for use in a hot-humid environment. With regard to this, the circuit-breakers shall undergo a tropicalisation process which makes them suitable for use in a hot humid environment, as established by the prescriptions of the main shipping registers and in accordance with the international IEC 60068-2-30 Standards.



12.4. Construction Characteristics

- 12.4.1. Guide edge for labels
- 12.4.2. Prepared for locking devices
- 12.4.3. Quick and easy removal of installed device

12.5. Wiring

- 12.5.1. Busbars: Terminals for in and out coming feeder on top of busbars. The MCB shall have a "safe terminal". Each pole shall have 2 connection points. Combining busbar and wire in same terminal shall not be permitted. Combining wire of un-equal sizes in the same terminal shall not be permitted.

12.6. Accessories

- 12.6.1. Retrofit accessories (extract):
 - Universal signal contact/auxiliary contact (right): 1SO
 - Auxiliary contact (right): 1SO
 - Auxiliary contact (left): 1NO/1NC, 2NO or 2NC
 - Bottom-fitting auxiliary contact: 1NO or 1NC
 - (bottom fitted without increasing width of MCB)
 - Undervoltage- or Shunt trip release
 - Hand operated neutral
 - Motor operating device (remote control)
 - DDA-Block
 - Labelling system (marked or blank)
 - Locking devices

12.7. Functional Characteristics (80 to 100 Amps)

- 12.7.1. Miniature Circuit Breaker for cable protection according to:
DIN VDE 0641 Teil 11, DIN VDE 0660 Teil 101, IEC 60898, EN 60898, IEC 60947-2, EN 60947-2
- 12.7.2. Rated short-circuit capacity shall be minimum: 6 kA unless otherwise stated.

12.8. Tripping Characteristics

- 12.8.1. B mit In 80/100 A
C mit In 80/100 A
Number of poles: 1/2/3/4
Energy Limiting Class: 3
Rated Voltage:
Single-pole: 230 VAC and 60 VDC
Single-pole: 400 VAC and 125 VDC
Suitable for isolation acc.: IEC 60947-1/-3

12.9. General Features

- 12.9.1. Label holder
- 12.9.2. Prepared to get equipped with toggle-locking device



12.10. Wiring

- 12.10.1. Busbars: Terminals for in and out coming feeder on top of busbars. The MCB shall have a "safe terminal". Each pole shall have 2 connection points. Combining busbar and wire in same terminal shall not be permitted. Combining wire of un-equal sizes in the same terminal shall not be permitted.

12.11. Accessories

- 12.11.1. Auxiliary contact: 2 or 3 contacts (screw-able or push-in-able)
- 12.11.2. Auxiliary contact (low power): 1 or 3 contacts
- 12.11.3. Signal contact or signal contact/auxiliary contact: 3 contacts
- 12.11.4. Undervoltage release or shunt trip
- 12.11.5. Neutral conductor
- 12.11.6. Printed labels
- 12.11.7. Labels for individual printing
- 12.11.8. Locking devices

12.12. Functional Characteristics (DC Protection)

- 12.12.1. Miniature Circuit Breaker for cable protection according to:
 DIN VDE 0641 Teil 12, DIN VDE 0660 Teil 101, IEC 60898,
 EN 60898, IEC 60947-2, EN 60947-2, UL1077
- 12.12.2. Rated short-circuit capacity: 4,5/6 kA

12.13. Tripping characteristics shall conform to the following

B: In 6/10/16/20/25 A
 K: In 0,2/0,3/0,5/0,75/1/1,6/2/3/4/6/8/10/16/20/25/32/40/50/63 A
 In 0,5/1/1,6/2/3/4/6/8/10/16/20/25/32/40/50/63A
Number of poles : 1/2/3/4 (K,Z); 1/2 (B)
Rated Voltage:
 Single-pole: 230/400 VAC and 220 VDC
 Multi-pole: 400 VAC and 440 VDC
 Suitable for isolation acc: IEC 60947-1/-3

12.14. General Features

- 12.14.1. Label holder
- 12.14.2. Prepared to get equipped with toggle-locking device

12.15. Wiring

- 12.15.1. Busbars: Terminals for in and out coming feeder on top of busbars. The MCB shall have a "safe terminal". Each pole shall have 2 connection points. Combining busbar and wire in same terminal shall not be permitted. Combining wire of un-equal sizes in the same terminal shall not be permitted.

**12.16. Accessories**

- 12.16.1. Auxiliary contact: 2 or 3 contacts shall be (screw-able or push-in-able)
- 12.16.2. Auxiliary contact (low power): 1 or 3 contacts
- 12.16.3. Signal contact or signal contact/auxiliary contact: 3 contacts
- 12.16.4. Undervoltage release or shunt trip
- 12.16.5. Neutral conductor
- 12.16.6. Printed labels
- 12.16.7. Labels for individual printing
- 12.16.8. Locking devices

13. CONTACTORS

- 13.1. Contactors shall comply with SANS 60947. Duty cycle shall be AC3. Contactor coil voltage may be either 230V or 400V unless otherwise stated.
- 13.2. Lighting contactors for 24 to 63 Amps (AC1) shall be DIN mounted on the same rail as the MCBs and feature a DC solenoid actuator and are thus hum-free. They shall have a switching position indicator, integrated coil protection circuits and overvoltage protection for the solenoid coil up to 5kV.
- 13.3. Contactors from 9 to 38 Amps shall be electronic coils.
- 13.4. For contactors from 50 to 300 Amps, standard coils will be accepted.
- 13.5. Contactors from 400 to 2050 Amps shall be electronic coils.
- 13.6. Mixture of contactors shall not be permitted.

13.7. Ambient characteristics

- 13.7.1. Climatic withstand according to IEC60068-2-0 AND 60068-2-11

13.8. Construction characteristics**13.8.1. Contactors with electronic coils 9 to 38 Amps AC3 shall have:**

- 13.8.1.1. Maximum of two frame sizes from 9 to 16 amps AC3
- 13.8.1.2. Width not to exceed 45mm for contactors 9 to 38 amps AC3 rating
- 13.8.1.3. Contactor up to 16 amps to include built in auxiliary contact
- 13.8.1.4. Common auxiliaries for contactors 9 to 38 amps AC3

13.8.2. Contactors 9 to 110 Amps with standard coil shall have:

- 13.8.2.1. Mounting positions: only position 6 not permitted (see appendix 1)



- 13.8.2.2. Maximum of 4 frame sizes from 9 to 110 amps
- 13.8.2.3. Quick fixing on mounting rail according to IEC 60715 standards as:-
 - 35 x 7.5 mm for 9 to 40 amps contactors
 - 35 x 15 mm for 9 to 75 amps contactors
 - 75 x 25 mm for 50 to 110 amps contactors
 - Terminal with captive screws
 - Terminal screws to be of Pozidriv type up to 75 amps AC3
 - Terminal screws to be M8 Hexagon socket for main terminals and Pozidriv for coil terminals

13.8.3. Contactors 145 to 750 Amps AC3 with Standard or Electronic Coil shall have:

- 13.8.3.1. Maximum of 4 frame sizes from 145 amp to 750 amp
- 13.8.3.2. Mechanical design to incorporate power terminal at base of contactor, operating coil to be mounted on top of contactor. Coil removal to side of contactor shall not be permitted.
- 13.8.3.3. Shall have front access to coil , with no need to remove the power cables when changing coils
- 13.8.3.4. Shall have front access to main fixed and moving contacts , without the need to remove the power cables
- 13.8.3.5. Removal and replacement of the fixed and moving contacts shall be able to be accomplished without the need to remove the power cables
- 13.8.3.6. Contactor shall have quick release quarter turn screws for easy access to main contact inspection
- 13.8.3.7. Clear marking of contactor electrical information, marking to be clearly visible on front of contactor
- 13.8.3.8. Electrical characteristics and performances**
 - 13.8.3.8.1. All Contactors shall be electrically coordinated with upstream protection device, whether device or the fuse type, MCCB, or manual motor starter. All coordination to be backed up by Manufactures coordination tables, available on request.

13.8.4. Contactors with electronic coils 9 to 38 Amps AC3

- 13.8.4.1. Same coil to cover both the AC or DC control supplies
- 13.8.4.2. Coil to be of toroidal design
- 13.8.4.3. Coil to have extended voltage operating limits.
- 13.8.4.4. 4 coil types only covering: 24..500 V 50/60Hz and 20..500 V DC
- 13.8.4.5. Coil Consumption not to exceed the following limits
- 13.8.4.6. On pull in 50VA
- 13.8.4.7. On holding 2.2VA



- 13.8.4.8. Built-in surge protection to be incorporated
- 13.8.4.9. Flexible position of Coil terminals i.e. can be transferred from the top to the bottom of contactor
- 13.8.4.10. With additional coil terminal block, it shall be possible to connect the coil both at the top and at the bottom.

13.8.5. Contactors with standard AC coil 50 to 30 Amps AC3 shall have:

- 13.8.5.1. Rated operational voltage 690V for contactors up to 40 amp AC3
- 13.8.5.2. Rated operational voltage 1000V for contactors 50 to 750 amps AC3.
- 13.8.5.3. Rated making capacity to be equal to 10 x AC3 rated operational current, or greater.
- 13.8.5.4. Rated breaking capacity to be equal to 8 x AC3 rated operational current, or greater.
- 13.8.5.5. Coil operating limits (according to IEC60947-4-1) 0.85 1.1 x rated Control circuit voltage, at temperature less or equal to 55degrees Celsius
- 13.8.5.6. Drop out voltage in %age of rated Control Voltage approximately 40 to 65%
- 13.8.5.7. Contactors 400 amp AC3 upward to incorporate electronic coil technology

13.8.6. Contactors with electronic coils 400 to 750 Amps AC3 shall have:

- 13.8.6.1. As above but to include the following
- 13.8.6.2. Same coil to cover both the AC or DC control supplies
- 13.8.6.3. Coil to have extended voltage operating limits.
- 13.8.6.4. Can withstand voltage interruptions or voltage dips in control supply up to 20ms.
- 13.8.6.5. Distinct opening and closing voltages as follows
- 13.8.6.6. Opening 0.55 x min operating voltage
- 13.8.6.7. Closing 0.85 x min operating voltage
- 13.8.6.8. Coil types only covering: 24..500 V 50/60Hz and 20..500 V DC

13.9. Accessories

- 13.9.1. All auxiliary contacts shall employ the "wipe action" mechanism for the self cleaning of the contact tips.
- 13.9.2. Front mounted auxiliary contact blocks rated insulation voltage equal to 690V a.c or greater
- 13.9.3. Rated operation voltage 24...690VAC
- 13.9.4. Rated making capacity 10 x AC-15 rated operational current



- 13.9.5. Rated breaking capacity 10 x AC-15 rated operational current
- 13.9.6. Rated short time withstand current 100amps for 1sec.; 140 amps for 0.1 sec
- 13.9.7. Electrical durability, max electrical switching frequency 1200 cycles per hour or greater

13.10. Side Mount Auxiliary Contact Blocks shall have:

- 13.10.1. Rated insulation voltage equal to 690V a.c or greater
- 13.10.2. Rated operation voltage 24...690V a.c
- 13.10.3. Rated making capacity 10 x AC-15 rated operational current
- 13.10.4. Rated breaking capacity 10 x AC-15 rated operational current
- 13.10.5. Rated short time withstand current 100amps for 1sec.; 140 amps for 0.1 sec
- 13.10.6. Electrical durability, max electrical switching 1200 cycles per hour or greater.

14. LIGHTNING AND SURGE PROTECTION

14.1. Main Distribution Board

- 14.1.1. According to the IEC 62305 recommendations, electrical installations shall be protected against direct lightning and surge impulses with din rail Class 1/Type 1 (10/350µs) lightning current arresters.
- 14.1.2. SPD shall use a triggered spark gap technology to allow high lightning discharge current, unpluggable type to avoid ejection of the cartridge during the discharge of the current and non-blow out technology to avoid fire risks.
- 14.1.3. The SPD shall provide either common protection in TNC network or common and differential mode protection in TT and TNS network according to the IEC60364 recommendations.
- 14.1.4. Lightning arresters shall have the following technical specifications:
 - 14.1.4.1. Class of test (IEC 61643-1) I
 - 14.1.4.2. Lightning impulse current: $I_{imp}/pole (10/350\mu s) \geq 25kA$
 - 14.1.4.3. Nominal voltage U_n 230 / 400V
 - 14.1.4.4. Maximum continuous AC voltage U_c 255V
 - 14.1.4.5. Follow current extinguishing capability $I_{fi} \geq 50kA$
 - 14.1.4.6. Protection level U_p : 2.5kV
 - 14.1.4.7. Max. back up fuse gG/gL: 125A
 - 14.1.4.8. Visual state indicator: Yes

**14.2. Sub-Main Distribution Board**

- 14.2.1. According to the IEC 62305 recommendations to avoid oscillations and magnetic coupling phenomenon, sensible equipments shall be protected against indirect surges with din rail Class 2 / Type 2 (8/20 μ s) surge arresters.
- 14.2.2. The SPD shall have a safety reserve system and shall be pluggable for preventive and easy maintenance. The SPD shall provide either common protection in TNC network or common and differential mode protection in TNS and TT network according to the IEC 60 364 recommendations.
- 14.2.3. In case of common and differential mode protection the SPD shall use an association of MOV and GDT to provide isolation to the ground and low protection level in all protection modes. The associated switching element
- 14.2.4. (MCB/Fuse) (to insure a safe end of life) shall be the same brand as the SPD to insure a good coordination.
- 14.2.5. Surge arresters technical specifications:
 - 14.2.5.1. Class of test (IEC 61643-1) II
 - 14.2.5.2. Max. discharge current: $I_{max}/pole$ (8/20 μ s) $\geq 40kA$
 - 14.2.5.3. Nominal current I_n / pole $\geq 20kA$
 - 14.2.5.4. Nominal voltage U_n 230 / 400V
 - 14.2.5.5. Maximum continuous AC voltage U_c 275 / 255V
 - 14.2.5.6. Protection level U_p at 20kA ≤ 1.5 kV
 - 14.2.5.7. Protection level U_p at 3kA (Class 3 test)
 - 14.2.5.8. Pluggable :Yes
 - 14.2.5.9. Visual status indicator: Yes
 - 14.2.5.10. Safety reserve: Yes
 - 14.2.5.11. Remote indicator :Yes

14.3. Data line / Telecom line

- 14.3.1. The selection of the surge protection device shall be according the IEC 62305 recommendations and therefore shall be a type C2 SPD.
- 14.3.2. The SPD shall be pluggable type for easy maintenance and shall provide the dialling tone returns when the cartridge is withdrawn in case of end of life.
- 14.3.3. The cartridges, whatever the nominal voltage, shall be adaptable onto different base. The base shall be chosen according to the connection of the wire: it can be RJ11, RJ45 or screw connection. The connections to the earth shall be either by a DIN rail contact or by a screw terminal.



14.3.4. The SPD dimension shall not exceed 12.5 mm wide to save space. The SPD shall use two level of protection: the first one by GDT, the second one by zener diode. These two levels shall be coordinated and shall provide common and differential mode protection.

14.3.5. Low current surge arresters technical specifications:

14.3.5.1. Class of test (IEC 61643-21): C2

14.3.5.2. Nominal voltage U_n According to the Max.voltage of signal

14.3.5.3. Maximum continuous AC voltage U_c (L-N / N-G): According to the Max. voltage of signal

14.3.5.4. Loading current: 140mA

14.3.5.5. Max. discharge current: $I_{max} / \text{line } (8/20\mu s) \geq 10kA$

14.3.5.6. C2 Nominal discharge current $I_n / \text{line } (8/20\mu s) \geq 5kA$

14.3.5.7. Protection level U_p (L-L / L-G): According to the Max. voltage of signal

14.3.5.8. Pluggable: Yes

15. ANTI-CONDENSATION HEATERS

15.1. Anti-condensation 220 Volt heaters shall be provided for all compartments. A switch with thermostat shall be provided to control the heaters.

15.2. The wiring from the heater elements to terminals shall be high temperature insulation covered, a suitable compression type gland shall be fitted for the incoming 231V supply.

16. INDICATING INSTRUMENTS

16.1. A flush mounted, industrial grade, 96 mm square voltmeters and ammeter conforming to SABS 1299 shall be mounted near the centre top of the front panel and connected to measure the busbar voltage and current.

16.2. The calibrated scale length shall be a minimum of 70 mm. Means shall be provided for zero adjustment from the front without any dismantling of the indicating instrument.

16.3. A voltmeters selector switch with phase to phase, phase to neutral, and "off" position shall be provided.

16.4. An ammeter selector switch shall be provided with an "OFF" position.

16.5. Meters shall indicate by means of colours the relevant phase that it is metering.

17. CURRENT TRANSFORMERS

17.1. Current transformers shall comply with BS 3938.

18. MECHANICAL CABLE GLANDS



- 18.1. Cable glands shall be of the compression type, manufactured in brass and/or bronze, and suitable for termination of earth-continuity conductor type cables where applicable.
- 18.2. The gland body shall incorporate a knurled cone for clamping the armouring and an integrally cast earth lug, complete with earthing screw.
- 18.3. All metal portions of the gland shall be electroplated for corrosion resistance.
- 18.4. The glands shall be supplied complete with weatherproof neoprene shrouds.
- 18.5. Entries for multi-core PVC, PVC, wire armoured, PVC sheathed cables shall comprise cone grip mechanical type glands mounted on robust gland plates.
- 18.6. The board shall be supplied complete with all glands for all outgoing and incoming circuits as indicated on the drawing.

19. LIGHT SENSITIVE CONTROL UNIT

- 19.1. Light sensitive control units shall be supplied by others.
- 19.2. A suitably rated single pole over-riding switch, for over-riding the unit in 19.1, and moulded case circuit breaker shall be provided, when called for in the drawings or appendices hereto.
- 19.3. The switch and circuit breaker shall be wired to a suitable terminal strip, mounted within the distribution board, to facilitate connection of the light sensitive control unit when installed.

20. EARTHING

- 20.1. The components shall be effectively bonded to the main frame of the distribution board, which shall also be bonded to the main earth bar. Earthing shall comply with SANS-10142 code of practice for the wiring of premises.

21. CABLING AND WIRING

- 21.1. All cables and wires used shall be stranded, 600/1000 V grade and comply with SABS 150, except where special cables have been otherwise specified.

22. LABELS

- 22.1. Labels shall be provided comprising conspicuous engraved black lettering on white background secured with rivets or screws on or adjacent to the items concerned, and worded in English.
- 22.2. Labels of embossed tape or labels secured with adhesive are not acceptable.
- 22.3. All fuse-switches, circuit breakers, isolators, contactors, relays, etc., shall be clearly designated.
- 22.4. The terminals of all outgoing circuits shall be provided with labels to correspond with the labelling of the units on the panel of the distribution board.
- 22.5. All terminal connections shall be provided with durable tags or clips, on which shall be clearly and indelibly marked, the identifying code letters of each wire. Such code letters shall correspond to those used on the wiring diagram.



23. PAINTING

- 23.1. All surfaces of the distribution board shall be light orange to SABS 1091 colour No. B26. (Transnet orange; Pantone 165C / 021U; Coats 50/50; Vermilion MW52; RAL 2004 rein orange; Trichromatic 70% magenta, 90% yellow), unless otherwise specified.
- 23.2. All surfaces shall be cleaned according to the appropriate method described in SABS 064 for the particular surface to be cleaned, the contamination to be removed and the primer to be applied.
- 23.3. Blast cleaning of components shall be in accordance with clause 4.3 of SABS 064 to a degree of cleanliness of at least Sa2 for inland exposure components and Sa 1/2 for coastal exposure components. See Table 1 of SABS 064 for the appropriate profile.
- 23.4. Sheet metal that cannot be blast cleaned shall be cleaned by pickling according to clause 4.6 of SABS 064.
- 23.5. Components that shall be powder coated shall be cleaned and prepared by the surface conversion process according to clause 5 of SABS 064 to a medium-weight classification of table 2 of that specification.
- 23.6. Oil and accumulated dirt on steel components where no rusting is present shall be removed according to clause 3 of SABS 064.
- 23.7. The powder-coating process shall be in accordance with SANS 1242 - type 4 : Corrosion-resistant coatings for interior use and using the thermosetting type high gloss coating.
- 23.8. All specified coatings shall be applied according to the relevant specification and the manufacturer's instructions shall be followed.
- 23.9. Coatings shall not be applied under conditions that may be detrimental to the effectiveness of the coating or the appearance of the painted surface.
- 23.10. When examined visually the finished products shall have a uniform appearance as far as gloss is concerned and shall show no sign of damage. Damaged areas shall be repaired coat for coat to obtain the desired finish.

24. ADDITIONS AND MODIFICATIONS TO EXISTING DISTRIBUTION BOARDS

- 24.1. Where the contractor needs to make modifications or additions to existing distribution boards, the following minimum criteria shall be adhered to :
 - 24.1.1. Re-labelling and proving of existing circuits in accordance with security of existing terminations to be confirmed
 - 24.1.2. Isolation barriers, cover blanks to be in place where required
 - 24.1.3. Panel modification in terms of architraves, DB covers, and the closing of redundant openings to be undertaken by an accredited switchboard manufacturer.
 - 24.1.4. Wiring to be examined for integrity correct sizing and tidied and/or replaced and neatened as required.
 - 24.1.5. A certificate of compliance shall be issued for the full distribution board and not the additions only.

**25. INSPECTION**

25.1. Transnet Projects reserves the right to carry out inspection of any items of equipment and work at any time during the manufacture at manufacturer's works and to be present at any tests.

25.2. A final inspection by Transnet Projects before delivery to site is required.

26. TESTS

26.1. All prescribed tests as referred to in the standard specifications may be called for at the discretion of Transnet Projects.

26.2. Transnet Projects also reserves the right to carry out any check tests on the equipment.

26.3. Notwithstanding the successful completion of tests, the tenderer shall still be responsible for the efficient operation of the equipment.

26.4. The tenderer shall bear all costs for any tests, which shall be required.

27. GUARANTEE

27.1. The Contractor shall undertake to repair all faults due to bad workmanship and / or faulty materials and to replace all defective apparatus or materials during a period of twelve (12) calendar months, calculated from the date of delivery.

27.2. Any defects that may become apparent during the guarantee period shall be rectified to the satisfaction of, and free of cost.

27.3. The Contractor shall undertake work on the rectification of any defects that may arise during the guarantee period within 7 days of his being notified by Transnet Projects of such defects.

27.4. Should the Contractor fail to comply with the requirements stipulated above, Transnet Projects will be entitled to undertake the necessary repair work or effect replacement of defective apparatus or materials, and the Contractor shall reimburse Transnet Projects the total cost of such repair or replacements, including the labour costs incurred in replacing defective material.

28. SPARES

28.1. The tenderer shall state whether a complete range of spares is held in stock by their local representatives for subsequent purchase by Transnet Projects as and when required.



WITNESSES

1.

2.

**Transnet Capital Projects
Design Services**

.....
TENDERER

.....
DATE

SCOPE OF WORKS SUPPORTING ANNEXURES:

**Annexure H: Technical specification for the installation of
medium and low voltage cables**

**SPECIFICATION FOR THE SUPPLY AND INSTALLATION OF MEDIUM VOLTAGE
AND LOW VOLTAGE ELECTRICAL CABLES**

REVISIONS		
REV	DATE	APPROVED
0	July 2009	S.Sewdayal

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APPENDICES

Appendix 1 - "Statement of Compliance"

1.1 SCOPE OF WORK

The scope of this specification covers the minimum requirements for the supply installation, testing and commissioning of medium and low voltage cables, instrumentation cables, cable racking, trenching, sleeves and earthing reticulation on Transnet sites on behalf of Transnet Capital Projects.

Contractors are required to familiarise themselves with all applicable Standards and Codes of Practice listed herein, and to ensure compliance in the execution of any work in terms of this document. Failure to comply may render the contractor liable for corrections at his own cost.

These Standards and Codes of Practice should be read in conjunction with all other Specifications and drawings as issued for a particular contract. Where discrepancies occur, these must be brought to the attention of Transnet Capital Projects in writing before commencement of work. In the event of any conflict between the contents of any documents forming part of a contract (as listed in the Master Index) and this document, the former shall prevail.

1.2 APPLICATION TO WORK ACTIVITIES

The Standards and Codes of Practice contained herein apply to all installations requiring Medium and Low voltage Electrical and Instrument Cabling, Racking, Trenching Sleeves and Earthing Reticulation and include amongst others the following standards:

- Supply of electrical and instrument cable trenches
- Supply, installation of electrical and instrument ladder racking reticulation
- Supply, installation of electrical and instrument dropper reticulation
- Supply, installation and termination of electrical and instrument cabling
- Cable Tagging and Core Identing standards for electrical and instrument cabling
- Supply, installation of instrument and electrical earthing

2. STANDARDS AND REFERENCES

2.1 The requirements of the materials, design, layout, fabrication, assembly, erection, examination, inspection and testing of equipment and facilities on site shall be in accordance with the relevant sections of codes: -

a)	SANS 10142-1	-	Code of Practice for the Wiring of Premises
b)	SABS 763	-	Hot dip (galvanising) Zinc Coating.
c)	SABS 1507	-	Electric cables with extruded solid dielectric Insulation for fixed installation.
d)	SANS 1574		
e)	ASME/ANSI.B31.3	-	Chemical Plant and Petroleum Refinery piping
f)	ASME/ANSI.B31.4	-	Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols.
g)	SABS 089:Part II-1965	-	The Petroleum Industry Part II: Electrical Code
h)	SABS 089 - Part II	-	The Handling, Storage and Distribution of

Petroleum Products (Electrical Code)

- i) SABS 0198 - "The Selection, Handling and Installation of Electric Power Cables of rating not exceeding 33KV"
- j) API 2003 - Protection against ignitions arising out of static, Lighting and stray currents.
- k) SABS 03 - The Protection of structures against lightning.
- l) SABS 086 - The Installation and Maintenance of Electrical Equipment used in explosive atmospheres. Refer to Section 2 for Hazardous area classification.
- m) IEC 79-14 - Electrical Installations in Hazardous Areas
- n) Government, local authorities or other statutory bodies' regulations, laws, requirements or customs which are more stringent than those specified in this project specification.

2.2 The following standard specifications are to be used for reference purposes and need to be noted by Contractors in order to signify familiarity and compliance with the requirements. It is expected of Contractors that they be familiar with the applicable clauses and that these will be adhered to in the execution of any work in terms of this specification. Contractors will be required to confirm that they are able to meet these requirements.

- a) SABS 0108 : 1995 The Classification of hazardous locations and the selection of electrical apparatus for use in such locations
- b) The Occupational Health & Safety (OHS) Act No. 85 of 1993.
- c) SABS 0314 Flameproof Enclosures for Electrical Apparatus
- d) SABS 0549 Intrinsically Safe Electrical Apparatus
- e) API Manual of Petroleum Measurement Standards Chapters 4 to 12
IP Chapter 10 and Papers 2 and 3
- f) SABS 969 Enclosures for electrical apparatus
- g) BS 5490 Classification of degrees of protection provided by enclosures
- h) Safety Regulations for Contractors
- i) Technical Instruction No. 16 - Contractors Work Permit Procedures.
- j) VDE Standards

2.3 Where no specific rules, regulations, codes or requirements are contained in this specification nor covered by the above mentioned codes, the contractor shall, in consultation with Transnet Capital Projects, adhere to internationally accepted modern design and engineering practices in the Electrical and Petrochemical Industry.

3.0 SERVICE CONDITIONS

3.1 The cable shall be designed and rated for continuous operation under the following conditions :-

3.1.1 Ambient/Environment Conditions :

- 3.1.1.1 Altitude : Sea level.
- 3.1.1.2 Ambient temperature : -5° C to +45° C (daily average +35° C).
- 3.1.1.3 Relative humidity : As high as 96%
- 3.1.1.4 Lightning conditions : Severe, with a maximum lightning ground flash density 11 flashes per km² per annum.
- 3.1.1.5 Exposure conditions : Salt laden, industrial atmosphere as well as hazardous gases and dust atmosphere.
- 3.1.1.6 Electrolytic corrosion conditions prevail in all the areas owing to the proximity of direct current traction system and cathodic protection schemes.

3.1.2 Electrical Conditions:

- 3.1.2.1 The system of supply will be three phase, 3 wire, 50 Hertz, 11KV alternating current for medium voltage and three-phase, 4 wire, 50 Hz 400 Volts alternating current for low voltage.
- 3.1.2.2 The voltage may vary within the range of 95% to 105% of the nominal and all cable shall be suitably rated.

4.0 RESPONSIBILITY FOR WORK, SAFETY

- 4.1 The Contractor shall be responsible for all aspects associated with the provision of the cables. This includes items such as supply of testing cable to test the cables prior to commissioning, provision of site office and storage facilities.
- 4.2 Occupational Health and Safety Act (Act No 85 of 1993) must be complied with in all respects during the execution of this contract. The onus shall be on the contractor to ensure that staff under his control adheres to the provisions of the act at all times.

5.0 ELECTRICAL CABLE SPECIFICATION

This part of the specification covers the general specification of electrical cables to be used on Transnet sites on behalf of Transnet Capital Projects.

5.1 TYPES OF CABLE

5.1.1 CROSS-LINKED POLYETHYLENE (XLPE)

- 5.1.1.1 Cross-linked Polyethylene (XPLE)-insulated cables shall be individually screened, 3 core, stranded copper conductor, type A, cable manufactured in accordance with SABS.1339. The cable is to be supplied with an overall graphite coating to the outer PVC sheath.

- 5.1.1.2 The cable shall have embossed on the outer P.V.C. sheath next to the **S.A.B.S.** mark the following letters:

T/G/B

where T = TRANSNET STANDARD G = GRAPHITE COATED B = BEDDING TEST

Only the above mentioned cable shall be accepted.

- 5.1.1.3 The cable shall be capable of withstanding continuous operational temperatures up to 90^o C.

- 5.1.1.4 Completed cable runs are subjected to the following tests :-

- a. As laid down in S.A.B.S. 1339 (Appendix "E" paragraph E-1.4)
- b. Anti-electrolysis insulation, applied between armouring and earth, tested at 10kV D.C. for one minute. Bedding shall be tested at 4kV D. C. for one minute.

All the above tests shall be carried out in the presence of the Engineer

5.1.2 PAPER INSULATED

- 5.8.2.1 Fully impregnated hygroscopic paper insulated, Helically lapped, insulated, Three core, Stranded copper conductors, Outer layer numbered for core identification, Seamless pure lead sheath, Covered with bitumen impregnated paper, Single steel wire armoured, extruded plastic sheathed, Operational voltage 6.35 to 11kV.

- 5.1.2.2 The cable shall have embossed on the outer P.V.C. sheath next to the **S.A.B.S.** mark the following letters:

T/G/B

Where: T = TRANSNET STANDARD
G = GRAPHITE COATED
B = BEDDING TEST

Only the above mentioned cable shall be accepted.

- 5.1.2.3 The cable is to be supplied with the P.V.C. outer sheath impregnated with a high quality graphite powder coating.

- 5.1.2.4 Type general purpose copper woven taped screened (Table 19) cable manufactured in accordance with S.A.B.S. 97 is required.

- 5.1.2.5 The cable shall be capable of withstanding continuous operational temperatures up to 70 / 80^o C.

- 5.1.2.6 Completed cable runs are subjected to the following tests

- a. As laid down in S.A.B.S. 97
- b. Anti-electrolysis insulation, applied between armouring and earth, tested at 10Kv D. C. for one minute. Bedding shall be tested at 4Kv D.C. for one minute.

All the above tests shall be carried out in the presence of the Engineer

5.1.3 LOW VOLTAGE PVC CABLE

5.1.3.1 Low voltage cables shall be PVC insulated cables with ECC, and shall comply with SABS.1507.

5.1.3.2 Earth continuity conductors shall be single core PVC insulated copper cables, and shall comply with SABS. 1507.

5.1.3.3 The cable shall be capable of withstanding continuous operational temperatures up to 70^o C.

5.1.3.4 Electrical LV Power cabling installed in hazardous locations (flammable environment) running between Equipment located in the field, LV Panels or Motor Control Centre Panels, Valve Panels and Distribution Boards shall comprise of steel wire armoured, earth continuity conductor (ECC), PVC Insulated, four core cable, as follows:

Conductors.

Core Size : 4 core - Rated as per application (SABS 10142-1)
Stranded untinned copper, 7 strands minimum

PVC Insulated, Insulation Breakdown Voltage to withstand 2 kV 50Hz RMS for a 1 min period.

Insulation Colours: Colored RD-BL-YE/WT-BK (not numbered)

Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Inner Jacket

Extruded fire retardant black PVC with rip cord for jacket removal.
Minimum thickness 1.2mm

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – fire retardant and UV resistant (Carbon black added).

Jacket thickness 1.5mm

Jacket to be totally bonded to a steel wire armoured sleeve.

Fire retardant, low halogen (20% Halogen, Blue Stripe) plastics to be used in non-ventilated areas. Fire retardant, high halogen (100% Halogen, Red Stripe) plastics may be used in ventilated areas. Fire retardant, no halogen (0% Halogen, White Stripe) plastics not required to be used.

5.1.3.5 Electrical Control cabling running between the Equipment located in the field, Control System Marshalling Cabinets, LV Panels and Incomer Breaker panels will comprise of steel wire armoured, PVC Insulated, multi-core cable, as follows :

Conductors.

Core Size : 7 core – 1.5 mm² (Valve Actuators)
12 core – 1.5 mm², 19 core – 1.5 mm² (Switchgear)

Stranded untinned copper, 7 strands minimum

PVC Insulated, Insulation Breakdown Voltage to withstand 2 kV 50Hz RMS for a 1 min
Insulation Colours: 7 core and less – colored BL-YE/WT-RD-GR-BK-BR-PR/OR
(Not numbered)
12 core and more – black, conductors to be numbered
Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Inner Jacket

Extruded fire retardant black PVC with ripcord for jacket removal.
Minimum thickness 1.2mm up to 7 core, 1.5mm for 12 and 19 core

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – fire retardant and UV resistant.
Jacket thickness 1.5mm up to 7 core, 2.0mm for 12 and 19 core
Jacket to be totally bonded to a steel wire armoured sleeve.

Fire retardant, low halogen (20% Halogen, Blue Stripe) plastics to be used in non-ventilated areas. Fire retardant, high halogen (100% Halogen, Red Stripe) plastics may be used in ventilated areas. Fire retardant, no halogen (0% Halogen, White Stripe) plastics not required to be used.

- 5.1.3.6 Completed cable runs are subjected to the following tests as laid down in SANS 10142-1.
Insulation resistance test between Phases, Phases and Neutral, Phases and ECC, Neutral and ECC.

5.1.4 INSTRUMENTATION CABLING

- 5.1.4.1 Instrument Cabling as defined within this and other Transnet Capital Projects Specifications includes the following types of cabling:

1. PVC SWA Multicore instrument cables running between Instrument Junction Boxes in the field and PLC Cabinets (IS and non-IS rated)
2. PVC SWA Multicore instrument cables running between instruments in the field and PLC Cabinets (IS and non-IS rated)
3. Dekabon armoured instrument cables running between Junction Boxes in the field and the instruments themselves (IS and non-IS rated)

- 5.1.4.2 All Instrumentation Cabling will comply in all respects to the specifications as contained in the Scope of Work attached to an Order. In the absence of cable specifications being detailed in the Scope of Work attached to an Order, the following cable specifications will apply.

- 5.1.4.3 Instrument cabling will be marshalled on Instrument racking and trenching as defined elsewhere within this specification.

- 5.1.4.4 Instrument multi-core cabling running between the Field Junction Boxes and the Control System Marshalling Cabinets will comprise of steel wire armoured, PVC Insulated, individual and overall screened multi-core cable. Note that Petronet has standardised on 1 pair, 2 pair, 8 pair and 16 pair cable – prior approval from Petronet will be required to deviate from these specifications.

Conductors

Core Size : 1.0 mm²

Stranded untinned copper, 7 strands minimum

PVC Insulated, Insulation Breakdown Voltage to withstand 2 kV 50Hz RMS for a 1 min.

Insulation Colours : Black and White

Multipair cores to be numbered (numeric on both conductors of the pairs)

Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Shield/Screen

Individual & overall screened – plasticised aluminium foil (100%) coverage

Stranded tinned copper drain wire 0.5 mm²

Inner Jacket

Extruded fire retardant black PVC with rip cord for jacket removal.

Minimum thickness 1.2mm up to 8 pair, 1.5 mm for 16 to 36 pair

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – fire retardant and UV resistant (Carbon Black added).

Jacket thickness 1.5mm up to 8 pair, 2.0 mm for 16 to 36 pair.

Jacket to be totally bonded to a steel wire armoured sleeve.

Fire retardant, low halogen (20% Halogen, Blue Stripe) plastics to be used in non-ventilated areas.

Fire retardant, high halogen (100% Halogen, Red Stripe) plastics may be used in ventilated areas.

Fire retardant, no halogen (0% Halogen, White Stripe) plastics not required to be used.

IS Circuits: Jacket color light blue Non IS Circuits: Jacket color black.

5.1.4.5

Individual Instrument cabling running between the Field Junction Boxes and the individual field mounted Instruments will comprise of Dekabon armoured, PVC Insulated, individual and overall screened multi-core cable. Note that Petronet has standardised on 1, 2, 4 and Triad cable – prior approval from Petronet will be required to deviate from these specifications.

(Note that this specification only applies to cabling running on racks above the ground, all Instrument cables running in trenches will need to comply with the Instrument Multi-core Cable Specifications detailed above).

Conductors.

Core Size : 1.5 mm²

Stranded untinned copper, 7 strands minimum

PVC Insulated, Insulation Breakdown Voltage to withstand 2 kV 50Hz RMS for a 1 min

Insulation Colours : Black and White

Multipair cores to be numbered (alphanumeric on both conductors of the pairs)

Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Shield/Screen

Individual & overall screened – plasticised aluminium foil (100%) coverage

Stranded tinned copper drain wire 0.5 mm²

Inner Jacket

Extruded fire retardant black PVC with ripcord for jacket removal.
Minimum thickness 1.2mm

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – fire retardant and UV resistant (Carbon black added).

Jacket thickness 1.5mm.

Jacket to be totally bonded to an inner waterproof aluminium sleeve, with a ripcord under the sleeve for jacket removal.

Fire retardant, low halogen (20% Halogen, Blue Stripe) plastics to be used in non-ventilated areas. Fire retardant, high halogen (100% Halogen, Red Stripe) plastics may be used in ventilated areas. Fire retardant, no halogen (0% Halogen, White Stripe) plastics are not required to be used.

IS Circuits: Jacket color light blue Non IS Circuits: Jacket color black.

6.0 CABLE TERMINATIONS

6.1 Medium and Low Voltage cables shall be terminated to busbars and switchgear in the panels, distribution boards and kiosks using suitable cable lugs. Cable earth wires shall be brought into glands on gland plates. The insulation between cable armouring and cable earth wires shall be maintained at terminations. The separate earth conductor cable shall terminate to the main earth bar.

6.2 All materials necessary for installing all cable terminations shall be provided by the Contractor and the cost thereof shall be included in the tender price.

6.3 Glanding

6.3.1 All instrument and electrical cables will be glanded at both ends using the appropriate sized gland and will include associated adaptors, washers, ferrules, bands, etc. Provision for all glands, adaptors, washers, ferrules, bands etc. shall be included in the Tenderer's offers. All cable glands shall comply with the following specification, unless otherwise specified in the Scope of Work attached to an Order:

6.3.2 Dekabon Armoured Cabling (Instrumentation)
Increased Safety Ex"e" rated compression gland, IP68 rated, complete with UV resistant black shroud where required, in accordance with SABS 1031.

6.3.3 PVC SWA Cabling (Instrument & Electrical motors)
Increased Safety Ex"e" rated non-compression gland, IP68 rated, complete with SWA protection (CCG Corrosion Guard or similar), in accordance with SABS 1031.

6.3.4 PVC SWA Cabling (Ex"d" rated Valve Actuators)
Flameproof Ex"d" rated non-compression gland, IP68 rated, complete with SWA protection (CCG Corrosion Guard or similar), in accordance with SABS 808.

6.3.5 PVC SWA Cabling (Electrical and PLC Panels located within buildings rated as Safe Areas in terms of Hazardous Area Classifications SABS 0108)

Non-Flameproof rated, non-compression gland, IP68 rated, complete with UV resistant (black) shroud where required.

All glands will be waterproof and in the case of Hazardous Areas, correctly rated in terms of the Explosion Proof Classification of the equipment housings to which they are installed.

6.4 Termination

6.4.1 All cables will be terminated at field instrumentation, electrical equipment, field junction boxes, switchgear panels and control room marshalling cabinets according to manufacturers specifications, instrument hook-up diagrams and control system specifications as provided/approved by Petronet.

6.4.1.1 Instrument Dekabon Cabling

- Outer Dekabon armouring shall be stripped back to the entry point into the associated termination/junction box. Protrusion of cable sheath/armouring into the termination/junction box (through the compression gland) shall be a minimum of 15mm and a maximum of 50mm.
- Cable pair inner aluminium foil shall be stripped back to the point at which the individual cores leave the PVC Trunking to be terminated onto the respective terminal rails. Ends of the inner foil shall be neatly taped/heat shrunk so as to prevent unravelling.
- Individual cable ends shall be sealed with the use of heat shrink tubing applied over the cable sheath/armouring at the point of entry into the termination/junction box/panel, in order to protect the cable and prevent the ingress of moisture.
- Both cable overall (drain wire) and individual screens shall be insulated with the use of appropriately sized green coloured sleeving, to prevent inadvertent contact with metallic surfaces.
- All individual cable cores (including spares) will be left long enough to accommodate 200mm slack, i.e. taking into account the routing via the trunking.
- Excess lengths of individual cable cores will be neatly folded and tied within the trunking provided. All spare cores shall be terminated into terminals so provided.
- Termination of individual cable cores in the termination strips will be such that all Control System related cabling will be terminated to one side of termination strips, whilst all field instrumentation/equipment cabling will be connected to the other side of termination strips.

In the case of Field Junction Boxes with dual terminal strips, multi-core cabling will be glanded in the centre of the gland plate and terminated into terminal rails provided, running from the centre PVC Trunking outwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the outermost PVC Trunking inwards.

In the case of Field Junction Boxes with single terminal strips, multi-core cabling will be glanded on the right side of the gland plate and terminated into terminal rails provided, running from the right hand side of the panel inwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the left hand side of the panel inwards.

- All cables connected to individual instruments/equipment will be provided with a single loop of minimum diameter of 150mm. All loops will be neatly strapped.
- All cores (including spares) will be terminated into allocated termination strips/rails in the respective Instrumentation, Termination and Field Junction Boxes

6.4.1.2 Instrument PVC SWA Multi-core Cabling

- Cable SWA armouring shall be stripped back to the entry point into the associated marshalling cabinet/junction box and shall be glanded in such a manner so as to ensure electrical continuity with the gland. When terminated in hazardous areas, cable armouring shall be bonded to the panel equi-potential bonding system via means of earthing rings provided as an integral part of the gland. Contact between the gland and the gland plate shall not be considered as sufficient for bonding purposes.
- Protrusion of cable inner PVC sheaths into the marshalling cabinet will be a minimum of 25mm and a maximum of 50mm.
- Cable inner aluminium foil shall be stripped back to the point at which the individual cores leave the PVC Trunking to be terminated onto the respective terminal rails. Ends of the inner foil shall be neatly taped/heat shrunk so as to prevent unravelling.
- Cable ends shall be sealed with the use of heat shrink tubing applied over the cable inner sheath at the point of entry into the termination/junction box/panel, in order to protect the cable and prevent the ingress of moisture.
- Both cable overall and individual screens shall be insulated with the use of appropriately sized green coloured sleeving, to prevent inadvertent contact.
- All individual cable cores (including spares) will be left long enough to accommodate 200mm slack, i.e. taking into account the routing via the trunking.
- Excess lengths of individual cable cores will be neatly folded and tied within the trunking provided. All spare cores shall be terminated into terminals so provided.
- Termination of individual cable cores in the termination strips will be such that all Control System related cabling will be terminated to one side of termination strips, whilst all field instrumentation/equipment cabling will be connected to the other side of termination strips.

In the case of Field Junction Boxes with dual terminal strips, multi-core cabling will be glanded in the centre of the gland plate and terminated into terminal rails provided, running from the centre PVC Trunking outwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the outermost PVC Trunking inwards.

In the case of Field Junction Boxes with single terminal strips, multi-core cabling will be glanded on the right side of the gland plate and terminated into terminal rails provided, running from the right hand side of the panel inwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the left hand side of the panel inwards.

- All cores (including spares) will be terminated into allocated termination strips/rails in the respective Instrumentation, Termination and Field Junction Boxes

6.4.1.3 Electrical Power and Control Cabling (Low Voltage)

- Cable SWA armouring shall be stripped back to the entry point into the associated equipment housing/termination box/panel and shall be glanded in such a manner so as to ensure electrical continuity with the gland. When terminated in hazardous areas, cable armouring shall be bonded to the panel equi-potential bonding system via means of earthing rings provided as an integral part of the gland. Contact between the gland and the gland plate shall not be considered as sufficient for bonding purposes.
- (Option 1) Cable inner PVC sheath shall be cut back at the point of entry into the equipment housing/termination box/panel, protrusion of the inner sheath into the associated switchgear cabinet/equipment housings shall be a minimum of 25mm and a maximum of 50mm. Heat shrink tubing shall be applied at the point of entry into the equipment housing/termination box/panel, in order to protect the cable and prevent the ingress of moisture.

(Option 2) Where cables are glanded into panels, cable inner PVC sheaths may be taken directly into trunking/marshalling arrangements, with the inner PVC sheaths cut back at point of termination. Note that in this instance, heat shrink need not be applied at the point of entry into the cabinet.
- All individual cable cores (including spares) will be left long enough to accommodate 200mm slack, i.e. taking into account the routing via the trunking.
- Excess lengths of individual cable cores will be neatly folded and tied within the trunking provided.
- Termination of individual cable cores in the termination strips will be such that all Starter related cabling will be terminated to one side of termination strips, whilst all field cabling will be connected to the other side of termination strips.
- All cables connected to individual instruments/equipment will be provided with a single loop of minimum diameter of 150mm. All loops will be neatly strapped.

6.5 Cable Core Lugging

All individual cable cores will be neatly terminated. Appropriately sized lugs will be attached to all core ends, using the appropriate crimping tool (not side cutters or ordinary pliers). The colouring of crimps will match the size of the associated cable core. All cable lugs utilised shall comply with the following specification, unless otherwise specified in the Scope of Work attached to an Order:

- Instrument Cables - bootlace ferrules
- Electrical Power Cables - spade lugs for compression terminals, ring lugs for screw terminals (pin lugs are not acceptable)
- Electrical Control Cables - spade lugs for compression terminals, ring lugs for screw terminals (pin lugs are not acceptable)

6.6 Cable Screening – Instrument Cabling

6.6.1 Individual Screens

- 6.6.1.1 All Individual Instrument Cable Pair Screens shall be terminated into terminals provided within the Instrument Termination Boxes as well as the Field Junction Boxes, and shall be grounded to a common insulated earth rail to be provided in each of the Control System Marshalling Cabinets,

alongside the Termination Rails provided. Individual Screens shall be terminated in such a manner so as to be continuous from the Instrument/Instrument Termination Box to the Control System Marshalling Cabinets i.e. individual instrument cables as well as multi-pair cables.

6.6.1.2 Individual screen terminals shall be insulated in the Termination Boxes and Field Junction Boxes provided, thus ensuring that the individual cable pair screens are not grounded at instrument/equipment ends, i.e. to prevent common mode noise. Where Instrument Cables terminate directly into Instrument housings, individual screens shall be cut back and insulated within the Instrument housing using heat shrink sleeving, to prevent inadvertent contact with any conducting surfaces.

9.6.1.3 All individual screen earth rails in the Control System Marshalling Cabinets will be connected to the existing panel Instrument Earth bar via means of a 25mm insulated earth cable, which shall in turn be connected at two points via means of PVC Cu 70mm² insulated earth cables (Yellow/Green in colour), to the Instrument Earth bar located within the control room.

6.6.2 Overall Screens

6.6.2.1 All Instrument Cable Overall Screens/Drain wires shall be terminated to insulated earth bars provided within the Field Junction Boxes, and shall be earthed to a common electrical earth bar to be provided in each of the Control System Marshalling Cabinets. Overall Screens /Drain Wires shall be cut back and insulated within the Instrument Termination Boxes and Instrument housings (where applicable) to prevent inadvertent contact with the Termination Box housing, utilising heat shrink sleeving. Overall Screens shall be terminated in such a manner so as to be continuous from the Instrument Junction Box to the Control System Marshalling Cabinets.

6.6.2.2 The electrical earth bar shall be earthed to the Cabinet Frame, and connected at two points via means of PVC Cu 70mm² insulated earth cables (Yellow/Green in colour), to the Electrical Earth bar located within the control room.

6.7 Cable Screening – Electrical Cabling (Power & Control)

6.7.1 All electrical cable screens/drain wires (where applicable) will be grounded to a common electrical earth bar to be provided in each of the Control System Marshalling Cabinets/Switchgear Cubicles. The electrical earth bar shall be earthed to the Cabinet Frame, and connected at two points via means of PVC Cu 70mm² insulated earth cables (Yellow/Green in colour), to the Electrical Earth bar located within the control and switchgear rooms.

7 ADDITIONAL REQUIREMENTS FOR EX IA/IB INSTALLATIONS

7.1 All I.S. (Ex ia/ib Intrinsically Safe) Installations shall be in strict compliance with IEC 79-14 Electrical Installations in Hazardous Areas, and in particular Chp 12 "Additional Requirements for type protection Intrinsic Safety", inclusive of the under mentioned items.

7.2 Clause 12.2.

In installations with Zone 1 and 2 classifications, IS apparatus and the intrinsically safe parts of associated apparatus shall comply to at least category "ib". Note that Petronet has standardised on category "ia" protection, and permission will need to be sought in writing for relaxation to "ib".

7.3 Cables – General

Where multi stranded cables are used in a hazardous area, the ends of the conductor shall be protected against separation of individual strands, by means of cable lugs.

Where cable screens are required, these shall be connected to earth at one point only, normally in the non-hazardous area. (Refer to Section 9.6 and 9.7 of this specification).

Cable armouring shall normally be bonded to the equi-potential bonding system via the cable entry devices (glands), at the end of each cable run. Where interposing Junction Boxes exist or other apparatus, the armouring shall be similarly bonded to the equi-potential bonding system at these points. In this regard and where earthing rings are provided as an integral part of the gland, use of these is recommended in serving this function. Contact between the gland and the gland plate shall not be considered as sufficient for bonding purposes.

Conductors of intrinsically safe circuits and non-intrinsically safe circuits shall not be carried in the same cable.

Conductors of intrinsically safe circuits and non-intrinsically safe circuits in the same bundle or duct shall be separated by an intermediate layer of insulated material or by an earthed metal partition. No segregation is required if metal sheaths or screens are used for intrinsically safe or non-intrinsically safe circuits. Note that Petronet has standardised on physical separation regardless of whether the cabling is screened or not, and permission will need to be sought in writing for relaxation.

7.4 Cables – Marking

Un-armoured Cables containing intrinsically safe circuits shall be marked. If outer sheaths are marked by color, the color used shall be light blue. Note that whilst armoured cabling is not required to be marked in terms of IEC79-14, Petronet has standardised on the principle of marking all cable outer sheaths carrying intrinsically safe circuits by color (light blue), whether armoured or not, and that this will need to be complied with in all instances.

7.5 Cable Insulation Tests

All cables carrying intrinsically safe circuits shall be proven to be capable of withstanding an RMS AC test voltage of twice the normal voltage of the intrinsically safe circuit with a minimum of 500 V between the armouring and screens joined together and the individual conductors. Tests shall be conducted in accordance with manufacturers specifications. Where no such method is available, tests shall be carried out as follows:

- Voltage shall be an ac voltage of sinusoidal waveform at a frequency of between 48 and 62 Hertz
- Voltage shall be derived from a transformer of at least 500 VA output
- Voltage shall be increased steadily to the specified value in a period of not less than 10 seconds and maintained for a period of not less than 60 seconds.

7.6 Cable Termination

All terminals shall be reliably separated from non-intrinsically safe circuits (for example by a separating panel or gap of at least 50mm). Terminals of intrinsically safe circuits shall be marked as such. Petronet has standardised on marking by color - the specified color being light blue. All terminals, plugs and sockets shall satisfy the requirements of IEC79-11 Sections 6.3.1 and 6.3.2 respectively (6mm creepage and clearance rules 4mm to earth).

7.7 Zone 1 Installations - Surge Protection

All equipment installed in Zone 0 areas and exposed to hazardous potential differences (e.g. lightning surges), shall have a surge protection device installed between each non-earth bonded conductor/core and the local earthed structure as near as is practically possible. The surge protection device shall be capable of diverting a minimum peak discharge current of 10kA (8/20 microsecond impulse according to IEC60-1, 10 operations). The bonding connection between the protection device and the structure shall have a minimum cross sectional area equivalent to 4 mm² copper.

Note that Petronet has extended these requirements to include all analogue transmitters installed in the field, whether in hazardous areas or not, and will need to be complied with in all instances.

8. CABLE JOINTS

8.1 MEDIUM VOLTAGE CABLE JOINTS

8.1.1 The contractor shall give the Engineer advance notice of his intention to do jointing of medium voltage cables to enable arrangements to be made for measuring and inspection.

8.1.2 The complete cable installation, including all joints shall be fully insulated from earth throughout.

8.2 LOW VOLTAGE CABLE JOINTS

8.2.1 The low voltage cable through joints shall be of the epoxy resin filled type. The low voltage joints shall be constructed according to manufacturer's instructions.

9. CABLE ROUTES

9.1 All low voltage cables and associated earth continuity conductors shall be installed as shown in drawings PPD: BDD059C-E-01, sheet 1 of 3.

10. SURVEY OF ROUTE

10.1 The drawings showing the proposed cable route listed in the "Schedule of Drawings" shall not be taken to show the precise final cable route. The Contractor shall within 30 days after being awarded the Contract carry out a final route survey, which shall include digging test holes, and using the routes shown on the drawings as a general guide, to determine a suitable route.

10.2 The Contractor shall submit details of the cable routes selected in final survey to the Engineer for approval. No excavation of any section of the cable route shall commence until the Engineer has authorised the commencement of work on the section concerned.

10.2.1 After completion of all cable laying and jointing and before commissioning of any cable the Contractor shall carry out a final "as laid" survey of the cable routes and hand to the Engineer cable route plans. The cable route plans shall include the following information:

- (i) Overall length of each cable.
- (ii) Centre to centre distances between all joints and between final joints and terminations of each cable including auxiliary cables.

- (iii) Accurate indications of the position of each cable joint and cable marker preferably by triangulation, i.e. indicating two distances to each joint or marker from structures not likely to be moved such as permanent buildings, bridge piers, etc.
- (iv) Tables showing all information regarding each high-voltage cable necessary for cable fault location by the reflected pulse method.
- (v) Soil thermal resistivity and temperature values as determined on final survey shown on the plans at the positions where they were determined.

11. EXCAVATIONS

- 11.1 Excavations shall be carried out in strict compliance with the specification for works on, over, under or adjacent to a railway line No. E.7 (July 1998) (Part 1) that forms part of the tender documents.
- 11.2 The procedure and the order of doing the work shall be subject to the approval of the Engineer.
- 11.3 The Contractor shall, before trenching commences, familiarise himself with the route and conditions on site. The Contractor shall be advised of any known buried services such as cables, pipes, etc., in the vicinity of the cable route. However, the Contractor shall at all times exercise care to ensure that any uncharted services are not damaged.
- 11.4 Power driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to other cables, water mains, or any other plant liable to be damaged by the use of such plant. Their use along sections of the route shall in each case be subject to approval of the Engineer.
- 11.5 Trenches shall be as straight as possible and each trench shall be excavated to the dimensions indicated in this specification. The Contractor shall provide shuttering for use in places where danger exists should the sides of the trench collapse. The strength of such shuttering must be adequate especially where railway tracks in proximity are concerned and the shuttering must be braced across the trench. Provision of shuttering will be paid for per metre length of shuttered trench.
- 11.6 The bottom of each cable trench shall be as firm as conditions permit and be of smooth contour.
- 11.7 In sections where the soil or water level conditions indicate that the cable trench will endanger rail tracks or any nearby structures, the Contractor must restrict the length of continuous open trench to a distance to be indicated by the Engineer.
- 11.8 The Contractor shall take all reasonable steps to ascertain if the cables will be liable to be subjected to chemical or other damage or electrolysis action and shall submit his recommendations for approval, of any precautionary measures to be taken, in such instances.
- 11.9 The material excavated from each trench shall be placed adjacent to the trench in such a manner as to prevent nuisance or damage to adjacent ditches, railway lines, drains, gateways and other properties and shall be stacked so as to avoid undue interference with traffic. Where, owing to certain considerations, this is not permissible, the excavated materials shall be removed from the site and be returned for refilling the trench on completion of laying.

- 11.10 Surplus material shall be disposed of by the Contractor at his cost. Where the possibility exists that railway line ballast may be fouled by excavated material or material brought on site, the Contractor shall take precautions as directed by the Engineer.
- 11.11 The Contractor shall not trench beneath any railway line without departmental supervision. Should the contractor wish to carry out such work the Engineer must be advised not less than 14 working days before hand to arrange for the necessary supervision. The cost of such supervision shall not be charged to the Contractor.
- 11.12 Prior to laying the cable, the trench shall be inspected thoroughly by the Engineer or his authorised representative to ensure that it is free from all objects likely to damage the cable either during or after cable laying operations. Cable laying shall not proceed unless the Engineer or his authorised representative is satisfied with the condition of the trench.
- 11.13 When trenching, the Contractor shall take all precautions necessary to prevent damage to any other cables, water mains, roads, pavements, drainage systems, building or any structure etc. Should any of the above be damaged by the Contractor's staff, it shall be reported immediately to the Engineer, who shall arrange for the necessary repairs. The Contractor is responsible for the cost of repairs.
- 11.14 Should it be necessary for any reason to remove accumulated water or other liquid from the trench, this shall be done by the Contractor at his expense and should be taken into account at the time of tendering. The Contractor is to provide all pumps and appliances required to carry out this operation. Water or any other liquid removed shall be disposed of without creating any nuisance or hazard.
- 14.15 Trenching procedure shall be programmed in advance with the Engineer and the programme approved by the Engineer shall not be departed from save with his consent.
- 11.16 Programming of trenching shall be on the basis of the Contractor giving the Engineer an assurance that any length of trench opened on a particular day will be back-filled and compacted to an adequately firm surface on the same day where possible. If it is anticipated that trenching will remain open for longer periods, the Contractor shall first obtain the approval of the Engineer. No new sections of trenching shall commence if previously uncompleted sections still exist. Under no circumstances may sections greater than 300 metres be opened.
- Where such approval is given, the onus shall be on the Contractor to safeguard the works to the satisfaction of the Engineer during the extended period such trenches remain open. Where cables have already been laid, but not covered, steps shall be taken by the Contractor to protect cables and the personnel around.
- 11.17 The near side of any cable trench shall preferably not be less than 2500mm from any adjacent railway line. Approval from the Engineer will be required if the above clearances cannot be achieved. The conditions of clause 13.1 shall apply.
- 11.18 The removal of obstructions along the cable routes shall be subject to the approval of the Engineer and shall be paid for at pre-agreed rates.
- 11.19 The area traversed by the cable routes has been used for many years. It is inevitable that there will be uncharted services. On encountering any such service the Contractor shall promptly advise the Engineer who shall direct what action shall be taken.

- 11.20 Transnet Capital Projects reserves the right to alter any cable route or portion thereof in advance of cable laying. Payment in respect of any additional or wasted work involved shall be at scheduled rates.
- 11.21 Any existing electrical cables obstructing the cable routes shall be removed or deviated as appropriate by the Contractor. The work shall be paid for at scheduled rates.
- 11.22 The bottom of the trench shall be filled with 200mm of suitable soil sifted through a 6mm mesh and levelled off. Only soil with a satisfactory thermal resistivity may be used for this purpose and ash which occurs on the route shall not be used. Where no suitable soil is available in proximity, imported fill shall be arranged. The manufacturer's assurance is required that the current rating of cables is not reduced by the ground conditions.

12.0 TRENCH/EXCAVATION SPECIFICATION

Separate Trenches shall be supplied to cater for the following cable types:

12.1 ELECTRICAL HV/MV TRENCHES

- Trench Dimensions : 1200 mm deep by 500 mm wide (two cables), add 300mm width for additional cables
- River Sand Bedding : PVC Piping – 75 mm above pipe, 50mm under pipe
: Direct Burial – 100 mm
- Identification : PVC or Concrete Interlocking Tiles at a depth of 350mm
- Cable Markers : Concrete with engraved anodised aluminium ID plates
cable Marker Colour – Brilliant Green
- Cabling : Medium and High Voltage Power Cabling > 400 VAC
- Separation : 400 mm (LV cabling), 800mm (Instrument cabling)

12.2 ELECTRICAL LV TRENCHES

- Trench Dimensions : 800 mm deep by 300 mm wide
- River Sand Bedding : PVC Piping – 75 mm above pipe, 50mm under pipe
: Direct Burial – 100 mm
- Identification : Polythene Marker Tape (150mm wide, yellow and
marked with the words "Electric Cable" at a depth of
350mm
- Cable Markers : Concrete with engraved anodised aluminium ID plates.
cable Marker Colour – Black
- Cabling : Low Voltage Power Cabling 400 VAC/230 VAC
(e.g. Actuators, Aux Motors, DB circuits)
: Control Cabling
(e.g. MV Breaker Inter-tripping cables, Actuator control signals,
Aux Motor local stop/start panels etc.)
- Separation : 400 mm (HV/MV cabling), 800mm (Instrument cabling)

12.3 INSTRUMENT TRENCHES

Trench Dimensions	:	500 mm deep by 300 mm wide
River Sand Bedding	:	PVC Piping – 75 mm above pipe, 50mm under pipe Direct Burial – 100 mm
Identification	:	PVC Tiles / Polythene Marker Tape (150mm wide, yellow and marked with the words “Electric Cable/Elektriese Kabel”) at a depth of 350mm
Cable Markers	:	Concrete with engraved anodised aluminium ID plates cable Marker Colour – Light Blue
Cabling	:	Instrument Multi-core & Single Pair Cabling (IS and non IS)
Separation	:	800mm (HV/MV/LV Electrical cabling)

13. CABLE LAYING

13.1 CABLES BURIED UNDERGROUND.

- 13.1.1 HV, MV, LV AND Instrument cables shall be spaced as indicated in Table 1 below. Pilot cables shall be laid beside the associated power cable. Cables crossing beneath railway tracks, roads, etc., shall be enclosed in 150mm diameter uPVC pipes. Where more than one length of pipe is required for a crossing, uPVC couplings with PVC glue, shall be used to prevent water from penetrating the joint. Cable pipes must maintain or exceed the specified cable spacing.

Table 1

CABLE	MINIMUM SPACING BETWEEN CABLES
MV To MV	300mm
MV To LV	400mm
LV TO LV	300mm
MV To instrumentation	800mm
LV To instrumentation	800mm

- 13.1.2 All pipes laid beneath the railway lines, roads, pavements shall be laid with their tops not less than 900mm below the formation level, and shall where possible extend at least 2000mm on either side of the centre of the outer most line. Where there is more than one line crossed and in the case of roads and pavements at least 900mm on either side of the road and 1 or pavement. All pipes shall be graded for water drainage ; the required grade is 75mm in 30m.
- 13.1.3 All Low voltage cables shall be laid at a depth of 750mm. All cable depth measurements shall be made to the top of the cable when laid direct in the ground, otherwise to the top of the duct concerned.

- 13.1.4 Except where ducts, tunnels or pipes are provided and unless instructed to the contrary by the Engineer, the Contractor shall lay the cables direct in the ground.
- 13.15 Rollers may be used during the laying of cables, but they shall have no sharp projecting parts liable to damage the cables. They shall be carefully placed in the trench or duct in such a manner that they will not readily capsize during cable laying operations.
- 13.1.6 The Contractor shall ensure that all cable is laid in the same direction. No crossing of conductors inside through joints or end boxes will be permitted.
- 13.1.7 Where cables have to be drawn around corners, skid plates shall be used for this purpose and these plates shall be well lubricated. The skid plates shall be securely fixed between rollers and shall be constantly examined during the cable laying operations.
- 13.1.8 Cable shall be visually inspected for damage during and after laying.
- 13.1.9 Cable pulling and laying shall preferably be done manually whenever possible. Mechanical means such as winches and the like may only be used subject to the approval of the Engineer. No cable shall be subjected to a tension exceeding that stipulated by the cable manufacturer.
- 13.1.10 In the event of mechanical means of cable pulling being approved, the Contractor shall establish means of communication between the operator of the winch or other pulling device and the persons tending the drum from which the cable is being run off, to the satisfaction of the Engineer.
- 13.1.11 The contractor shall be wholly responsible for making his own arrangements for transporting all materials to and from and on the working sites.
- 13.1.12 At locations where cables run under concrete bridges, the cables shall be supported on suitable brackets secured on the side of concrete wall. These brackets shall be spaced a maximum of 500mm apart. Brackets and fixing material shall be of robust design and shall meet with Engineer's approval. Drawing of proposed ' bracket shall accompany tender. Brackets shall be galvanised in accordance with SABS 763, and thereafter painted to the satisfaction of the Engineer.
- 14.0 CABLES LAID IN DUCTS, CABLE TRAYS AND LADDERS**
- 14.1.1 Cables installed in ducts shall be supported by cable ladder installed along the walls of the ducts or installed on the duct floor. If the cable ladder is installed on the duct floor, it shall be supported at +/- 50mm from the duct floor.
- 14.1.2 Cables installed in perforated cable trays and cable ladder shall be secured by means of heavy duty cable ties, cable clamps, etc.
- 14.1.3 Where medium and low voltage cables share the same wire-ways a reasonable space shall be left between the medium voltage and low voltage cables.
- 15.0 CABLE SLEEVING**
- 15.1 All areas subject to vehicle traffic, rail crossings and paved areas shall be sleeved.
- 15.2 Sleeves shall be designed and installed so as to ensure 25 % spare capacity.
- 15.3 Sleeve Specifications

Material : PVC or PHD Polyethylene
Dimensions : 100 mm OD min
Standards : DIN EN50086-2, BS EN50086-2-4:1994

16.0 DRAW BOXES

- 16.1 Where cable sleeves are utilised and to facilitate the hauling of cables, brick draw boxes shall be provided at all trench junctions, complete with concrete slab, as detailed below:

Draw Box Dimensions (min) : Internal 450 mm square, 3 courses of stock brick deep.

Base & Top : Concrete 50mm thick

17. COVERING, BACKFILLING AND REINSTATEMENT

- 17.1 Filling in of trenches shall not be commenced until the Engineer or his authorised representative has inspected and approved the cables in situ in the section of trench concerned. Such inspection shall not be unreasonably delayed.
- 17.2 Where, in the opinion of the Engineer, the soil on site is unsuitable for riddling or backfilling, the Contractor shall arrange for the importation of approved material. A 75mm thick layer of soil sifted through a 6mm mesh shall be laid above the high-tension cables and consolidated by hand ramming only. The conditions of clause 13.20 apply in this case also.
- 17.3 All excavations made (whether for the purpose of cable laying, joint bays or trial holes) shall be back-filled in 150mm layers, the earth in each layer being well rammed and consolidated and sufficient allowance being made for settlement. The back-filling shall be completed to the satisfaction of the Engineer.
- 15.4 The refilled trench shall be maintained by the Contractor at his expense in a thoroughly safe condition for the duration of the contract. In the case of tarmac surfaces, until such time as this surface has been restored.
- 17.5 All backfilling of road crossings shall be mechanically rammed by means of approved type of mechanical power driven rammer.
- 17.6 The replacement of made up surfaces, such as roads, pavements, tarred aprons, verandas, floors, etc., necessitated by trenching or other works shall be arranged by the contractor at his cost. The price thereof shall be included in the tender price.
- 17.7 Concrete cable protection slabs to Drawing No. PPD-PA-10 shall be laid on top of the 75mm layer of soil referred to in clause 15.2 before the trenches are backfilled. Cable protection slabs shall be laid close butted, convex end to concave end, directly above each cable throughout the underground portion except where otherwise protected such as by. pipes, etc. Three coloured slabs to drawing PPD-PA-9 shall be provided to give the indication of the route in the case of a change of direction. Only unbroken cable protection slabs, and those actually laid will be paid for.
- 17.8 When back filling of cable trench has reached a level, after consolidation, approximately 150mm below the normal level of the surface of the surrounding area the Contractor shall lay a continuous plastic cable warning tape directly above each cable for the full length of the cable trench before completing the backfilling.

- 17.9 Concrete cable markers to Drawing No. PPD-PA-12 shall be provided and installed by the Contractor at his cost. The price thereof shall be included in the tender price. Initial cable markers shall be installed as close as possible to cable terminations, thereafter at approximately 60m intervals and at cable joints, also on either side of crossings of oil pipelines and at ends of underground cable pipes.
- 17.10 Changes of direction and joints in cable runs shall be indicated by installing two markers at such positions in the manner shown on Drawing No. PPD-PA-12. The markers shall be coloured orange with oxide mixed into the concrete. Cable markers shall project approximately 25mm above normal ground level except where projecting cable markers could be a hazard to pedestrians such as in shunting yards, walkways, pavements, etc. In such cases the cable markers shall be flush with the surface.
- 17.11 If more than one cable is laid in one trench, only one row of cable markers shall be placed on the centre line of the trench to define the general route of the cables.
- 18. CABLE TESTING AND TEST DATA**
- 18.1 All tests on completed cables shall be carried out in the presence of a representative of Transnet Projects. Not less than 14 working days notice of the Contractor's intention to carry out such tests shall be given to the Engineer.
- 18.2 On completion of the jointing and termination of cables, the 11kV cables are to be subjected to the test laid down in paragraph E-1.4 of Appendix E of S.A.B.S.1339 and the low voltage type cables to be tested for insulation and loop resistance.
- 18.3 The anti-electrolysis insulation of each 11kV cable run complete, shall withstand for 1 minute, a test voltage of 10kV D.C., applied from the cable armouring to earth. The bedding shall withstand a test voltage of 4kV D.C. between screen and armouring for 1 minute.
- 18.4 As a graphite coating is required to be applied to the PVC oversheath (in accordance with British Standard), a D.C. voltage test will be carried out on all cables after installation. The D.C. voltage test can only be carried out on the installed system if the joints are suitably insulated from earth, otherwise the D.C. voltage test should be carried out prior to jointing.
- 18.5 The contractor shall obtain written confirmation from the manufacture of all cables, joints and terminations -etc. that the test that Transnet Projects requires the contractor to carry out in terms of this specification meets with the manufacturers approval. Such confirmation must be obtained prior to any, tests commencing.
- 18.6 The electrical Contractor shall on completion of the tests submit three copies of all test results. The costs of all the tests mentioned above shall be borne by the Contractor.
- 18.7 In addition the cable manufacturer shall provide test sheets of each manufactured cable drum length together with the cable drum numbers which shows all the test results.
- 18.8 Transnet Projects reserves the right to carry out any further tests deemed necessary itself, using either the Contractor's instruments and cable, or its own, or both. The costs of such tests shall not be charged to the Contract.

18.9 Cable Testing – Low Voltage Cables (< 1 kV)

Each individual core of all cables (including spares) will be checked for continuity and insulation breakdown, in accordance with SABS 150 (PVC):

- Insulation Resistance shall be measured with a 1000V Megger and the readings tabulated and certified.
- Similarly, earth continuity resistance shall be measured and recorded.
- All cables will be checked for correct termination.

18.10 Cable Testing – Medium Voltage Cables (< 22 kV)

Each section of laid and jointed cable shall be tested, in accordance with SABS 97 (PILC/SWA):

- Insulation Resistance shall be measured with a 1000V Megger, followed by the relevant pressure test. Readings shall be tabulated and certified.
- AC test voltage must be applied to each phase in turn for one minute, or alternatively the DC test voltage for fifteen minutes. Leakage current shall be measured and recorded for each test.
- All cables will be checked for correct termination.

19. MEASUREMENTS OF CABLES

19.1 All measurements for payment purposes shall be made jointly by representatives of the Contractor and Transnet Projects and shall be agreed and approved by both parties.

19.2 Measurements of cable length shall be made from centre to centre of cable joints and to the cable ends and will exclude any wastage due to jointing and terminating.

19.3 Measurements of trench width and depth shall be made to the nearest 50mm and shall not take into account subsidence or unnecessarily large excavations. No allowance shall be made where trenches have to be widened at the bottom to accommodate cables, cable joints and protection slabs

APPENDIX 1

STATEMENT OF COMPLIANCE (TO BE COMPLETED BY TENDERER)

This tender complies with specification TPD: 003-CABLESPEC in all respects.

SIGNATURE : _____ DATE : _____

This tender complies generally with specification TPD: 003-CABLESPEC but differs from it on the following points.

SIGNATURE : _____ DATE : _____

Transnet Capital Projects

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure I: Technical specification for electrical installations to building other than dwelling houses

SPECIFICATION FOR ELECTRICAL INSTALLATIONS TO BUILDINGS OTHER THAN DWELLINGS HOUSES

REVISIONS		
REV	DATE	APPROVED
01	April 2016	S.Sewdayal

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32.	QUALITY ASSURANCE AND INSPECTION

1.0 SCOPE

- 1.1 This specification covers the requirements with respect to the electrical installation, including the supply of all material and labour necessary to complete the EL&P installation for buildings.
- 1.2 This specification also applies to electrical alterations and additions carried out to existing installations.

2.0 REFERENCES

The latest editions of the following standards, codes, and regulations shall apply to this specification:

- 2.1 Fundamental Installation & Safety Codes
 - SANS 10142-1: The Wiring of Premises (Low-voltage installations)
 - Occupational Health and Safety Act, 1993 (Act 85 of 1993) and associated Construction Regulations
 - SANS 204 / SANS 10400-XA: Energy Efficiency in Buildings
- 2.2 Environmental & External Protection
 - SANS IEC 62305: Protection against lightning
 - SANS 10108: The classification of hazardous locations
 - SANS IEC 60079 series: Equipment for explosive atmospheres
 - SANS 10086-1: Installation and maintenance of electrical equipment in explosive atmospheres
- 2.3 Distribution & Control Gear Assemblies
 - SANS IEC 61439 series: Low-voltage switchgear and control gear assemblies
 - SANS IEC 60947 series: Low-voltage switchgear and control gear (All relevant parts)
- 2.4 Cables, Wiring Systems & Support
 - SANS 1574: Polyvinyl chloride (PVC) insulated cables and flexible cords
 - SANS 1065: Screwed metal conduit and fittings
 - SANS 950: Unplasticized PVC (uPVC) conduit and fittings
 - SANS 1085: Wall outlet boxes for electrical accessories
 - SANS IEC 61537: Cable management systems (Cable trays and ladders)
- 2.5 Protective Devices
 - SANS IEC 60898-1: Miniature circuit-breakers (MCBs)
 - SANS IEC 60947-2: Circuit-breakers and Moulded Case Circuit Breakers (MCCBs)
 - SANS IEC 60269 series: Low-voltage fuses
 - SANS IEC 61008-1 & SANS IEC 61009-1: Residual current devices (RCCBs & RCBs)
 - SANS IEC 61643-11: Surge protective devices (SPDs)
- 2.6 Luminaires & Lighting

SANS IEC 60598 series: Luminaires
SANS IEC 62722 & SANS IEC 62717: LED general lighting - Performance requirements
SANS IEC 62471: Photobiological safety of lamps and lamp systems
SANS 10114-1: Interior lighting - Artificial lighting of interiors

- 2.7 Socket-Outlets, Connectors & Transformers
SANS 164-2: Plug and socket-outlet system (ZA Plug)
SANS IEC 60309-1: Plugs, socket-outlets and couplers for industrial purposes
SANS IEC 61558 series: Safety of transformers, reactors, and power supply units
- 2.8 Finishes & Corrosion Protection
SANS 1091: National colour standards for paint
SANS 10064: Preparation of steel surfaces before coating
SANS 1274: Coatings applied by the powder-coating process
SANS 121: Hot-dip galvanized zinc coatings on fabricated iron and steel articles

3.0 SERVICE CONDITIONS

- 3.1 The equipment and installation shall be designed and rated for continuous operation under the following conditions:

3.1.1 Ambient/Environment Conditions :

- 3.1.1.1 Altitude: Sea level
- 3.1.1.2 Temperature range: -5 °C to +50 °C (daily average + 35 °C).
- 3.1.1.3 Relative humidity: Up to 96%.
- 3.1.1.4 Lightning conditions: Severe, with a maximum lightning ground flash density of eleven (11) flashes per km² per annum.
- 3.1.1.5 Atmosphere: Salt-laden, corrosive, high UV exposure. Electrolytic corrosion risk due to traction/cathodic protection systems. Installations shall consider climate resilience and extreme weather conditions
- 3.1.1.6 Wind: Withstand gusts up to 160 km/h.

4.0 ELECTRICAL INSTALLATION

- 4.1 The *Contractor* shall carry out the installation in accordance with SANS 10142-1: Code of Practice for the Wiring of Premises and the requirements of this specification.
- 4.2 Where the local supply authority requirements differ from those specified herein Transnet

National Ports Authority Electrical *Engineer* shall be approached for a decision.

- 4.3 All equipment and material shall comply with the relevant National or International standard specification. Where equipment does not comply it shall be submitted with the Transnet National Ports Authority Electrical *Engineer* for approval.
- 4.4 The system of supply will be three phase, 4 wire or single phase 2 wire 50 Hz. alternating current with earthed neutral at a nominal voltage of 400/230 volts. The voltage may vary within the range of ± 5 % of the nominal voltage.
- 4.5 Wiring
 - 4.5.1 All wiring shall be carried out in cable trunking and/or conduit. Only the loop in system of wiring shall be accepted.
 - 4.5.2 No joints in wiring, nor the cutting away of strands to facilitate connections shall be permitted.
 - 4.5.3 Single core cable smaller than 1,5 mm shall not be used.
 - 4.5.4 Colour identification of conductors shall be used as per SANS requirements.
 - 4.5.5 Flameproof equipment shall comply with SANS 60079-1.
 - 4.5.6 Equipment in hazardous areas shall be installed in accordance with SANS 10086-1 and comply with the classification requirements of SANS 10108 and the relevant parts of the SANS/IEC 60079 series.
- 4.6 The provision and installation of the supply cable to the building, the termination and the connection thereof to the distribution board main incoming isolating shall be the responsibility of the *Contractor*, as directed by the *Engineer*.
- 4.7 The *Contractor* shall be responsible for the provision and connection of power supplies to electric urns, stoves, geysers, fry-tops, fans etc. provided by others; unless otherwise stated in the Schedule of Requirements.
- 4.8 The *Contractor* shall also provide power supplies to air-conditioning equipment. The connection to air-conditioning equipment will be undertaken by others.
- 4.9 Cables shall be installed and supported so that no mechanical strain is imposed on terminations, in compliance with SANS 10142-1 requirements.
- 4.10 Drilling or welding of steelwork for the mounting of electrical equipment will not be permitted unless approved by Transnet's *Engineer* on site. Equipment shall be fixed to the steelwork by means of approved, purpose made clamp/brackets.
- 4.11 Lightning protection shall comply with SANS/IEC 62305 (Protection against lightning) and any additional requirements of the local supply authority.



5.0 DISTRIBUTION BOARDS

- 5.1 All distribution boards shall be designed, tested, and certified to comply with the latest edition of SANS IEC 61439 series. Workmanship and installation shall comply with SANS 10142-1.
- 5.2 Enclosures for indoor general use shall have a minimum degree of protection of IP41, while those for indoor dusty or damp environments shall be rated to a minimum of IP54. All outdoor distribution boards shall be weatherproof and corrosion-resistant with a minimum IP55 rating, constructed from materials such as powder coated stainless steel (3CR12/304/316) or hot-dip galvanized steel.
- 5.3 Enclosures shall have a substantial, dedicated earthing bar with tinned copper terminals, sized for all incoming and outgoing protective conductors. Separate neutral bars with adequate terminals for all outgoing circuits shall also be provided.
- 5.4 All distribution boards shall include 20% spare ways for future circuits. A minimum of 20% spare conduit entries (minimum 20mm diameter, minimum 2 conduits) shall be provided to ceiling/roof spaces.
- 5.5 Distribution boards with bottom cable entries shall be not less than 600mm above finished floor level. Adequate space for cable bending radii and proper segregation between incoming and outgoing cables shall be maintained.
- 5.6 All circuits shall be clearly labelled using durable, engraved or laminated printed labels permanently secured to the panel. A typed/engraved circuit schedule shall be permanently affixed behind a clear plastic window on the inside of the door.
- 5.7 All internal components shall be mounted on plated DIN or Samite rails. All live parts shall be fully insulated, with functional segregation between compartments where required by SANS IEC 61439.

6.0 ISOLATING SWITCHES (DISCONNECTORS)

- 6.1 Isolating switches shall comply with the latest edition of SANS IEC 60947-3 and shall be certified as switch-disconnectors meeting the requirements for isolation.
- 6.2 All isolating switches shall be lockable in the OPEN (OFF) position with padlock facilities to facilitate lockout procedures for safety.
- 6.3 Switches shall have a rated operational voltage of 415V AC, 50Hz, with a rated operational current suitable for the connected load.
- 6.4 The rated short-time withstand current (I_{cw}) shall be not less than the prospective short-circuit current at the point of installation.

- 6.5 Isolating switches shall be clearly marked with ON/OFF indicators and shall provide visible contact separation or have a reliable position indicator.
- 6.6 Enclosures for isolating switches shall provide a minimum degree of protection of:
- a. IP2X for protection against contact with live parts
 - b. IP30 for general indoor use
 - c. IP55 for outdoor or harsh environments

7.0 MINIATURE CIRCUIT BREAKERS (MCBs)

- 7.1 Miniature Circuit Breakers (MCBs) shall comply with the latest edition of SANS IEC 60898-1 or SANS IEC 60947-2. The applicable standard shall be declared by the manufacturer for the specific product.
- 7.2 MCBs shall have a minimum breaking capacity (I_{cn}) of 3kA at 230/400V.
- 7.3 MCBs shall be of the following types, as specified on the circuit drawings:
- a. Type B (3 to 5 I_n): For general purposes and cables
 - b. Type C (5 to 10 I_n): For circuits with moderate inrush currents
 - c. Type D (10 to 20 I_n): For circuits with high inrush currents (e.g., transformers, motors)
- 7.4 All MCBs shall feature:
- a. Single-pole switching in the phase conductor only
 - b. "ON/OFF" visible indicators
 - c. Trip-free mechanism (cannot be held closed against a fault)
 - d. DIN rail mounting compatibility
- 7.5 MCBs shall be from a single manufacturer throughout each distribution board to ensure proper coordination.

8.0 MOULDED CASE CIRCUIT BREAKERS (MCCBs)

- 8.1 Moulded Case Circuit Breakers (MCCBs) shall comply with the latest edition of SANS IEC 60947-2.
- 8.2 MCCBs shall have a rated ultimate short-circuit breaking capacity (I_{cu}) not less than the prospective short-circuit current at their point of installation, with a minimum value of 25 kA at 415V.
- 8.3 MCCBs shall be of the fixed thermal-magnetic type for standard feeder circuits as specified. Electronic trip units with adjustable settings (I_r, I_{sd}, I_i) shall be provided where shown on drawings or where required for selective coordination with downstream devices.
- 8.4 All MCCBs shall be equipped with standard features including:



- d. ON/OFF manual handle
- e. Trip indication (visual flag)
- f. Earth fault protection where specified (with adjustable settings)
- g. Auxiliary contacts (at least one normally open) for remote signalling

- 8.5 MCCBs shall be suitable for DIN rail mounting or panel mounting as appropriate for the enclosure type.
- 8.6 All MCCBs within a distribution system shall be from a single manufacturer to ensure proper coordination and compatibility.

9.0 EARTH LEAKAGE PROTECTION UNITS

- 9.1 Earth leakage protection units shall comply with the latest editions of SANS IEC 61008-1 (RCCBs) or SANS IEC 61009-1 (RCBOs), as applicable.
- 9.2 Devices shall have a residual current sensitivity of 30 mA for personnel protection. For fire protection in main circuits, a sensitivity of 300 mA may be specified.
- 9.3 All 30 mA devices shall be of Type A sensitivity (responsive to both AC and pulsating DC residual currents). Type AC devices are not permitted.
- 9.4 Devices shall have a minimum rated conditional short-circuit current (I_{cn}) of 3kA and shall be suitably coordinated with upstream overcurrent protective devices.
- 9.5 RCBOs shall combine earth leakage protection with overcurrent protection in a single modular unit suitable for DIN rail mounting.
- 9.6 Each device shall be equipped with a test button and a mechanical status indicator clearly showing whether the device is ON, OFF, or in a tripped state due to earth fault.

10.0 SURGE PROTECTION DEVICES (SPDs)

- 10.1 SPDs shall comply with the latest edition of SANS IEC 61643-11. A coordinated surge protection system shall be installed to protect the electrical installation from transient overvoltages, comprising Type 1, Type 2, and Type 3 SPDs as specified below.
- 10.1.1 Type 1 SPD (Surge Arrester): Shall be installed at the main service entrance distribution board, upstream of the main isolating device. Shall be tested with a 10/350 μ s impulse current wave. Shall have a minimum discharge current (I_{imp}) of 12.5 kA per phase.
- 10.1.2 Type 2 SPD (Surge Protector): Shall be installed at all sub-distribution boards. Shall be tested with an 8/20 μ s current wave. Shall have a nominal discharge current (I_n) of 20 kA per phase.



- 10.1.3 Combined Type 1 & Type 2 SPDs: A single device meeting the requirements of both Type 1 and Type 2 may be installed at the main distribution board as a combined solution, provided it has a minimum limp of 12.5 kA (10/350 μ s) and is listed by the manufacturer as a combined Type 1+2 device.
- 10.1.4 Type 3 SPD (Point-of-Use Protection): Type 3 SPDs shall be provided for critical or sensitive equipment (e.g., servers, PLCs, medical devices, security systems). They shall be installed close to the protected equipment, typically at the final socket-outlet or within the equipment enclosure. They are intended to provide fine protection in coordination with upstream Type 1 and/or Type 2 SPDs and are not to be used as a sole means of protection.
- 10.2 All SPDs shall feature visual status indicators showing operational or failed state and a remote signalling contact for monitoring.
- 10.3 SPDs shall be selected from a single manufacturer to ensure proper coordination between all stages.
- 10.4 Connection leads for Type 1 and Type 2 SPDs shall be as short as possible, not exceeding 0.5 meters.

11.0 FUSE SWITCHES

- 11.1 Fuse switches shall comply with the latest edition of SANS IEC 60947-3.
- 11.2 Fuse switches shall be the switch-disconnector type, fulfilling the isolation function as defined in the standard. They shall be the double-break, air-insulated type and shall be lockable in the OFF (open) position with a minimum of two padlocks for safety isolation.
- 11.3 The rated operational voltage shall be 415V AC, 50Hz, with a rated operational current (I_e) suitable for the connected load. The rated short-time withstand current (I_{cw}) shall be not less than the prospective short-circuit current at its point of installation.
- 11.5 The enclosure shall provide a minimum degree of protection of IP2X for live parts and IP30 for general indoor use. For outdoor or harsh environments, a minimum of IP55 shall be required.
- 11.6 Fuse switches shall be designed for DIN rail mounting or panel mounting as appropriate for the enclosure.

12.0 HIGH RUPTURING CAPACITY FUSE LINKS

- 12.1 High rupturing capacity (HRC) fuse links shall comply with the latest edition of SANS IEC 60269-1 and the relevant application-specific parts of SANS IEC 60269 (e.g., Part 2 for AC applications).



- 12.2 Fuse links shall be of the cartridge type with a minimum breaking capacity of 80kA at 400V AC.
- 12.3 Fuse links shall be of gG/gL (general application) or aM (motor circuit protection) type as required for the specific circuit application.
- 12.4 A complete spare set of fuse links for each different rating used in the installation shall be provided. Spares shall be housed in a dedicated, labelled container within the distribution board.
- 12.5 Fuse links shall be from a single manufacturer throughout the installation to ensure selective coordination.

13.0 CONTACTORS

- 13.1 Contactors shall comply with SANS/IEC 60947-4-1 and be rated for the duty cycle and utilization category required by the application (e.g., AC-1, AC-3, AC-4). The rated operational current (I_e) at 400V AC-3 shall be clearly marked and shall be a minimum of 1.5 times the full load current of the connected load(s).
- 13.2 Contactors shall be of the modular, clip-on type for easy mounting and replacement on standard DIN rails. Each contactor shall be fitted with at least one normally open (NO) auxiliary contact for control circuit signaling.
- 13.3 The coil voltage shall be 230V AC, 50Hz, unless otherwise specified on the drawings. Coils shall be protected by a fuse or miniature circuit breaker.
- 13.4 For motor applications, contactors shall be coordinated with an overload relay to provide Type 2 coordination as per IEC 60947-4-1. The overload relays shall be thermally delayed for all motor circuits, shall be a clip-on type, and feature manual/auto reset functionality and single-phasing protection.

14.0 ENERGY METERING AND MONITORING

- 14.1 The electrical installation shall include energy metering equipment to facilitate the monitoring and management of energy consumption as detailed in the project drawings and schedules.
- 14.2 All meters and associated current transformers (CTs) shall be suitable for use on a 400/230V, 50Hz system. The metering system shall be designed for integration into the existing Port SCADA system and/or Building Management System (BMS) where available, providing visibility and data acquisition.
- 14.3 Electronic energy meters shall be provided at the main incomer of the building and at all major sub-distribution boards feeding consumer supplies, large HVAC plants, and other significant loads as specified.



- 14.4 Energy meters shall have a minimum accuracy class of 1.0 for active energy (kWh) as per SANS IEC 62053-21. Meters shall measure and display, at a minimum, the following parameters:
- a) Import Active Energy (kWh)
 - b) Export Active Energy (kWh) (if applicable)
 - c) Current Demand (kW, kVA)
 - d) Voltage (V)
 - e) Current (A)
 - f) Power Factor
- 14.5 Energy meters shall be equipped with a standard communication port (e.g., RS485, Ethernet) and support an open protocol such as Modbus RTU/TCP or BACnet MS/TP/MSTP for integration into the Port's SCADA system, central Building Management System (BMS) or dedicated energy management platform. Where no central BMS or SCADA is specified, meters shall have a local digital display for manual reading of all measured parameters.
- 14.6 Current Transformers (CTs) shall be of the split-core or solid-core type as appropriate for the installation, with an accuracy class matching or exceeding that of the meter (e.g., Class 0.5). CTs shall have a rated primary current selected to match the normal operating current of the circuit, and a standard secondary current of 5A or 1A as required by the selected meter. CTs shall be installed in accordance with the manufacturer's instructions and SANS 10142-1.
- 14.7 Energy meters shall be mounted within the distribution board or in a dedicated, accessible meter cabinet. All wiring between meters, CTs, and voltage references shall be in accordance with the meter manufacturer's requirements and suitably labelled. The Contractor shall submit manufacturer's data sheets, communication protocol manuals, and typical wiring diagrams for all proposed metering equipment for approval.
- 15.0 LUMINAIRE HOUSING**
- 15.1 Luminaires shall be designed and manufactured for LED light sources only and shall be designed as integrated LED systems.
- 15.2 All materials shall be new, durable, and suitable for their intended environment and operating temperature.
- 15.3 The insulation of all internal wiring shall be heat-resistant (minimum 105°C rating) and securely held in place.
- 15.4 Housings for standard indoor applications (e.g., offices) shall have a minimum IP20 rating. Luminaires in bathrooms, under eaves, or other damp locations shall have a minimum IP44 rating. All exterior luminaires (e.g., bulkheads) shall have a minimum IP65 rating. In coastal or harsh industrial areas, a minimum of IP66 is required. Luminaires for classified hazardous areas shall comply with SANS IEC 60079 series and be certified for the specific zone and gas group.
- 15.5 Housings shall be constructed from corrosion-resistant materials such as die-cast aluminium, UV-stabilized polycarbonate, or fiberglass-reinforced polyester. Ferrous metal components shall



be hot-dip galvanised or stainless steel. Housings may be constructed from steel, aluminium, or high-grade, UV-stabilized polymers (e.g., polycarbonate, ABS) as appropriate for the application.

- 15.6 Diffusers shall be made from high-impact, UV-stabilized opal or prismatic polycarbonate or acrylic. Glass may be used where specified for specific aesthetic or durability reasons.
- 15.7 The luminaire housing shall incorporate an effective thermal management system (e.g., aluminium heat sinks, cooling fins) to maintain the LED junction temperature within the manufacturer's specified limits, ensuring rated lifetime and lumen maintenance.

16.0 LUMINAIRES (LED BASED)

- 16.1 All luminaires shall utilize Light Emitting Diode (LED) technology. The use of incandescent, fluorescent, or high-intensity discharge (HID) lamps shall not be permitted unless explicitly approved by the *Engineer* for a specific application not suitable for LEDs. All LED products shall be sourced from reputable manufacturers and must have a valid certificate of compliance from an accredited testing body, such as the NRCS (National Regulator for Compulsory Specifications) in South Africa. All Light Emitting Diode (LED) luminaires shall comply with the requirements of IEC 62722, IEC 62717, and IEC 62471 for performance and photobiological safety.
- 16.2 The luminaire shall have a minimum luminous efficacy of 130 lumens per watt (lm/W). LED luminaires shall have a minimum power factor of 0.95. For offices and interior amenity spaces, luminaires shall have a Unified Glare Rating (UGR) of < 19.
- 16.3 The minimum Colour Rendering Index, CRI (Ra) shall be 80 for general areas. For areas requiring accurate colour judgement (e.g., workshops, inspection areas, retail spaces), a minimum CRI of 90 shall be required. The Correlated Colour Temperature (CCT) shall be specified in the project schedules or drawing legends. Typical values shall be:
 - a. 3000K - 3500K (Warm White) for offices and interior amenity spaces.
 - b. 4000K (Neutral White) for workshops, industrial, and general areas.
 - c. 5000K (Cool White) for high-precision task areas, if required.
- 16.4 The luminaire shall have a suitable beam angle and photometric distribution (Type I, II, III, IV, V) as required for the specific application and spacing-to-mounting-height ratio.
- 16.5 The luminaire shall have a rated L90 lifetime of $\geq 100,000$ hours and be backed by a minimum 5-year manufacturer's warranty covering premature failure and lumen depreciation.
- 16.6 LED drivers shall be replaceable and comply with IEC 61347-2-13. Drivers shall include built-in surge protection with a minimum immunity of 2.5kV per ANSI/IEEE C62.41. The luminaire shall be designed with an effective thermal management system to ensure junction temperatures remain within the manufacturer's specified limits.
- 16.7 Where dimming is specified, luminaires and drivers shall be compatible with the designated control system (e.g., 1-10V, DALI) and shall operate without visible flicker (below 5% flicker index).



per IEEE 1789) or audible noise.

- 16.8 It is essential that full descriptions, datasheets, and photometric data of the luminaires offered accompany all tenders. This information shall include detailed descriptions and drawings of the luminaires as well as photometric data (in IES or LDT format) issued or certified by the manufacturer, suitable for use in recognised lighting design software

17.0 ELECTRIC HEATERS

- 17.1 Fixed electric heaters shall comply with IEC 60335-2-30 or equivalent applicable standards.
- 17.2 Tubular heaters shall be provided with an enclosed terminal box for safe connection of line, neutral, and earth conductors, with provision for conduit entry. Heater ratings shall be in accordance with project requirements and manufacturer's recommendations. Tubular heaters shall be mounted at the minimum clearances recommended by the manufacturer, but not less than 200 mm above finished floor level.
- 17.3 Convector Heaters or infrared panels shall comply with IEC 60335-2-30 or IEC 60335-2-43, be suitable for fixed wall or ceiling mounting, and incorporate over-temperature protection, thermostat control, and appropriate safety isolation. Mounting clearances shall be in accordance with the manufacturer's installation requirements.
- 17.4 Fan Heaters shall be wall mounted, equipped with directional airflow adjustment, and incorporate a protected fan motor. A control unit with thermostat and isolating switch shall be provided, allowing heater and/or fan-only operation.

18.0 ROOM THERMOSTATS

- 18.1 Room thermostats shall be electronic, digital-display types and shall comply with SANS/IEC 60730-2-9.
- 18.2 Thermostats shall include programmable setpoints for daily scheduling (7-day programmability) to support energy-saving modes (e.g., setback/setup during unoccupied hours).
- 18.3 A manual override facility shall be provided. Where no Building Management System (BMS) is present, this shall be a local switch. Where a BMS is installed, override shall be possible both locally and via the BMS interface.
- 18.4 Thermostats shall be mounted approximately 1.4 m above finished floor level on internal walls, away from direct sunlight, draughts, and heat sources.
- 18.5 Where specified, thermostats shall feature communication capability (e.g., BACnet MS/TP, Modbus) for integration with the central BMS.



19.0 LIGHT SWITCHES AND CONTROLS

- 19.1 Light switches shall comply with SANS 1663 and shall be of the rocker type. For areas requiring lighting control (e.g., offices, meeting rooms), dimmer switches or electronic switches with pre-set scenes shall be provided as specified.
- 19.2 Switches shall be mounted at a uniform height of 1200 mm above the finished floor level to align with accessibility guidelines, and where practicable, 150 mm from the door frame on the handle side to allow for standard architrave widths.
- 19.3 All switches controlling lighting in corridors, stairwells, and large open areas shall be key-operated or installed within a lockable enclosure to prevent unauthorized switching.
- 19.4 Where integration with a Building Management System (BMS) is required, programmable or network-based lighting control switches (e.g., DALI, KNX) shall be provided as specified.
- 19.5 The finish and colour of all switches and plates shall be coordinated throughout the installation and as specified in the schedule of finishes.

20.0 LIGHT SENSITIVE CONTROL UNITS

- 20.1 Light sensitive control units (photocells) shall be fully electronic and designed for the automatic control of luminaires based on ambient light levels.
- 20.2 The unit shall be housed in a corrosion-resistant enclosure with a minimum ingress protection rating of IP65. Photocells shall be suitable for continuous operation in the ambient temperature range of -25°C to +55°C.
- 20.3 The light sensor in the photocell shall have a spectral response closely matched to the human eye (photopic response). The turn-on (dusk) light level shall be field-adjustable within a range of 2 to 100 lux. The turn-off (dawn) level shall be factory-set approximately 1.5 to 2 times the turn-on level to prevent cycling near the threshold. The unit shall incorporate an adjustable time delay (0.5 to 15 minutes) to prevent nuisance switching caused by transient light sources such as vehicle headlights or lightning.
- 20.4 The main switching contacts of the photocell shall be rated for a minimum resistive load of 16 A at 230V AC. The unit shall be capable of withstanding in-rush currents from LED drivers, electronic ballasts, and capacitive loads equivalent to at least ten times the rated current for 100 microseconds. The photocell shall have a built-in metal oxide varistor (MOV) for surge protection, rated to withstand a minimum of 2.5 kV per ANSI/IEEE C62.41 or equivalent SANS standard.
- 20.5 The photocell unit shall be provided with an integral manual ON/AUTO/OFF switch or an equivalent function to allow for testing and manual override. For installations requiring centralised control, photocells with a digital interface (e.g., DALI, 0-10V) for integration into a Building Management System (BMS) or lighting control network shall be provided, as specified in the project schedules.



- 20.6 Photocells shall be mounted in a location that ensures an unobstructed view of the natural ambient sky conditions and is not influenced by the light output of the controlled luminaires. They shall be compatible for use with LED, fluorescent, and HID luminaires without causing interference or malfunction.

21.0 SOCKET OUTLETS AND APPLIANCE POWER POINTS

- 21.1 All 230V socket outlets for general purpose use shall comply with SANS 164-2 (the "ZA Plug" system). The use of a standalone SANS 164-1 outlet is only permitted for direct like-for-like replacement in an existing installation or where explicitly required for compatibility with existing equipment and approved by the *Engineer*.
- 21.2 The legacy SANS 164-1 system is not permitted for new installations as a sole outlet. A SANS 164-1 socket may only be installed directly adjacent to a SANS 164-2 socket on a combined outlet plate to ensure backward compatibility.
- 21.3 Socket outlets in offices, workshops, and general areas shall be mounted at a uniform height of 300mm above finished floor level, unless otherwise specified for specific applications (e.g., 1500mm in industrial areas, power skirting, etc).
- 21.4 Where specified on the project drawings, socket outlets shall be installed within power skirting systems. The standard configuration for these outlets shall be a 4x2, 4-module, 2-gang assembly, comprising a single plate that integrates one single-pole, one-way switch, one SANS 164-1 socket outlet, and one SANS 164-2 ("ZA Plug") socket outlet.
- 21.5 Socket Outlets rated at 32V, 5A, provided for lead lights shall be the industrial two-pin, weatherproof type (minimum IP54) with a screw cover attached by a short chain. They shall be mounted 1500mm above floor level or in recesses in inspection pits.
- 21.6 Welding socket outlets shall comply with IEC 60309-1, be rated for 63A (or as specified on drawings), and be of the 5-pin, 6h configuration. Matching plugs shall be supplied. The circuit shall be protected by a 30mA Earth Leakage Device.
- 21.7 Power points for fixed appliances (e.g., air conditioners, extractor fans, machinery) shall terminate in a 100mm x 100mm conduit box mounted adjacent to the unit. A local, lockable isolating switch shall be provided for all fixed appliances, mounted within easy reach and sight of the appliance (typically 1500mm AFFL).
- 21.8 A 2 or 4-pole isolating switch shall be provided for water heaters, installed adjacent to the cylinder or tank. A 2 or 3-pole isolating switch shall be provided for Cooking Appliances mounted at 1500mm AFFL, with the outlet at 500mm AFFL. Connection to tubular heaters or hand driers shall be via a cord grip isolator installed adjacent to the heater. Fans power points shall include a separate box for the control unit. Power points for smoke/CO₂ detection shall include a 30A, 2-pole isolating switch, lockable in the "ON" position.

**22.0 TRANSFORMERS 230V/32V**

- 22.1 Transformers for 32V socket outlets shall be safety isolating transformers complying with the latest edition of SANS IEC 61558-2-6 and shall be designed for a primary power supply of 230V and have a no-load output voltage not exceeding 33V.
- 22.2 The transformer shall be of the double-wound, enclosed type, providing full electrical separation between the primary and secondary circuits.
- 22.3 The transformer shall be rated for continuous duty and shall be suitable for the total connected load of the 32V socket-outlet circuit, with a minimum rating of 150 VA.
- 22.4 The transformer shall be mounted in a well-ventilated, accessible location, preferably within the distribution board feeding the 32V circuit or in a dedicated enclosure.
- 22.5 The secondary (32V) winding shall be solidly earthed at one point, and the 32V socket-outlet circuits shall be protected by a suitably rated overcurrent device on the primary side.

23.0 ISOLATING AND SAFETY ISOLATING TRANSFORMERS

- 23.1 Isolating and safety isolating transformers shall comply with the latest editions of SANS IEC 61558-1, SANS IEC 61558-2-4 (for isolating transformers), and SANS IEC 61558-2-6 (for safety isolating transformers).
- 23.2 The specific type and rating of the transformer shall be as specified on the project drawings for the intended application.
- 23.3 Safety isolating transformers shall provide a Safety Extra-Low Voltage (SELV) or Protective Extra-Low Voltage (PELV) output, with a no-load output voltage not exceeding 50V AC for single-phase transformers.
- 23.4 All transformers shall be of the double-wound, enclosed type, providing full electrical separation between the primary and secondary circuits.
- 23.5 Transformers shall be rated for continuous duty and installed in a well-ventilated, accessible location.
- 23.6 The secondary circuit of an isolating transformer shall not be earthed. The secondary circuit of a safety isolating transformer configured as a PELV system shall be earthed. The chosen configuration must be clearly documented.
- 23.7 Transformers shall be provided with appropriately rated overcurrent protection on both the primary and secondary sides.



24.0 CONDUIT AND ASSOCIATED FITTINGS

- 24.1 All conduit systems shall be installed in accordance with SANS 10142-1. The type of conduit (metallic or non-metallic) shall be as specified for the location and environment.
- 24.2 Metallic heavy-gauge steel conduit and fittings shall comply with SANS 1065. Cut ends and threads of galvanized conduit shall be protected by applying a high-zinc content paint or approved anti-corrosive compound. Non-Metallic PVC (uPVC) conduit and fittings shall comply with SANS 950. In coastal areas (within 50 km of the coast) or corrosive industrial atmospheres, only hot-dip galvanized steel conduit (to SANS 121) or uPVC conduit shall be used. For exposed outdoor runs, UV-stabilized uPVC or hot-dip galvanized steel conduit shall be used.
- 24.3 Wall outlet boxes shall comply with SANS 1085. They shall be positioned with the major dimension vertical and not more than 6 mm behind the finished wall surface for plaster, or flush for drywall. Cover plates shall fit plumb and flush with the wall surface.
- 24.4 Conduits shall be cast into concrete or built into masonry or plastered brick walls as the construction proceeds. Where concealment is not possible, conduits shall be installed neatly on the surface as approved by the *Engineer*, using appropriate saddles and fixings. Chasing of finished walls, concrete work, or face brick walls is not permitted. Conduits shall not be chased into structural members.
- 24.5 Where specified, steel wireway/trunking or PVC skirting/trunking systems may be used as an alternative to traditional conduit for surface wiring, provided they comply with the relevant SANS standards and are approved by the *Engineer*.

26.0 CABLES AND GLANDS

- 26.1 Polyvinyl chloride (PVC) insulated cables shall comply with SANS 1574.
- 26.2 Armoured cables shall be of the steel wire armoured (SWA) type with a separate copper earth continuity conductor (ECC) sized in accordance with SANS 10142-1.
- 26.3 All cables shall be rated for a minimum operating temperature of 70°C and shall have a voltage rating of 600/1000V.
- 26.4 The current-carrying capacity and voltage drop of all cables shall be sized in accordance with SANS 10142-1 for the specific installation method and ambient conditions.
- 26.5 Cable colours shall comply with the latest requirements of SANS 10142-1.
- 26.6 Cable glands shall be of the compression type, constructed from non-corrosive material (brass, bronze, or stainless steel 316), and be suitable for the specific type of cable (e.g., SWA, PVC).

- 26.7 Glands for armoured cables must provide secure mechanical grip on the armour and ensure effective electrical continuity by suitable contact with the armour wires and the incorporation of an earth tag for the connection of the ECC.
- 26.8 All glands shall be supplied with an integral neoprene shroud to provide insulation and strain relief at the cable entry point.
- 26.9 The ingress protection (IP) rating of the gland assembly shall be maintained after installation. Glands for outdoor or hazardous areas shall maintain the enclosure's specified IP rating.
- 26.10 Glands shall be certified by the manufacturer as suitable for the specific cable type and size.
- 26.11 For installations in highly corrosive environments as defined in Section 3.0 (e.g., coastal areas, salt-laden or industrial atmospheres), cable glands shall be of a dedicated corrosion-resistant type. These glands shall feature a multi-component sealing system incorporating an internal nylon barrier and external O-rings to prevent the ingress of moisture and corrosive agents along the cable and thread interface. The gland's design must ensure all internal metallic components are fully encapsulated and isolated from the external environment.

27.0 BUSBAR TRUNKING

- 27.1 Busbar trunking systems shall be designed, tested, and certified to comply with the latest edition of SANS IEC 61439-6 for busbar trunking systems.
- 27.2 The system shall be rated for a minimum of 415V, 50Hz and shall have a rated short-time withstand current (I_{cw}) and rated conditional short-circuit current (I_{cc}) not less than the prospective fault level at the point of installation.
- 27.3 For riser and main distribution (Feeder Trunking), shall be of the fully insulated, compact design.
- 27.4 For supplying machinery and equipment in workshops and industrial areas (Plug-in Trunking), shall allow for tap-off points at standard intervals (e.g., 1m or as specified) without de-energizing the system.
- 27.5 Trunking enclosures shall be constructed from high-quality, pre-galvanized sheet steel or aluminium with a minimum protection of IP54 for general industrial use. Higher IP ratings (IP65/66) shall be provided for harsh environments. Busbars shall be made of high-conductivity copper, fully insulated, and configured as 4-wire (3Ph + N) or 5-wire (3Ph + N + PE) as required by the system design. A dedicated, full-size protective earth (PE) conductor shall run the entire length of the trunking.
- 27.6 The trunking shall be supported at intervals not exceeding the manufacturer's recommendations to prevent sagging. A minimum of 20% spare capacity in terms of plug-in positions shall be allowed for future extensions. Tap-off units shall be equipped with their own local circuit protection (e.g., MCB, MCCB, Fuse).



- 27.7 The *Contractor* shall submit manufacturer's technical data sheets, type test certificates, and detailed installation drawings, including support details.

28.0 CABLE SUPPORT SYSTEMS (CABLE TRAYS AND LADDERS)

- 28.1 Cable trays and cable ladders shall be manufactured and installed to provide a secure, continuous, and adequately supported pathway for cables. The design and loading shall comply with the latest edition of SANS IEC 61537.
- 28.2 Cable trays for indoor use shall be constructed from hot dipped galvanized steel, aluminium, or Grade 3CR12 stainless steel; provided that where Grade 3CR12 is used, it shall be finished with a certified powder coating system complying with SANS 1274 to enhance its corrosion resistance. For outdoor or corrosive environments, cable trays shall be hot-dip galvanized to SANS 121 or manufactured from a corrosion-resistant material, which includes Stainless Steel Grade 304 for general corrosive atmospheres, Stainless Steel Grade 316 for severe coastal and industrial atmospheres, or UV-stabilized, glass-reinforced polyester. The use of Grade 3CR12 stainless steel is not permitted for outdoor applications.
- 28.3 The finish shall be suitable for the environment as defined in Section 3.0 (Service Conditions) without premature degradation.
- 28.4 Cable trays shall be of the ventilated trough type. Cable ladders shall be used for heavy power cables or spans exceeding 3 meters. The system shall be adequately supported at intervals not exceeding the manufacturer's specifications for the designed load. When fully loaded, the maximum deflection at mid-span shall not exceed 1/200 of the span length, with an absolute maximum of 10mm. The installed system shall maintain a minimum clearance of 150mm from other services (e.g., pipes, ducts) unless otherwise approved. Cables shall be arranged in a single layer where possible. Where multiple layers are unavoidable, the current-carrying capacity of the cables shall be derated in accordance with SANS 10142-1.
- 28.5 The fill ratio shall not exceed 50% of the tray's usable cross-sectional area to allow for heat dissipation and future additions. Power cables and control/communication cables shall be segregated on separate trays or by a solid, non-combustible barrier within a common tray, in accordance with SANS 10142-1.
- 28.6 The entire cable support system shall be electrically continuous and effectively bonded to the electrical earth at multiple points along its run, as per the requirements of SANS 10142-1.

29.0 EARTHING AND BONDING

- 29.1 The complete electrical installation, including all metallic services, shall be earthed and bonded to form an equipotential zone in accordance with SANS 10142-1.
- 29.2 Earth electrodes shall be copper-bonded steel rods, consisting of a high-strength steel core with



a minimum 0.25 mm thick molecularly bonded copper outer layer. The main earth electrode system shall consist of a minimum of two rods, driven to a minimum depth of 2.4 meters and spaced at least equal to the driven depth apart, interconnected with a bare copper conductor. Where soil conditions lead to high resistivity, approved, non-corrosive, hygroscopic backfill compounds shall be used to achieve the required resistance.

- 29.3 The earth resistance of the electrode system, measured with a calibrated earth resistance tester, shall not exceed 5 ohms. If the 5-ohm value cannot be achieved with additional rods, the design shall be submitted to the *Engineer* for approval of an alternative solution, which may include a concrete-encased electrode or a ring earth.
- 29.4 Main protective bonding conductors connecting metallic services (water, gas, other pipes) and structural steel to the main earth terminal shall have a minimum cross-sectional area of 10 mm² copper. Copper tape used for the bonding of waste pipes and other extraneous conductive parts shall have a minimum cross-sectional area of 12 mm². All earthing and bonding conductors shall be securely fixed and protected against mechanical damage. When run along walls, they shall be fixed with non-ferrous screws in plastic plugs at maximum intervals of 300 mm. The electrical installation's earth termination system shall be bonded to the building's lightning protection system (LPS) in accordance with SANS 10313.

30.0 FINISHES AND CORROSION PROTECTION

- 30.1 All electrical equipment, enclosures, cable support systems, and exposed metallic components shall be provided with a finish suitable for their environment as defined in Section 3.0, ensuring long-term protection against corrosion, UV radiation, and physical damage.
- 30.2 All surfaces shall be cleaned and prepared in accordance with SANS 10064, achieving a minimum standard of Sa 2.5 for abrasive blast cleaning or equivalent for mechanical or chemical preparation, suitable for the specified coating system.
- 30.3 Components designated for powder coating shall be prepared and coated in accordance with SANS 10064 and SANS 1274. The powder coating system shall consist of a single coat with a minimum nominal dry film thickness of 80 µm, or an approved primer plus topcoat system.
- 30.3.3 The finished coating shall be smooth, uniform, and free from defects such as orange peel, runs, or pinholing.
- 30.4 Where a wet paint system is used or for site-applied touch-ups, it shall be a high-quality, manufacturer-approved system. The system typically shall consist of a zinc-rich primer and a suitable chemical-resistant polyurethane topcoat, applied to achieve a total minimum dry film thickness of 120 µm.
- 30.5 All distribution boards and major electrical enclosures shall be finished in Light Orange to SANS 1091 colour No. B26, unless otherwise specified in the project schedules. Other equipment shall generally be finished in the manufacturer's standard colour. Colour coding for specific services (e.g., emergency systems) shall be as specified on the drawings.



- 30.6 Coatings shall not be applied under adverse environmental conditions such as rain, high humidity (>85%), or on surfaces where the temperature is less than 3°C above the dew point. 30.6.2 The finished product shall have a uniform colour and gloss, with no visible runs, sags, misses, or abrasions. Adhesion shall be tested in accordance with the manufacturer's instructions. Any damaged areas shall be repaired to the original specification, with proper surface preparation and feathering of edges, to match the existing finish.

31.0 TESTING, COMMISSIONING, AND CERTIFICATION

- 31.1 The *Contractor* shall be responsible for testing all electrical installations and equipment upon completion and before being put into service. All tests shall be carried out in accordance with the latest edition of SANS 10142-1 and the specific requirements of this specification, in the presence of the *Engineer* or their authorised representative.
- 31.2 The *Contractor* shall provide all necessary testing instruments, which shall be calibrated with a valid certificate of calibration from an accredited laboratory. Transnet National Ports Authority reserves the right to witness any test and to use its own calibrated instruments to verify results.
- 31.3 The following tests, as a minimum, shall be performed and recorded:
- Continuity of Protective Conductors: Verify the continuity of all earthing conductors and equipotential bonding.
 - Earth Electrode Resistance: Measure the resistance of the earth electrode system. The value shall not exceed 5 ohms.
 - Insulation Resistance: Test between all live conductors (line-line) and between live conductors and earth. The insulation resistance value shall be not less than 1 MΩ for the entire installation, with distribution boards and final circuits achieving a minimum of 1 MΩ as per SANS 10142-1.
 - Polarity: Verify the correct polarity of all single-pole devices, socket outlets, and lampholders.
 - Earth Fault Loop Impedance: Measure the earth fault loop impedance at every distribution board and at a representative number of final circuits to verify the correct operation of protective devices.
 - Functionality of Protective Devices: Verify the correct and coordinated operation of all circuit breakers, RCDs/RCBOs (including trip time testing at 1x IΔn and 5x IΔn), and isolators.
 - Functional Tests: Perform full operational tests of all control circuits, contactors, lighting control systems, and other equipment to ensure they function as designed.
- 31.4 Upon successful completion of all tests, the *Contractor* shall provide a comprehensive test report containing all measured values and observations. An Electrical Certificate of Compliance (CoC) for the entire installation, issued by a registered person in accordance with the *Occupational Health and Safety Act, 1993 (Act 85 of 1993)* and SANS 10142-1, shall be provided before the installation is energised.

32.0 QUALITY ASSURANCE AND INSPECTION



- 32.1. The Contractor shall operate a comprehensive quality assurance system for the entire duration of the project to ensure all materials, equipment, and workmanship comply with this specification and the referenced standards. The Contractor shall provide all necessary resources, including qualified personnel and calibrated testing equipment, to implement this QA system effectively.
- 32.2. For major equipment, including but not limited to distribution boards, busbar trunking, and custom-built control panels, the Supplier shall conduct thorough inspection and testing at their workshop prior to delivery.
- 32.3. The *Contractor* shall notify Transnet National Ports Authority (TNPA) in writing at least 14 days prior to scheduled Factory Acceptance Tests (FAT). The Authority reserves the right to witness these tests. The *Contractor* shall provide certified test reports for all such equipment upon delivery.
- 32.4. The *Contractor* shall submit manufacturer's data sheets, test certificates, samples, and proof of SANS/IEC compliance for all major materials and equipment for approval prior to procurement and installation. All equipment and materials delivered to site shall be new, undamaged, and stored correctly to prevent deterioration.
- 32.5. All workmanship shall be of a high standard and carried out by qualified and competent personnel. Transnet National Ports Authority reserves the right to inspect all work at any stage of the installation. Any non-conforming product or workmanship shall be clearly identified and raised with the contractor. Non-conforming products shall not be installed or used until corrective action has been approved by the *Engineer*. The *Contractor* shall rectify any defective work or non-compliant materials promptly at their own cost.
- 32.6. Upon project completion, the *Contractor* shall submit a complete set of marked-up "as-built" drawings and equipment schedules reflecting the final installed configuration. These shall include all deviations from the issued-for-construction drawings and shall be prepared in both hard copy (A1 or A3) and electronic format (AutoCAD/Revit and PDF) as required by the *Engineer*.

SCOPE OF WORKS SUPPORTING ANNEXURES:

**Annexure J: Technical specification for earthing and the
protection of buildings and structures against
lightning**

SPECIFICATION FOR EARTHING AND THE PROTECTION OF BUILDINGS AND STRUCTURES AGAINST LIGHTNING.

REVISIONS		
REV	DATE	APPROVED
01	04-04-2017	S.Sewdayal

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1.0 SCOPE

- 1.1 This specification covers Transnet Capital Projects requirements with respect to the protection of buildings and structures against lightning and the requirements for air terminal systems, down conductors and earthing of installation of this specification
- 1.2 This specification applies to assessing, testing and upgrading of existing lightning protection systems and earthing on existing buildings and structures.

2.0 STANDARDS, SPECIFICATIONS AND DRAWINGS

- 2.1 The following publications (latest editions and amendments) are referred to herein.

South Africa Bureau of Standards (South African National Standards)

SANS 10313	-	The protection of structures against lightning.
SABS IEC 61643	-	Surge protective devices connected to low voltage power distribution systems.
SANS IEC 60950	-	Information technology equipment – safety.
SANS 10142	-	Code of practice for the wiring of premises
BS 6651	-	Code of practice for protection of structures against lightning.
BS 7430	-	Code of Practice for Earthing.
SABS 064	-	Code of Practice for the Preparation of Steel Surfaces for Coating.
SABS 086	-	Installation and Maintenance of Electrical Equipment used in Explosive Atmospheres.
SANS 10108	-	The Classification of Hazardous Locations and the Selection of Electrical Apparatus for use in such Locations.
SABS 0199	-	The design and Installation of Earth Electrodes
SABS 763	-	Hot Dip Zinc (galvanised) Coatings
SABS 1091	-	National Colour Standards for Paints.
SABS 1507	-	Electric Cables with Extruded Solid Dielectric Installation for Fixed Installations
SABS IEC 742	-	Isolating Transformers and Safety Isolating Transformers.

OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993 (ACT 85 OF 1993).

3.0 SERVICE CONDITIONS

3.1 The cable shall be designed and rated for continuous operation under the following conditions :-

3.1.1 Ambient/Environment Conditions :

- 3.1.1.1 Altitude : Sea level.
- 3.1.1.2 Ambient temperature : -5° C to +45° C (daily average +35° C).
- 3.1.1.3 Relative humidity : As high as 96%
- 3.1.1.4 Lightning conditions : Severe, with a maximum lightning ground flash density 11 flashes per km² per annum.
- 3.1.1.5 Exposure conditions : Salt laden, industrial atmosphere as well as hazardous gases and dust atmosphere.
- 3.1.1.6 Electrolytic corrosion conditions prevail in all the areas owing to the proximity of direct current traction system and cathodic protection schemes.

4.0 EQUIPMENT AND MATERIALS

- 4.1 Equipment and materials to be used, shall be of high quality, and shall comply with all relevant specifications, codes as mentioned in this specification as well as the Occupational Health and Safety Act of 1993(Act 85 of 1993).
- 4.2 Where equipment and material does not comply with the relevant specifications it shall be submitted to Transnet Project's Engineer for approval.
- 4.3 All materials used for the lightning protection system shall withstand the electric and electromagnetic effects of lightning current and predictable stresses without being damaged.
- 4.4 Materials and sizes shall be chosen bearing in mind the possibility of corrosion of either the lightning protection system or the structure to be protected.
- 4.5 Components of the lightning protection system may be manufactured from the materials listed in Table 8 of SANS 10313, provided they have sufficient electrical conductivity and corrosion resistance.

5.0 LIGHTNING PROTECTION REQUIREMENTS

- 5.1 The contractor shall carry out the installation in accordance with SANS 10313: Code of Practice for the protection of structures against lightning and the requirements of this specification.
- 5.2 Where the local supply authority requirements differ from those specified herein Transnet Group Capital's Electrical Engineer shall be approached for a decision.
- 5.3 All equipment and material shall comply with the relevant National or International standard specification. Where equipment does not comply it shall be submitted to the Transnet Group Capital Electrical Engineer for approval.

- 5.4 The system of protection will be finials/air terminals, down conductors and earth spike or roof conductors, down conductors and earth spike.
- 5.5 The earth resistance for separate earth electrodes if down conductors are not connected to a ring earth shall be not exceed the following;

Rt = 10 Ohm for category A structures
Rt = 15 Ohm for category B and C structures.

6.0 DESIGN OF LIGHTNING PROTECTION

The designer of lightning protection shall take into consideration the following principles and requirements during the design of the system.

6.1 GENERAL PRINCIPLES

- 6.1.1 Basic Principles of Lightning Protection:** the requirements of the basic principles of lightning protection as detailed in SABS 0313 shall be taken into consideration to ensure proper protection of structures against lightning.
- 6.1.2 Evaluation of Risk:** The risk of lightning stroke shall be evaluated as described in SANS 10313.
- 6.1.3 Effective height of a structure (He):** The effective height of the highest point shall be determined by considering the average height of building, trees and structures and land profile of the surrounding area.
- 6.1.4 Ground flash density (Ng):** The ground flash density (Ng) for general buildings, structures and installations shall be estimated from the average ground flash density given in table 1 of SANS 10313 as a general guide. For important structures and installations the value of the ground flash density shall be determined on the basis of at least 5 lightning years, or from existing records
- 6.1.5 Number of flashes to structure per 100 year (Nt):** The number of flashes to structures per 100 year shall be determined taking into consideration type and the height of the structure as described in SANS 10313.

6.2 HAZARD CATEGORY

- 6.2.1 Buildings and structures where lightning protection system will be installed shall be categorised prior to the installation. Hazard categories are based on the nature of the building, its content and occupancy.
- 6.2.2 The Hazard categories are classified as follows in SABS 03 -1985 Code of practice for the protection of buildings structures against lightning.

Category A: High Hazard

Category A1: Structures and areas containing explosives of Category Z.

Category A2: Structures and areas classified as

- Division 0 areas in accordance with SABS089: Part II, or
- Class I, Division 0 locations in accordance with SABS 0108.

Category A3: Strategic control and communications installations such as airport towers

Category A4: Thatched-roof structures of historic values or that contain irreplaceable works of art or like values.

Category B: Medium Hazard

Category B1: Structures and areas containing explosives of Category X or Y.

Category B2: Structures and areas classified as

- a) Division 1 or 2 areas in accordance with SABS089, Part II, or
- b) Class I, Division 1 or 2 locations, or Class II, Division 1 location in accordance with SABS 0108.

Category B3: All structures not included in Category A and to which the public normally has access or which are of historic value.

Category B4: Large temporary structures used for exhibitions and entertainment.

Category B5: Thatched roof dwelling houses.

Category B6: Communications towers, water towers and reservoirs.

Category B7: Caravans and Yachts.

Category B8: Buildings and areas used for livestock, fuel or flammable material.

Category C: Low Hazard

Category C1: Small buildings that are infrequently occupied.

Category C2: Dwelling houses other than thatched-roof houses.

Category C3: Farm buildings, other than those included in category B8.

6.3 ZONES PROTECTION AND SHIELDING ANGLES

6.3.1 The zone of protection shall be the area covered by either one of the following types of protection:

- a) Single Vertical air terminal
- b) Single horizontal air terminals
- c) Area between two or more air terminals
- d) Area between roof conductors.

6.3.2 The shielding angles β and β_s are given in table 3 of SABS03-1985, Code of practice for the protection of buildings and structures against lightning.

6.3.3 The zone protection for Shielding Angles on Steep Slopes and High Ridges is not considered effective beyond a horizontal distance from the nearest air terminal of greater than $2H_e$, where H_e is the effective height of the part of the air terminal above its immediate surroundings.

6.3.4 In roof areas away from the edges of tall structures (generally of $H_e > 50\text{m}$), shielding angles given in table 3, SABS 0313 can be used appropriate to hazard category of the roof area so protected and the effective height H_e of the air terminal above the roof area.

6.4 SELECTION OF AIR TERMINAL

6.4.1 Mast Protection: An air terminal consisting of one or more masts that cover the structure or area to be protected with the appropriate shielding angle will, with the possible exception of a few weak lightning strokes, successfully intercept lightning strokes.

6.4.2 Air Terminals as Part of the Structure: An air terminal as part of the structure may be one or more of the following:

- a) A continuous metal roof.
- b) A metal roof structure supporting a metal roof
- c) The metal reinforcement in the roof of a reinforced concrete structure with peripheral conductors and finials where necessary.
- d) Roof conductors and finials, where necessary, on a non-conducting roof.
- e) Finials in chimney, gable ends, parapet walls, etc.

6.4.3 Air Terminal Systems For Category A Hazards: The protection is based on the principle that a primary air terminal system must be provided for the interception of major lightning strokes with, if necessary a secondary air terminal system for the interception of those weak lightning strokes that might penetrate the protection of the primary air terminal system. The secondary air terminal system shall not be intended to carry currents of major lightning strokes.

One of the following lightning protection systems shall be used as detailed in SANS 10313.

- Mast protection used as a primary air terminal
- Metal roof used as primary air terminal system
- Reinforced concrete structure used as primary air terminal system.

6.5 MASTS AND CATENARY CONDUCTORS OVER THE STRUCTURE TO BE PROTECTED

6.5.1 GENERAL

6.5.1.1 A lightning protection system consisting of free standing masts separate from the structure provides the highest degree of protection, subject to the correct positioning of the mast and to the correct choice of shielding angle.

6.5.1.2 The number and height of masts (and, where necessary, the provision of the catenary conductors between the masts) shall be based on cost, aesthetics, shielding angles and mechanical consideration

6.5.2 CLEARANCE FROM STRUCTURES

6.5.2.1 A safe clearance distance shall be kept between the mast and the catenary conductor strung between the masts and the structure to be protected by the mast or the catenary conductor. The clearance distance depends to various factors detailed in SANS 10313.

6.5.2.2 Where a common earth electrode is provided for mast and structures in close proximity, the following clearance distance "d" shall be maintained with a minimum of 100 m.

- a) Between the mast and any point of structure: $d \geq 0,06.h \text{ m}$.

- b) Between the catenary conductor and any part of the upper surface of the structure: $d \geq 0,1 \cdot (L/2)$ m for Category A hazard, and $d \geq 0,06 \cdot (L/2)$ m for Category B and C hazards.
- c) Between a network of conductors and any part of the upper surface of the structure:
 $d \geq 0,1 \cdot (D + (L - D)/N)$ m for Category A hazard, and
 $d \geq 0,06 \cdot (D + (L - D) / n)$ m for Category B and C hazards.

Where $L =$ length of path measured from the base of one mast along the catenary conductor to the base of the other mast between which the catenary conductor is suspended, m.
 $D =$ spacing between the mesh of the network measured along the catenary conductor, m
 $h =$ height of structure, m
 $n =$ number of cross bonds between two catenary conductors.

6.5.2.3 Where the earth electrode of a mast is separate from the metal water main, other services or the earth electrode of a structure, the following clearance distance “d” shall be maintained with a minimum of 1.00 m:

- a) Between the mast and any point of the structure: $d \geq 0,06 \cdot h + 0,1 \cdot R_s$ m.
- b) Between a horizontal catenary conductor and any part of the roof of the structure:
 $d \geq 0,06 \cdot (L/2) + 0,1 \cdot R_s$ m.

Where $R_s =$ numerical value of the earth electrode resistance of the mast or, where masts are connected together by a catenary conductor, of the mast thus connected together, measured in ohms.

6.5.2.4 The minimum clearance distance “d” where the structure has no earth electrode and has limited water or electricity supply, shall be maintained within the following minimum clearance distances:

- a) $d \geq 1,00$ m between the mast or catenary conductor and any part of the structure.
- b) $D \geq 0,1 R_s$ m between the mast and any water pipe or electric cable, whether buried or above ground unless the mast electrode is bonded to the metal pipe of the underground water main. If R_s is not known, the clearance distance D must be at least 3m.

6.5.3 MAST PROTECTION IN THATCHED ROOFS

6.5.3.1 Thatched roofs shall be protected by one or more free-standing masts only. The zone of protection of the masts must include gable ends, chimneys, antennas, vent pipes and any other metal objects.

6.5.3.2 Telephone wires, overhead services connections to the electricity supply, or other overhead metal wires or pipes, shall not enter the structure through or close to the thatch.

6.5.3.3 On remote chimneys or gable ends close to imaginary surface of the protection zone, install a finial and down conductor well away from the thatch.

6.5.3.4 Metal wires and metal-coated insulating sheets used in the construction of the thatched roof shall be bonded together and to the earthed metal water main or electrode of the structure.

6.5.3.4 Where metals used in the construction of the roof are not bonded and earthed, a minimum clearance distance c of 1m between metals of the roof and water pipes, vent pipes, tanks, gas pipes, antennas, telephone and bell wires, bugler alarms and electrical wiring and conduits shall be maintained.

7.0 INSTALLATION

7.1 AIR TERMINALS ON THE STRUCTURE TO BE PROTECTED.

- 7.1.1 The purpose of an air terminal on a structure to be protected shall be to intercept lightning strokes at preferential points of an air terminal, thereby:
- a) Minimizing penetration of a lightning discharge current which could have followed a random path in the roof structure with possibility of a resultant fire.
 - b) Preventing the loosening of masonry or the cracking of precast panels or reinforced concrete.
- 7.1.2 The selection of the air terminal system and the position of down conductors shall be so selected such that at any likely point of incidence of lightning stroke, there are at least two parallel paths for the current to flow to earth.
- 7.1.3 Parallel routes shall not be necessary in the following cases.
- a) An air terminal on a small structure having only one prominent point of incident.
 - b) Dead-ended conductors, i.e those conductors of the air terminal for which it is not feasible to provide a connection to a down conductor.
- 7.1.4 Where a peripheral roof conductor is required for the protection of the outer side edge of a structure, the conductor shall be installed as close to the edge as is practicable (preferable not more than 100mm from the outer edge)
- 7.1.5 Where buttresses or parapet walls are not already equipped with an air terminal in the form of continuous metal cladding or similar metalwork and peripheral conductors are to be provided at an effective height H_e of 15 m or more, finials shall be added on all exposed outer corners and at intervals not exceeding 30 m between outer corners. The finials shall be placed as close as possible to the outer edge, and so position the down conductors such that their connection to the peripheral conductor is close to the finial.
- 7.1.6 Concrete masonry chimneys or gables ends that are not protected with the appropriate shielding angle of another structure shall be protected by means of a finial or metal cap. Where the chimney or gable end is of masonry, a peripheral conductor along the gable or around the chimney shall be used instead.
- 7.1.7 Where it is not feasible to provide a down conductor at one end of an air terminal or a connection to another part of the lightning protection system, a dead ended conductor shall be used provided it is not longer than 10 m and generally flows a horizontal or downward course from the free end to end connected to the remaining part of the lightning protection system.
- 7.1.8 Where a dead-ended conductor partly flows an upwards course, the dead-ended conductor shall be not longer than 7.5 m. If the top of the protected part is considerably lower than the ridge conductor to which the dead-ended conductor is connected, a finial shall not be used at the free end, unless it is required for the enhancement of the protection of the surrounding area, in which case an additional down conductor at the free end is recommended.
- 7.1.9 Metal gutters shall be bonded along the outside perimeter of the roof to the nearest down conductor, or to the metal of the roof, where applicable.

7.2 METAL ROOFS AND NON-METAL ROOFS SUPPORTED BY METAL ROOF STRUCTURES

- 7.2.1 Structures having roofs covered with electrically continuous metal sheets do not require air terminals, but shall be earthed by down conductors.
- 7.2.2 Sheet metal separated from each other by insulating strips or by epoxy or plastic coating s, may be regarded as providing continuous metal roof. However where sparking between such roofing is considered undesirable because of magnetic interference, all sheets adjacent to the ridge conductor or peripheral conductor shall be bonded.
- 7.2.3 A non-metal roof consisting of non-combustible roofing material held by metal fasteners to a roof supporting structure of metal construction may be considered to be a metal if the metal structure is earthed by down conductors, or supported by earthed metal columns, and spacing between roof beams does not exceed 15m for Category B and C hazards.

7.3 REINFORCED CONCRETE STRUCTURES

- 7.3.1 Reinforced steel shall not be used as parallel paths to enable lightning discharge current to flow safely to general mass of the earth.
- 7.3.2 Air terminals or finials and where necessary peripheral conductors shall be installed, taking into consideration the likely points of incidence of lightning and the path of the current through internal down conductors.
- 7.3.3 Where the outer support columns of the structure may be regarded as continuous from roof to basement, the peripheral and air terminal conductors shall be bonded to the internal or external down conductors.
- 7.3.4 Peripheral conductors and finials shall be used for medium height structures with reinforced concrete. Where the peripheral conductor is on a parapet wall that surrounds a metal roof or the air terminals of other structures, the other air terminal shall be connected to the peripheral conductor, preferably close to a down conductor. The peripheral conductor and other air terminal shall be connected to internal or external down conductor.
- 7.3.5 If the upper edge of the structure with chimneys and cooling towers and of medium height is not metal clad, horizontal conductors around the upper circumference of the structure, equipped with finials at intervals of not more than 15 m, with a minimum of two shall be installed.
- 7.3.6 On tall reinforced concrete structures, one of the following shall be installed in order to increase the protective efficiency, depending on the risk and the degree of protection required, height and slenderness of the structure:
 - a) At intervals of not more than 10 m, install oblique finials along the upper perimeter, pointing upwards and outwards such that the tip of each finial points outwards at an angle of 30° to the vertical through the outer edge of the structure, and is at least 400mm above the structure, each finial being connected to a peripheral conductor.
 - b) A horizontal conductor that follows the contour of the structure and that is so raised on oblique struts of length at least 500 mm that the conductor is displaced outwards at an angle of 30° to the vertical through the outer edge of the structure.
 - c) Oblique finials spaced as in (a) above, positioned on a horizontal conductor arranged as in (b)

above and in line with the oblique struts, each finial pointing upwards and outwards at an angle of 30 to the vertical through the outer edge of the structure, and of length such that the tip of the finial is at least 800 mm above the outer edge of the structure.

Where the structure is slender, an air terminal as in (b) or (c) above is to be preferred to that in (a)

The air terminal shall be bonded to the internal down conductor at intervals not exceeding 10 m, or where the circumference exceeds 60 m, at appropriate intervals not exceeding 30m with a minimum of six bonds.

7.4 FINIALS AND ROOF CONDUCTORS

- 7.4.1 Roof conductors and finials shall be installed along the ridges of the roof and on other projections, in accordance to SANS10313 – code of practice for the protection of structures against lightning.
- 7.4.2 Protruding metal objects shall be bonded in a horizontal or in a downwards direction to the nearest roof or down conductor where the distance between the metal object and the conductor is less than 7.5m otherwise provide a separate down conductor. In all cases where the pitch of the roof is less than 30°, metal gutters and roof conductors shall be bonded or eaves conductors shall be provided.
- 7.4.3 In the case of large roofs of non-conducting material, additional conductors shall be installed across the surface of the roof, perpendicular to the long side of the roof and at extremely equal spaces not exceeding 15m. If the width of the roof exceeds 15m install conductors to form a grid at approximately equal spacing not exceeding 15m in either direction.
- 7.4.4 Roof conductors, finials and roof conductor grids shall be connected to the closest down conductor.
- 7.5.5 All roof conductors shall be manufactured from SABS approved single-core bare aluminium conductor with a minimum cross sectional area of 25mm².

7.5 DOWN CONDUCTORS

- 7.5.1 Down conductors shall be installed close to the point of the air terminal that are most likely to be struck by lightning and preferably run them vertically along the most direct route to the earth electrode.
- 7.5.2 At least two down conductors shall be provided in a building, such that in plan view no point of a structure is more than 15m from the nearest down conductor, except for masts and small structures having only one prominent point of incident, such as rondavels, these need only one down conductor.
- 7.5.3 Each down conductor shall be supplied with a separate earth electrode. This will reduce the current flow per down conductor, resulting in a lower voltage drop across the down conductor caused by the surge impedance of the conductor.
- 7.5.4 Down conductors shall not be placed close to doorways or entrances to buildings. Maintain a minimum clearance distance of the order of 1 m from the door and window frames, balustrades and other large metal objects.
- 7.5.5 Where down conductors deviate from a vertical route due to sharp bends and loops required to carry a conductor over eaves and parapet walls, shall be permitted, provided that all requirements stated in SANS 10313, clause 6.1.4 are met.
- 7.5.6 Steel columns and internal metal storm water drain-pipes shall be used as down conductors only if they

are joined by screwing, bolting or welding.

- 7.5.7 External metal stair cases, fire escapes or other large frames shall be used as down conductors if they are electrically continuous over their full height. If not electrically continuous they shall be bonded to the lightning protection system at the top or at the bottom of the framework.
- 7.5.8 In the case of structures of Hazard Category A, Test joints shall be installed in down conductors at convenient heights above finished ground level.
- 7.5.9 Internal reinforcing steel of vertical concrete column, particularly those on the outer corners can be used as down conductors, provided that the reinforcement is electrically continuous.
- 7.5.10 Vertically discontinuous reinforcement shall be bonded between the reinforcement of each section to provide a continuous path to ground or an external down conductor shall be installed.
- 7.5.11 Large external metal frames, balconies and metal cladding on the top floors of tail structures (typically 30 floors or more) that may be exposed to direct lightning strokes must be bonded to the reinforcement of the structure or to a down conductor that is connected to the reinforcement of the roof.

8.0 STATUTORY REQUIREMENTS

- 8.1 The Contractor shall ensure that the installation satisfies the requirements of all relevant South African Statutory Regulations
- 8.2 Where applicable, equipment items shall carry the SABS mark to demonstrate compliance with the regulations.

9.0 RESPONSIBILITY FOR WORK

- 9.1 The tenderer shall be responsible for the complete installation of the lightning protection system including testing, earthing conductors, surge protection devices, spikes etc. as required for various buildings and structures. These installations shall include the review and the upgrading of the existing lightning protection systems. Due considerations shall be taken of the effects of lightning covered herein below in clause 8, in providing the lightning protection system.
- 9.2 The tenderer shall undertake to repair all faults due to bad workmanship and/or the use of faulty materials and to replace all defective materials within six months after the installation date.
- 9.3 The tenderer shall rectify all the defects to the satisfaction of Transnet Group Capital, which may become apparent during the guarantee period.
- 9.4 The tenderer may be required to carry out builders work such as cutting of concrete columns and coring of holes for testing of the continuity of the existing steelwork or cabling. Good contact between reinforcing bars should be ensured.

9.0 APPLICABLE INFORMATION

- 10.1 **Electrical effect** – The current discharged through the earth electrode resistance produces a resistive volt drop which may raise the potential of the system to a high value relative to true earth.
- 10.2 **Side-flashing** – The point of strike may be raised to a high potential, and there is a risk of flashover from the protection system to any metal or in the structure.

10.3 **Thermal effect** – The thermal effect of a lightning discharge is confined to the temperature rise of the conductor through which the current passes.

10.4 **Mechanical effect** – When a high current is discharged along parallel conductors in close proximity or along a single conductor with sharp bends, a different mechanical effect is exerted by a lightning flash. This is due to a sudden rise of 30 000K in air temperature and the resulting explosive expansion of the adjacent air in the channel along which the charge is propagated.

11.0 PROTECTION AGAINST CORROSION

11.1 The tenderer shall ensure that atmospheric, chemical and or electrolytic corrosion of copper and other metals is prevented from occurring when used for the lightning protection system.

11.2 The contact surfaces of dissimilar metals shall be kept completely dry and protected against ingress of moisture to prevent the acceleration of electrolytic corrosion.

11.3 Although copper is highly resistant to many types of chemical attack, lead coating shall be recommended wherever subjected to severe corrosion due to presence of sulphur compounds.

11.4 Stainless steel material of similar grading shall not be used unless prior approval is obtained.

12.0 EARTHING CODES OF PRACTICE

This part of specification details standards and codes of practice to be adhered to in the supply, installation and termination of earthing systems on all Transnet Sites.

12.1 National Standards

12.1.1 The requirements of the materials, design, layout, fabrication, assembly, erection, examination, inspection and testing of an earthing system on site shall be in accordance with the relevant sections of codes: -

- SABS 089 Part 2 1965 Electrical Code for Petroleum Industry
- SABS 0121 1977 Cathodic Protection of Buried and Submerged Structures
- SABS 0123 1976 The Control of Undesirable Static Electricity
- SABS 0198 Part 12 1988 Installation of Earthing System
- SABS 0199 1985 The Design and Installation of and Earth Electrode
- SABS 0200 1985 Neutral Earthing in Medium Voltage Industrial Power Systems
- SABS 0292 1999 Earthing of Low Voltage (LV) distribution systems
- SANS 10313 Latest ammedment Protection of Structures against Lightning
- SABS 1063 1998 Earth Rods and Couplers

- SABS IEC 61000-5-2 1997 Electromagnetic Compatibility (EMC)
Part 5: Installation and mitigation guidelines
Section 2: Earthing and Cabling
- SABS IEC TS 61312-2 1999 Protection against Lightning Electromagnetic
Impulse (LEMP) Part 2: Shielding of structures, bonding
inside structures and earthing
- SABS IEC 61024-1 1990 Protection of Structures against Lightning
Part 1: General principles
- SABS IEC 61024-1-1 1993 Protection of Structures against Lightning
Part 1: General principles
Section 1: Guide A – Selection of protection levels for
lightning protection systems
- SABS IEC 61024-1-2 1998 Protection of Structures against Lightning
Part 1-2: General Principles
Guide B – Design, Installation, maintenance and inspection
of lightning protection systems
- SABS IEC 61312-1 1995 Protection against Lightning Electromagnetic
Impulse Part 1: General principles
- SABS IEC 61312-4 1998 Protection against Lightning Electromagnetic
Impulse Part 4: Protection of Equipment in existing
structures
- SABS IEC 61643-1 1998 Surge Protective Devices Connected to Low
Voltage Power Distribution Systems
Part 1: Performance requirements and testing methods
- SABS IEC TS 61312-2 1999 Protection against Lightning Electromagnetic
Impulse (LEMP) Part 2: Shielding of structures, bonding
inside structures and earthing

12.1.2 Statutory Requirements

- a) The Contractor shall ensure that the installation satisfies the requirements of all relevant South African Statutory Regulations
- b) Where applicable, equipment items shall carry the SABS mark to demonstrate compliance with the regulations.

12.2 Technical Requirements

12.2.1 General

- a) A common integrated station earthing system shall be provided for electronic and electrical systems equipment, static and lightning protection in accordance with the requirements of this document.
- b) A soil resistivity survey shall be carried out by a specialist earthing consultant/contractor. The consultant/contractor shall prepare a detailed report on the conditions identified and provide the survey data recordings together with proposals, for a basis of the earthing system design.
- c) Major electrical equipment such as switchgear, transformers, lighting boards, floodlight towers on poles, control panels etc. and associated metallic support frameworks, shall be connected to the station safety earth via Electrical Earth bars located nearby.

Use of embedded conductors within a power cable (spare core earth) may be utilised as the primary equipotential bonding system provided the following conditions are met: (SABS 086-1:2001)

- The embedded conductor has a cross-sectional area equal to those of the live and neutral conductors or equal to the values in Table 1 of SABS 0142)

In addition, a second visual earth connection shall be provided to each item of electrical equipment, to prevent the potential to earth of such equipment rising above spark potential. (SABS 089-2:2000)

- d) The neutrals of generators and transformers shall be connected to the main earth grid either directly or via an earthing resistor, as required. Where neutrals of transformers are connected directly to earth, this shall be done via means of connections to both an individual earth rod located nearby as well as to the station earth mat by means of Electrical Earth bar located within the Switchgear Room.
- e) Frames of motors shall be connected to the earthing system in accordance with the following table:

Motors kW Rating	Minimum Earth Conductor Size
Up to 30	16 mm ²
37 – 132	50 mm ²
150 – 175	70mm ²

Note:

In order to minimize the number of different sizes of earth conductor, the above three sizes only shall be used throughout, unless specifically stated otherwise.

- f) Cables supplying lighting fixtures shall be 3 core for single-phase supplies and 5 core for 3 phase supplies, of which one core shall be used as the earth conductor.
- g) Plant Infrastructure such as manifold piping, tanks and metallic support frameworks, shall be connected to the station safety earth, either directly or by means of Electrical earth bars located nearby.
- h) Flanged joints in metallic pipelines shall be considered inherently continuous provided the surfaces of one of the bolts are cleaned and identified for earthing. Flanges of metallic

pipelines that have insulated linings for purposes other than cathodic protection shall be bonded to ensure electrical continuity.

Pipelines shall only be connected to the earthing system where they enter and leave the battery limits.

- i) Storage tanks that are not cathodically protected shall be earthed through at least two separate connections to the tank. Tanks shall be earthed in accordance with the relevant SABS code.

Electrically continuous structural steel columns may be used as down conductors by means of which elevated tanks, vessels, etc. shall be deemed to be connected to the earthing system.

All tank covers, gauge floats and stirrers etc. as well as all pipes entering the tanks shall be earthed.

The steel roof shall be in a direct electrical contact with, or bonded to the tank shell.

Earthed grids, gauges, gratings and the like placed in or across the inlets of tanks are not to be used as a means of static discharge. Individual bonding shall be made to the earthing system.

- j) Cable trays and cable racks shall have continuous earth continuity. This shall be ensured by installing 10mm² earth straps across the racking fishplates (joints). Cable Trays shall be connected to the earthing system in two places - where they enter and leave the battery limits.

- k) Earthing connections to all equipment and process plant shall comprise of welded earth bosses in compliance with SABS 089 Part II: 1965 regulation 5.1.4K with properly provided terminations i.e. 10mm diameter earth studs. Anchor bolts shall not be used.

Earth connections to all equipment shall be effectively bolted, using crimped lugs.

All cable connections shall be fitted with a "star" or serrated washer in addition to the backnut, to ensure good earth contact.

- l) All earthing connections between the station earth system and respective earth bars/lightning protection systems shall where possible be made above ground, by means of bolts, crimped lugs and PVC taped.

All cable connections shall be fitted with a "star" or serrated washer in addition to the backnut, to ensure good earth contact.

Earth connection points shall be clearly labelled.

In cases where earth connection points are required to be made underground (e.g. to earth rods), inspection wells shall be provided comprising of pre-cast concrete/PVC surrounds complete with covers, to facilitate periodic inspection.

- m) Earthing conductors rising through paving or other concrete work shall be run in suitable protective sleeves which shall project above finished level.

- n) Earthing and bonding conductors shall be sized and installed in compliance with regulations detailed in the current SAIEE Standard Regulations for the Wiring of Premises and in SABS 03 as applicable.
- o) Extendable earthing rods shall be manufactured from stainless / copper clad / galvanized steel (dependant on soil acidity and chlorides and existence of cathodic protection systems) 16mm diameter, 1200 mm long sections, and shall have molecular bond between the two metals to prevent moisture ingress. Where it is necessary to join earth rods together, a non-ferrous corrosion resistant coupling device shall be used which shall prevent the ingress of moisture into the joint.
- p) Lightning and static earthing protection shall be provided for all tall steel, masonry and concrete structures, towers, vessels, tanks etc, as well as all buildings used to house sensitive electrical/electronic equipment. Lightning protection systems shall be connected both to individual earth rods as well as bonded to the station earth mat. Where possible, the mesh method (as defined in SANS 10313) should be utilised in the protection of buildings against lightning strikes i.e. the use of masts and catenary conductors are to be avoided.

Tall steel structures such as towers or structure columns, provided they are electrical continuous, shall be considered inherently protected against lightning by their connection to the earth.
- q) **The resistance of the common earthing system to the general mass of earth shall not exceed 1 Ohm.**
- r) Where a separate system is installed for other than electrical equipment in remote locations, e.g. storage tanks; its resistance to the general mass of earth shall not exceed 7 Ohms. (Note: This applies only for Lightning Protection and remote valve chambers that are not connected to the Station Earth).

12.2.2 Station Safety Earth

In cases where a new Station Safety Earth Mat is required to be provided, the following specifications shall apply:

The **Earth Mat** shall consist of a completely buried, lattice network of 40x3mm, bare copper tape. All the crossover points of the lattice shall be braised or cadwelded and protected with PVC insulation tape. Buried joints or splices shall not be clamped or bolted. The earth mat shall be buried, 1000mm minimum, below finished grade.

The interconnecting conductors shall be radially interconnected to form a common earthing system, for all electrical equipment, lightning protection and static earthing in accordance with relevant SABS requirements.

If required, additional earth electrodes may be installed to achieve the specified resistance, of the common earthing system to the general mass of earth. Where earth rods are paralleled in a group to reduce the earth resistance to the permissible value, they shall be spaced apart for a distance at least equal to their buried depth length.

12.3 Switchgear Room Building and Equipment

12.3.1 A Main Safety/Electrical Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Switchgear Room. Where possible, this Earth Bar shall be designated as the Primary Test Point for the station earthing system with the following equipment directly connected:

- **Station Earth Mat.** Where possible, a minimum of four separate connections shall be taken into the Switchgear Room via separate routes from the Earth Mat, by means of 40mm x 3mm Cu Earth tape. Connection to the Main Safety Earth bar shall be made in two places by means of 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductor, to facilitate testing of the Earth System.
- **Transformers.** By means of 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductor
- **MV/LV Panels.** By means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors
- **Generator.** By means of 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductor
- **Instrument Earth.** By means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors
- **Manifold Earth.** By means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors

Note that on existing sites, the earth mat has been connected to the station earthing system in multiple places (namely; the Switchgear Room, Control Room and Manifold), and thus designation of a single Primary Test point is not possible. Multiple test points have thus been defined as follows: Switchgear Room, Control Room and Manifold Mainline Pumps 1 & 4 (where possible).

12.3.2 All secondary earthing within the substation shall be attached to this station earth bar at appropriate demarcated points.

12.4 Control Room Building and Equipment

12.4.1 A secondary Safety/Electrical Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Equipment/Control Room in an easily accessible position. Where possible, this Earth Bar shall be directly connected to the Main Safety/Electrical Earth bar located in the Switchgear Room, by means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that all marshalling and equipment panels shall have an electrical earth bar, separate from an insulated instrument earth bar, installed and to which all electrical equipment earths shall be connected.

12.4.2 An Instrument Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Equipment/Control Room in an easily accessible position. Where possible, this Earth Bar shall be directly connected to the Main Safety Earth bar located in the Switchgear Room, by means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that all marshalling and equipment panels shall have an insulated instrument earth bar, separate from the electrical earth bar, installed and to which all clean/instrument earths shall be connected.

12.4.3 Instrument and Electrical Earth systems shall be clearly labelled.

12.5 Manifold Area and Equipment

12.5.1 All manifolds shall have an insulated manifold earthing system installed, comprising of the following specifications:

- 40mm x 3mm min flat copper tape, to run the entire length of the main electrical racking reticulation and supported off of insulators at distances of no more than 2m apart. Use of existing electrical racking reticulation supports shall be permitted. All joints will require to be braised. Earthing reticulation shall be installed in such a manner so as to be unobtrusive and yet accessible and shall be positioned so as to avoid obstruction to walkways and access routes.
- The Manifold Earth bar shall be connected to the main safety/electrical earth located in the Switchgear Room, by means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that on existing sites, the earth mat has been connected to the earthing system in multiple places (namely; the Switchgear Room, Control Room and Manifold), and thus designation of a single Primary Test point is not possible. Secondary test points have thus been defined where possible as follows: Switchgear Room, Control Room and Manifold Mainline Pumps 1 & 4.

12.4.2 All process plant and equipment located within the manifold area shall be attached to this manifold earth bar at appropriate demarcated points, via appropriately sized insulated PVC copper cable (green/yellow colored insulation), as follows:

- All electrical equipment shall be earthed via two separate earths, namely via the power cable earth core back to the respective Starter Panel electrical earth bar, and secondly via a separate visual earth from the motor frame to the manifold earth bar. Use of cable armouring as an earth conductor is not acceptable.
- All instrument stands and field junction boxes shall be separately earthed via means of an insulated 16mm² min PVC copper cabling.
- All process vessels (tanks, vessels and piping) and racking reticulation shall be earthed via insulated 70mm² min PVC copper cabling in two separate places.

All earth conductors utilized shall comprise of stranded, PVC insulated copper conductors with crimped cable lugs. All connections shall be fitted with a "star" or serrated washer in addition to the backnut, to ensure good earth contact.

12.6 Earth System Identification Standards

12.6.1 Earth Bar Labels

Earth bars shall be clearly labelled according to their functionality (e.g. "EB xx" to denote an electrical earth bar, "IB xx" to denote an instrument earth bar, where xx denotes a unique consecutive number). The Functional Identifier "EB 00" shall always denote the Station Earth Mat.

In addition, earth bars designated as Test Points shall be labelled accordingly.

Labels shall comprise of the Traffolyte engraved type, and fixed by means of stainless steel screws. Finish shall comprise of black letters against a white background, with text 40mm height.

Labels shall be readable/visible after the wiring has been done.

12.6.2 Earth cable Identification

Earth cables may be divided into two types, namely primary earth cabling running from subsystem earth bars directly or indirectly to the main station earth (and used for testing purposes), and secondary earth cabling running between the subsystem earth bars and equipment or infrastructure.

Only Primary earth cabling (i.e. those used for testing purposes) is required to be identified, by means of a Functional Identifier denoting both source and destination earth bars.

Identification numbers will comprise of the following specification:

- Grafoplast Targa Metal TGT System (Carrier Rail 58mm in length) 316 Stainless Steel Markers, with punched text 6 mm height minimum, fastened onto the cable at both ends via means of Stainless Steel cable ties

Examples:

EB01 – EB00 Cable Identifier for Earth cable running between Electrical Earth bar EB01 and the Station Earth Mat

IB01 – EB00 Cable Identifier for Earth cable running between Instrument Earth bar IB01 and the Station Earth Mat

12.7 Testing

12.7.1 Earth Resistivity and Electrode Testing

It will be the Contractors responsibility to carry out all necessary earth resistivity tests on site, where applicable. Tests will be in accordance with the requirements of BS 1013 as amended.

After all earth electrodes/trench earth's have been installed, an earth "Megger" shall be used to test the earth resistance at the earth bar or connection point to the main station earth and the results recorded. Note that all ECC connections, and any other bonding material shall be disconnected from the earth connection point whilst the earth is being tested.

Earth Continuity Testing.

Earth continuity readings shall be measured and recorded from the earth bar to each item of equipment and process plant, and shall include all piping, vessels, transformers, motors, actuators, switchgear cabinets, marshalling enclosures and instrumentation.

12.7.2 The following are the maximum acceptable earth electrode resistances:

Electrical Earth

- Main substation - 1 ohm
- Miniature substations and kiosks - 2 ohms
- Highmasts - 5 ohms.

Instrument Earth

- Instrument Earth - < 1 ohm

13.0 INSPECTION AND GUARANTEE

- 13.1 Transnet Group Capital reserves the right to inspect the installation and the equipment to be used.
- 13.2 All lightning protection systems shall be inspected and certified by an accredited person after completion of the installation, to verify conformance as required by Code of Practice, SANS 10313.
- 13.3 All components of the lightning protection system shall be inspected to ensure that they are in good condition and are capable of performing their designed functions.
- 13.4 The tenderer shall ensure that all elements of the electrical installation have been incorporated into the protected space by bonding or extensions to the lightning protection system.
- 13.5 The mechanical condition of all conductors, bonds, joints and earth electrodes shall be checked and the observations noted. .
- 13.6 The tenderer shall undertake to repair and replace all faults and faulty materials due to bad workmanship during a period of six months.
- 13.8 The tenderer shall be required to guarantee the installation for a period of twelve (12) months.

END

SIGNATURE OF TENDERER: -----

DATE: -----

**TRANSNET GROUP CAPITAL
DESIGN SERVICES**

SCOPE OF WORKS SUPPORTING ANNEXURES:

**Annexure K: Mechanical Technical Specifications Fire
Suppression and Detection System**

REPORT

For:	Technical Specification for Supply, Installation, Testing and Commissioning of Fire Suppression System
Project Name:	National Fire Service Building Upgrade Port of Port Elizabeth
Project Number:	PLZ/ENG00051
Author:	Kyle Hankey
Owner:	Transnet
Client:	Transnet National Port Authority
Project Sponsor:	Transnet National Port Authority
Project Manager:	Carlin Van Aswegen
Revision Number:	0A
Approved by:	Aslam Haffejee
Release Date:	
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Document No:	PLZENG00051-ENG-M-SP-0002

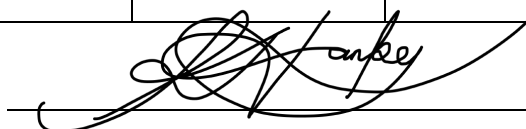
Distribution

Name	Title
Khethelo Mhlanga	Engineering Manager

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Prepared by:



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13-12-2022

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12/06/2024

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Accepted by:

 (Senior Project Manager)

 Date

ADDITIONAL SIGNATORIES (TNPA):

Accepted by:

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 Date

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1 General

The Contractor shall:

- a) Supply, deliver, install, and commission, and testing of the manual fire suppression system, consisting of Fire Hose reels and hydrants, booster connection for the fire water reticulation, extinguishers that complies with the requirements of SANS 10252-1, SANS 10400-T and subject to Local Fire Safety Authority acceptance.

2 Drawings and Approval

Suitable layouts for the required fire services are indicated on the Employer's drawings referred to in the list of drawings.

3 Pipes and Fittings

- 3.1 *The Contractor shall ensure that all piping, fittings, and valves used in the installation be new and of an accepted type capable of withstanding a test pressure of 1500 kPa.*
- 3.2 *The Contractor shall ensure that all rigid piping be non-galvanised mild steel manufactured in accordance with SANS 62 (medium grade), unless otherwise specified and shall be of an accepted brand and the best obtainable.*
- 3.3 *The Contractor shall ensure that all pipes shall be free of rust, flakes, or other faults. Notwithstanding the above stipulations, The Contractor shall ensure that all underground pipes shall be galvanised, and or HDPE with suitable transition connectors to metal above ground pipes in accordance with SANS 763.*
- 3.4 *The Contractor shall ensure pipe sections shall be manufactured in manageable lengths with joints at regular intervals.*

4 Pipe Joints

- 4.1 *The Contractor shall ensure all threaded pipe joints shall be made with an accepted cold-water pipe-jointing compound and flanges when used shall be bolted together with accepted gaskets. Pipe threads shall be standard right-hand Whitworth. Mechanical pipe-joints i.e., "Klambon", "Victaulic", or other pipe joints accepted by The Engineer may be used provided they have been accepted by the Automatic Sprinkler Inspection Bureau (ASIB) and are installed strictly in accordance with the instructions of the manufacturer.*

5 Cutting of Pipes

- 5.1 *The Contractor is warned that, when using conventional pipe cutters, all burrs and lips are to be removed by proper reaming of the cut end before threading to ensure that the original diameter is obtained.*
- 5.2 *The Contractor shall ensure any pipes with ends of reduced diameter found on the Site shall be removed and The Contractor may be required to dismantle completed work so as to convince the Project Manager that no such pipes were used elsewhere in the installation.*

6 Welding

- 6.1 *The Contractor shall ensure welding in-situ not take place without the prior permission of the Project Manager and without necessary "hot work permit" shall not be permitted.*

6.2 *The Contractor* shall ensure welded joints be properly machined and the use of a welding torch for making holes shall not be permitted. Distribution pipes with welded crosses and tees shall be provided with female thread so that the branch pipes can be connected in the conventional way. All welded joints shall be hydraulically tested to 2000 kPa.

6.3 Welded joints in branch pipes will not be permitted.

7 Water Supply

7.1 A single water supply connection with a nominal diameter of 110NB, connecting from valve chamber provided as per the *Civil Engineering* drawings and a transition piece shall be fitted to transform from underground HDPE pipe to steel pipe going into the building, must be provided.

7.2 *The Contractor* shall, from this point on, commence with the supply and installation of all manifolds, piping, valves, etc. as required to complete the works listed above.

8 Pressure Gauges

8.1 *The Contractor* shall ensure that all pressure gauges used comply with clause 4050 of the ASIB 11th edition rules and regulations.

8.2 *The Contractor* shall supply and install, commission, and test the above-mentioned pressure gauges onto the Feeder main of the fire hose reel reticulation at each fire hose reel as indicated in the list of detail drawings to facilitate periodic testing of the Equipment.

8.3 *The Contractor* shall ensure all pressure gauges installed have not less than 100 mm face diameter with porcelain faces registering 1600 kPa.

8.4 Their connections shall be taken from purpose made outlets on the valves and shall comprise a "U" tube without any fittings (elbows etc.) with all bends neatly executed.

8.5 The gauges shall be fitted upright with brass shut-off cocks or other accepted means of shut-off so as to permit their removal under pressure, if required.

9 Prevention of Air Locks

9.1 In order to prevent the lodgement of air, a proper inclination of pipelines shall be maintained throughout the work.

10 Drains and Drain Cocks

10.1 *The Contractor* shall supply and install, commission, and test all terminal drain valves at the extremity of each distribution pipe in accordance with clause 4042 of the ASIB 11th edition rules and regulations.

11 Sleeves and Pipe Supports

11.1 *The Contractor* shall ensure that, where so required, positions and quantities are indicated on drawings and provided to the *Project Manager* timeously.

11.2 *The Contractor* shall supply and install, commission, and test all pipe supports, clamps and other suspension fittings.

11.3 *The Contractor* shall ensure all pipe supports and suspension fittings and the spacing thereof shall comply with the requirements as laid out in clauses 4078 - clause 4087 of the ASIB 11th edition rules and regulations.

- 11.4 *The Contractor shall ensure all pipe supports and suspension fittings shall be installed in accordance with clauses 4088 - clause 4090 of the ASIB 11th edition rules and regulations in conjunction with manufacturer's recommendations.*
- 11.5 *The Contractor shall ensure all components forming part of the pipe support assembly shall be mild steel construction with hot dip galvanised or zinc electroplated finish.*
- 11.6 *The Contractor shall ensure the distribution and branch pipes shall be properly secured and branch pipes shall be anchored within 0,15m from the last outlet.*
- 11.7 *The Contractor shall secure all suspended using pipes clamps similar to Unistrut P75 pipe clamps, subject to Table 412 of the ASIB 11th edition rules and regulations, unless otherwise specified.*
- 11.8 *The Contractor shall ensure all rising mains shall be secured by means of pipe clamps equal or accepted equivalent to Cabstrut split clamps.*
- 11.9 *The Contractor shall provide a drawing showing full details of the sizes and manner of the suspension fittings, to the Project Manager for its acceptance, by the Engineer.*

12 Testing

- 12.1 *The Contractor shall ensure the Fire water reticulation installation be tested in accordance with SANS 102521, and any defect made good.*

13 Painting

- 13.1 *The Contractor shall paint all portions of the fire lines including hose reel and hydrant pipework.*
- 13.2 *The Contractor shall ensure before painting is undertaken, all work shall be thoroughly cleaned of rust, scale, etc., by brushing with a stiff wire brush wherever necessary. A prime coat of high-quality zinc chromate primer shall be applied before delivery to the Site. After installation, all fittings shall also be primed with zinc chromate primer and where the primer has come off the pipes, these shall be re-primed where-after two coats of high gloss paint shall be applied. Unless otherwise specified, the colour of the high gloss paint shall be similar to No. D 30 Post Office red of CKS 279.*
- 13.3 *The Contractor shall ensure the final coat of paint shall be applied only after the system has been commissioned and tested, but before the ceiling boards are installed. The final coat shall not be applied without the express consent of The Engineer. Pipe supports and other fittings, which are not directly in contact with the pipe work, shall be painted the same colour as the ceilings*

14 Operating and Maintenance Instructions

The Contractor shall ensure Full installation operating and maintenance instructions shall be supplied in triplicate with each system and shall include schematics and detailed piping drawings with a full component list indicating not only component values but sources of supply. Equipment will not be accepted until this information has been handed to The Contractor, and accepted by The Engineer

15 Information Required with Tender

- 15.1 *The Contractor shall supply the information as requested in the Schedule of Equipment and Materials (supplied later for tender), together with their Offer.*

16 Fire Hydrants & Booster Connections

- 16.1 *The Contractor* shall ensure that all new fire hydrants comply with SANS 1128 and be in acceptance of the local Fire Brigade and in accordance with SANS 10400 as specified.
- 16.2 *The Contractor* shall insure that all hydrants and booster connections are supplied, installed, commissioned and tested, as per the drawings supplied.

17 Fire Equipment and Cupboards

- 17.1 Fire hose reels:
- 17.1.1 *The Contractor* shall supply, install, commission and test, all new fire hose reels, which shall come complete with 30 meter long, 20 mm diameter fire hoses that with reels (non-swivel type) that comply with SANS 543, including all valves, nozzles, etc., all are accepted by the Local Fire Safety Authority and in accordance with SANS 10400 as specified.
- 17.1.2 *The Contractor* shall fix the fire hose reels against walls with new 10 mm diameter hook or rawl bolts, not less than 150 mm long and built into walls in 3:1 cement mortar. *The Contractor* shall install the fire hose reels so that the centre of each fire hose reel is approximately 1500 mm above floor level.
- 17.1.3 *The Contractor* shall commission, test and certify compliance to statutory regulations of the entire fire hose reel installation.
- 17.2 Fire extinguishers
- 17.2.1 *The Contractor* shall supply, install and commission certified fire extinguishers, as per the numbers indicated on the List of Drawings.
- 17.2.2 *The Contractor* shall ensure the fire extinguishers shall all be in accordance with SANS 10400 and to the acceptance of the local Fire Safety Authority.
- 17.2.3 *The Contractor* shall install extinguishers on appropriate accepted wall mounted hangers complete with timber backing board, with the handle height at approximately 800 mm above finished floor level.
- 17.2.4 All new extinguishers shall be of the refillable handheld portable types according to the capacities indicated.
- a) Dry powder (DCP) extinguishers in accordance with SABS Specification 810.
 - b) CO₂ extinguishers accepted by *The Engineer*
 - c) 6L wet chemical extinguisher in the kitchen area as indicated on drawing

18 Marking and Signposting

The Contractor shall ensure the safety signage shall all be in accordance with SANS 1186-5 and be to the acceptance of the local Fire Safety Authority.

19 Standard specifications applicable to the Fire Services works

Regulation	Description	Release
ASIB 11 TH ed. Rules and Regulations	Eleventh edition rules for automatic sprinkler installations	2014

SANS 10252-1	Water supply and drainage for buildings Part 1: Water supply installations for buildings	2012
SANS 10400	The application of the National Building Regulations	2011
SANS 1128-1	Fire fighting equipment Part 1: Components of underground and above-ground hydrant systems	2010
SANS 1128-2	Fire fighting equipment Part 2: Hose couplings, connectors and branch pipe and nozzle connections	2010
SANS 543	Fire hose reels	2004
SABS 62-1 (SANS 62-1)	Steel pipes Part 1: Pipes suitable for threading and of nominal size not exceeding 150 mm	2013
SABS 62-2 (SANS 62-2)	Steel pipes Part 2: Screwed pieces and pipe fittings of nominal size not exceeding 150 mm	2013
SABS 763 (SANS 32)	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants	1997
SABS 810 (SANS 1910)	Dry Powder (DCP) Fire Extinguishers	2003
SABS 064 (SANS 10064)	The preparation of steel surfaces for coating	2011
SABS 630 (SANS 630)	Decorative high gloss enamel paints	2009
SABS 0140-3 (SANS 10140-3)	Identification colour markings Part 3: Contents of pipelines	2003
SANS 1186-5	Symbolic safety signs Part 5: Photoluminescent signs	2006

20 Mechanical Drawings

This is a list of mechanical drawings, which shall be read in conjunction with this specification

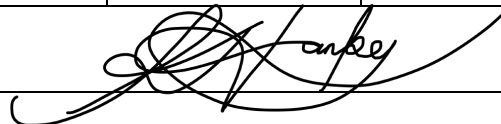
Drawing No.	Rev.	Description
PLZ0051-M-TBH-01	.1	Fire Suppression Layout Ground Floor

REPORT	
For:	Technical Specification for Technical Specification for Supply, Installation, Testing and Commissioning of Fire Detection System
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Project Number:	PLZ/ENG00051
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Project Sponsor:	Transnet National Port Authority
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Date

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1 GENERAL

The additional technical specification in this section shall be read in conjunction with the *Works Information*.

Should there be any conflict between any parts of this document then sections shall be considered in the following order of priority:

Technical Specification; Works Information; and Drawings.

2 STANDARDS

Full compliance shall be required as stipulated in the following standards.

The Materials and Equipment covered in this specification are to be manufactured and tested in accordance with the following latest revisions of standards:

- BS EN 50136: Alarm systems. Alarm transmission systems and Equipment.
- SANS 10142: Wiring Code
- SANS 10114-1: Interior lighting
- SANS 10400: National Building Regulations
- SANS 10139: Fire Detection & Alarm systems for buildings
- SANS 7629 & 7846: Electric cables specifications
- Occupational Health and Safety Act (Act 85, 1993)
- Local Municipal by-laws and regulations
- Local fire regulations
- Regulations of the Independent Communications Authority of South Africa (ICASA)
- CIBSE Commissioning Code C: Automatic Controls

The design of an automatic fire detection system, the equipment supplied for the system, and the installation of such equipment shall be in accordance with the Standards listed below. The equipment and components shall be deemed to have been tested and approved by a reputable and recognised international test laboratory to prove compliance with at least one or more of these Standards. Copies of test certificates shall be provided by tenderers with their tenders:

- EN 54: Components of automatic fire detection systems
- BS 5445: Components of automatic fire detection systems
- BS 5839: Fire detection and alarm systems for buildings

Material for which a SANS specification exists, shall be in accordance with such a specification, and shall bear the SABS mark.

All equipment used shall originate from suppliers which have been certified in accordance with SABS ISO 9001 (ISO 9001) for quality assurance. Copies of certificates of approval shall be provided by the tenderers with their tenders.

Equipment designed to BS 5446, Fire systems for residential premises, or similar other standards are not acceptable.

3 SITE CONDITIONS

The site of the proposed building for Port Elizabeth Fire Service Building within the Port of Port Elizabeth.

The site is subjected to the following prevailing conditions:

Maximum ambient temperature	- 29.9° C
Minimum ambient temperature	- 11° C
Mean relative humidity	- 80 %
Altitude	- 63 m above SL
Environmental	- Hot summer; cold winter; winter rainfall and moderate-to-heavy winds

The building is positioned in a severe coastal environment; therefore equipment offered shall be suitably corrosion resistant for such conditions.

4 SCOPE OF WORKS

The extent of works covered in this document comprises the supply, installation, testing and commissioning of a complete Fire Detection System, which comprises of the following:

- Fire Alarm Control panel;
- Optical Smoke and Heat Detector units;
- Manual Call Stations;
- Fire alarm sounders and sirens;
- Fire rated cabling;
- Integration of the Fire Detection system into HVAC control system;
- All accessories and miscellaneous equipment to ensure proper functioning of the systems;
- Supplying of O&M Manuals and training; and
- 12 Month Warrantee Period.

5 WORK UNDERTAKEN BY OTHERS

The work not included in the installation is as indicated in the Works Information, including the following as indicated in this section.

- All builder's work including penetrations through wall partitioning, brick walls and concrete structures;
- Major wireways (cable trays and trunking) and conduits for electronic cabling;
- Main electrical supplies to electronic equipment positions; and
- Main ICT communication infrastructure will be provided by Neotel.

6 DESIGN

Any uncertainty which may exist in regard to the specification requirements shall be submitted to *The Engineer* in writing.

The requirements and design standards of the specification shall be adhered to unless otherwise approved by the Authority or its authorised representative in writing.

Small items of equipment forming part of a system are not covered by this specification. However, it is still required that the total system shall comply with the highest standard of the design and fire protection practice.

6.1 Fire Detection System

The Fire Detection system shall be supplied and installed as per this specification, engineer's drawings, and relevant standards.

The system consists of a main Fire Control Panel (FCP) located within the Fire Service building Control room that is always manned. Smoke and heat detector units are to be installed throughout the building as indicated on *The Engineer's* drawings. Cabling of the system will be done in dedicated wire ways for the fire system.

The system shall be integrated ("hard-wired") to the following equipment / systems which are to be supplied and installed by other sub-contracting companies. Allowance for all necessary signals must be provided for.

- Smoke ventilation system – to enable ventilation of smoke in the event of a fire;
- Fresh Air and Air-Conditioning system – to disable operation of the systems;

7 MATERIALS

All materials used on the contract shall be new and of the very best of their respective types and kind.

No equipment or parts older than 2 years, at the commencement of the contract, shall be installed in this system.

All equipment and parts used in a particular system shall originate from one supplier as far as practicably possible.

8 ZONING

8.1 Fire Zones

Devices shall be grouped into zones as follows, unless the zones are indicated on the drawings and/or Supplementary Specification:

- A zone shall not have more than 20 field devices.
- Each building floor shall have a minimum of two (2) separate zones.
- The Vehicle roof area shall be on a separate zone.
- The floor area of a single zone shall not exceed 2000m².
- Every floor of a building larger than 300m² shall be on a separate zone.
- Every area enclosed by fire walls shall be on a separate zone.
- In an analogue addressable system, each zone shall be enclosed by 2 line isolators.

A minimum of 20% spare capacity shall be allowed in the design of the control panels, loops, zones, etc. The control panel shall have facilities to accommodate a further two detector circuits, additional to the required number of zones, without having to replace or add additional cabinets (extensions) to the control panel, unless specified otherwise.

9 ACCESS LEVELS

The levels of access (modified) applicable to the control panels are as follows.

Level 1: No password or key:	Access by members of the general public. In addition the "silence" function shall be accessible or operational.
Level 2: Password or key:	Access by the person responsible for the system and trained on the system, and for system maintenance.
Level 3: Password or key:	Access by persons trained to reconfigure the system.

Access by persons authorised by the system owner to allocate passwords to levels 2 and 3.

Level : Password or key: a) Access by persons trained and authorised by the manufacturer to repair, or to alter the firmware, thereby changing its basic mode of operation.

10 INSTALLATION METHODS & MATERIALS

10.1 Devices

The base of a detector shall always be mounted in the area which it protects so that the indicator LED can be seen from the doorway which normally provides access to the room. The indicator LED shall face towards the main entrance or lobby or side of main approach in the passage.

Bases shall be provided with dust caps to protect the base against dust and dirt whilst construction work is in progress. This is only applicable to bases that contain electronic components.

Surface mounted units shall be solidly fixed to the wall by means of their back plates.

Manual call point units shall be mounted at 1,4m above finished floor level, unless otherwise indicated on the Engineer's drawings.

10.2 Circuit Wiring

The following methods are acceptable for the wiring of detector circuits:

- Steel conduit and conduit accessories cast into, or built into, the building structure and wired with insulated conductors of a type which complies with the requirements of this specification.
- Steel conduit and conduit accessories, surface mounted in building structures and wired with insulated conductors of a type approved by the Department.

Wires and cables may also be installed in wiring trunking and armoured cable may also be installed on cable trays, as specified in this specification.

Cables with stranded wires shall be terminated by the crimping on of lugs. No stranded wires without lugs will be accepted.

T-Junctions shall be made only in approved draw boxes at detector outlets.

Separate wiring installations for detector circuits, evacuation communication wiring, audible alarms, electrical lock wiring, card reader wiring, AC and DC power circuits, remote control circuits and monitor wiring, video cables, computer cables, etc., shall all be done in separate conduit- or trunking installations. Detector wiring shall not be installed together with any other wires in wireways.

Detector wiring may share the same draw boxes or expansion joint boxes with other firefighting system wiring or security system wiring, but the boxes shall be subdivided by means of steel plates.

All electrical work and wiring associated with "FIRE DETECTION SYSTEMS" shall be carried out in compliance with the requirements of the "STANDARD SPECIFICATION FOR ELECTRICAL INSTALLATIONS" of the Client.

Cables installed over vertical distances of more than 1,5m, shall be properly supported at intervals of less than 1,5m.

10.3 Conduit & Accessories

The Contractor for the fire detection system shall be responsible for the supply and installation of all conduits, conduit accessories, wiring trunking and cable trays, as may be necessary or required for the system, unless specified otherwise.

Conduit and conduit accessories shall be cast in, or built into, the building structure in new buildings. No surface mounting will be acceptable in new buildings or structures.

Surface mounted conduit and conduit accessory work will be allowed only in existing buildings.

Steel conduit and conduit accessories surface mounted on building structures, steelwork and woodwork, shall be done neatly and in straight lines and shall be saddled at 1 m centres with spacer saddles.

M4 machine screws shall be used for fixing of spacer saddles onto steelwork. Suitable holes shall be drilled and tapped in the steelwork for this purpose.

Steel conduit and conduit accessories, surface mounted in roof spaces of buildings or structures with pitch roofs, shall follow the roof structural elements.

The quality of materials and the methods of installation of steel conduit and conduit accessories shall be carried out in compliance with the requirements of the "STANDARD SPECIFICATION FOR ELECTRICAL INSTALLATIONS" of the Client and SANS 10142.

Conduit installations shall be done in such a way that detector circuit wiring can be done without interruption and without T-joints.

Round draw boxes for detectors shall be mounted hard against the ceiling in the case of false ceilings or ceilings of pitch roof buildings and detector bases shall be mounted against boxes so that no open wiring occurs anywhere in a conduit and wiring system.

No sprague tubing or PVC conduits shall be used in detector circuit wiring systems. Only flexible conduit which is not of the spiral type may be used in special applications.

10.4 Wiring Trunking & Cable Trays / Ladders

To be supplied and installed by electrical sub-contractor.

11 EQUIPMENT REQUIREMENTS

11.1 Fire Control Panel (FCP)

11.1.1 General

Main FCP or network node shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

11.1.2 Operator Control

a) Acknowledge Switch:

Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from

flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

b) Alarm Silence Switch:

Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silence-able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

c) Alarm Activate (Drill) Switch:

The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

d) System Reset Switch:

Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

e) Lamp Test:

The Lamp Test switch shall activate all local system LEDs, light each segment of the LED and display the panel software revision for service personal.

11.1.3 System Capacity and General Operation

- a) The control panel or each network node shall provide or be capable of 200 intelligent/addressable devices.
- b) The control panel or each network node shall include Form-C alarm, trouble, supervisory, and security relays rated at a minimum of 5 amps @ 40Vdc.
- c) It shall also include four Class B (NFPA Style Y) or Class A (NFPA Style Z) programmable Notification Appliance Circuits.
- d) The Notification Appliance Circuits shall be programmable to Synchronize with System Sensor, Gentex, Wheelock, Advanced or similar Notification Appliances.
- e) The system shall include a full featured operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual colour coded system status LEDs, and an alphanumeric keypad with easy touch rubber keys for the field programming and control of the fire alarm system.
- f) The system shall be programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes.
- g) The system shall allow the programming of any input to activate any output or group of outputs. Systems that have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or require a laptop personal computer are not considered suitable substitutes.
- h) The FCP shall support up to 20 logic equations, including "and," "or," and "not," or time delay equations to be used for advanced programming. Logic equations shall require the use of a PC with a software utility designed for programming.
- i) The FCP or each network node shall provide the following features:
 - Drift compensation to extend detector accuracy over life. Drift compensation shall also include a smoothing feature, allowing transient noise signals to be filtered out.
 - Detector sensitivity test.

- Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
- Nine sensitivity levels for alarm, selected by detectors. The system shall support sensitive advanced detection laser detectors. The system shall also include up to nine levels of Pre-alarm, selected by detector, to indicate impending alarms to maintenance personnel.
- The ability to display or print system reports.
- Alarm verification, with counters and a trouble indication to alert maintenance personnel when a detector enters verification 20 times.
- Rapid manual station reporting (under 3 seconds) and shall meet requirements for activation of notification circuits within 10 seconds of initiating device activation.
- Periodic detector test, conducted automatically by the software.
- Self-optimizing pre-alarm for advanced fire warning, which allows each detector to learn its particular environment and set its pre-alarm level to just above normal peaks.
- Cross zoning with the capability of counting: two detectors in alarm, two software zones in alarm, or one smoke detector and one thermal detector.
- Walk test, with a check for two detectors set to same address.
- Control-by-time for non-fire operations, with holiday schedules.
- Day/night automatic adjustment of detector sensitivity.
- Device blink control for sleeping areas.

j) Network Communication:

The FCP shall be capable of communicating on a Local Area Network (LAN), a firmware package that utilizes a peer-to-peer, inherently regenerative communication format and protocol.

11.1.4 Central Microprocessor

- a) The microprocessor shall be a state-of-the-art, high speed, 16-bit RISC device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, Flash memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
- b) The microprocessor shall contain and execute all control-by-event programs for specific action to be taken if an alarm condition is detected by the system. Control-by-event equations shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
- c) The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file. The time-of-day and date shall not be lost if system primary and secondary power supplies fail. The real time clock may also be used to control non-fire functions at programmed time-of-day, day-of-week, and day-of-year.
- d) A special program check function shall be provided to detect common operator errors.
- e) An auto-program (self-learn) function shall be provided to quickly install initial functions and make the system operational.
- f) For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download, and have the ability to upgrade the manufacturers (FLASH) system code changes. This program shall also have a verification utility, which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.

11.1.5 System Display

- a) The system shall support an 80 character display. The display shall include an 80-character backlit alphanumeric Liquid Crystal Display (LCD) and a full PC style QWERTY keypad.
- b) The display shall provide all the controls and indicators used by the system operator:
 - The 80-character display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, ALARM ACTIVATE (drill), SYSTEM RESET, and LAMP TEST.
- c) The display shall annunciate status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
- d) The display shall also provide Light-Emitting Diodes:
 - The 80-character display shall provide 12 Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM WARNING, SECURITY ALARM, SUPERVISORY SIGNAL, SYSTEM TROUBLE, DISABLED POINTS, ALARM SILENCED, Controls Active, Pre-Discharge, Discharge and Abort.
- e) The display shall provide a QWERTY type keypad:
 - The 80-character display keypad shall be an easy to use QWERTY type keypad, similar to a PC keyboard. This shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
- f) The system shall support the display of battery charging current and voltage on the 80character LCD display.

11.1.6 Signalling Line Circuits (SLC)

- a) Each FACP or FACP network node shall support one SLC. Each SLC interface shall provide power to and communicate with up to 159 intelligent detectors (ionization, photoelectric or thermal) and 159 intelligent modules (monitor or control) for a loop capacity of 318 devices. SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
- b) CPU shall receive analogue information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analogue information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

11.1.7 Communication Interfaces

The system shall include two serial RS-232 interfaces. Each interface shall be a means of connecting peripherals.

The system shall also include a communication port to enable Ethernet TCP/IP (BACnet IP) protocol based communication with the main security server.

11.1.8 Enclosures

The control panel shall be housed in a cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

The back box and door shall be constructed of steel with provisions for electrical conduit connections into the sides and top.

The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.

11.1.9 Power Supply

- a) A high tech off-line switching power supply shall be available for the fire alarm control panel or network node and provide 6A of available power for the control panel and peripheral devices.
- b) Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
- c) Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries which allow for 4hrs of uninterrupted power or may be used with an external battery and charger system. Battery arrangement may be configured in the field.
- d) The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
 - Ground Fault LED
 - AC Power Fail LED
 - NAC on LED (4)
- e) The main power supply shall operate on 240Vac, 50 Hz, and shall provide all necessary power for the FACP.
- f) The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to which shall be sized to last 4hrs.
- g) All circuits shall be power-limited, per UL864 requirements.

11.1.10 Auxiliary Field Power Supply – Addressable

- a) The auxiliary addressable power supply is a remote 24Vdc power supply used to power Notification Devices and field devices that require regulated 24Vdc power. The power supply shall also include and charge backup batteries.
- b) The addressable power supply for the fire alarm system shall provide up to a minimum of 6.0 amps of 24Vdc regulated power for Notification Appliance Circuit (NAC) power or 10 amps of 24Vdc general power. The power supply shall have an additional 0.5 amp of 24Vdc auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge backup batteries to last 4hrs.
- c) The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits.
- d) The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized notification devices at the same time.
- e) The addressable power supply shall operate on 240Vac, 50Hz.

- f) The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signalling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24Vdc, 5Vdc and 0Vdc at approximately 3.33kbaud.
- g) The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
- h) The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.
- i) The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.
- j) The addressable power supply mounts in either the FACP back-box or its own dedicated surface mounted back-box with cover.
- k) Each of the power supply's four output circuits shall be programmed for Notification Appliance Circuit or General Purpose 24Vdc power. Any output circuit shall be able to provide up to 2.5A of 24Vdc power.
- l) The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of an end-of-line resistor. When the power supply's output circuit is selected as General 24Vdc power, the circuit shall be individually supervised when an end-of-line relay is used.
- m) When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.
- n) When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
- o) The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
- p) An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

11.1.11 Specific System Operations

- a) Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
- b) Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
- c) Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
- d) Point Read: The system shall be able to display or print the following point status diagnostic functions:
 - Device status
 - Device type
 - Custom device label
 - View analogue detector values
 - Device zone assignments
 - All program parameters

- e) **System Status Reports:** Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
- f) **System History Recording and Reporting:** The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
- g) **Automatic Detector Maintenance Alert:** The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyse the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be enunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
- h) **Pre-Alarm Function:** The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
- i) **Software Zones:** The FACP shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.
- j) **The fire alarm control panel shall include a walk test feature.** It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
 - Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
 - Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
 - All devices tested in walk test shall be recorded in the history buffer.
- k) **Water-flow Operation:**
An alarm from a water-flow detection device shall activate the appropriate alarm message on the main panel display turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.
- l) **Supervisory Operation:**
An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
- m) **Signal Silence Operation:**

The FACP shall have the ability to program each output circuit (notification, relay, speaker etc.) to deactivate upon depression of the signal silence switch.

- n) **Non-Alarm Input Operation:**

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

11.2 Fire Detection Field Components

11.2.1 General

- a) Addressable devices shall use simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
- b) Addressable devices, which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.
- c) Detectors shall be intelligent (analogue) and addressable, and shall connect with two wires to the fire alarm control panel Signalling Line Circuits.
- d) Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
- e) The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
- f) Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.
- g) The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base.
- h) The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
- i) Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
- j) Detectors will operate in an analogue fashion, where the detector simply measures its designed environment variable and transmits an analogue value to the FACP based on real time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analogue value of each detector.
- k) Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
- l) A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analogue value reaching 100% of the alarm threshold.
- m) Addressable modules shall mount in a 100 mm square, 54 mm deep electrical box. An optional surface mount Lexan enclosure shall be available.

11.2.2 Addressable Manual Fire Alarm Box (Manual Call station)

- a) Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- b) All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
- c) Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word "FIRE" shall appear on the front of the stations in raised letters, 44 mm or larger.

11.2.3 Intelligent Photoelectric Smoke Detector

The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

11.2.4 Intelligent Thermal Detectors

Thermal detectors shall be intelligent addressable devices rated at 58°C and have a rate-of-rise element rated at 9.4°C per minute. It shall connect via two wires to the fire alarm control panel signalling line circuit.

11.2.5 Advanced Multi-Criteria Intelligent Detector

- a) The intelligent multi criteria detector shall be an addressable device combining two sensing elements in a single sensing device providing the ability to detect two major elements of a fire. The detector design shall allow sensitivity setting between 1% and 4% per 30cm obscuration.
- b) The detector shall include a photoelectric sensing element, thermal sensing element

11.2.6 Addressable Control Module

- a) Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.
- b) The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y.
- c) Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised remote supply.
- d) For multiple circuit control a module shall be available that provides 6 Style B or 3 Style D control circuits.

11.2.7 Addressable Releasing Control Module

- a) An addressable Flash-Scan releasing module shall be available to supervise and control compatible releasing agent solenoids.
- b) The module shall operate on a redundant protocol for added protection.
- c) The module shall be configurable for Style Z or Style Y (Class A/B) and support one 24Vdc solenoids.

11.2.8 Addressable Relay Module

- a) Addressable Relay Modules shall be available for HVAC control and other network building functions. The module shall provide two relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to ensure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
- b) For multiple relay control a module shall be available that provides 6 programmable relays.

11.2.9 Isolator Module

- a) Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

- b) If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- c) The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- d) The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

11.2.10 Batteries

- a) The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.
- b) The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
- c) If necessary to meet standby requirements, external battery and charger systems may be used.

12 COMMISSIONING

The testing of the system shall be done in the presence and to the satisfaction of an authorised representative of the Client and the *Project Manager*.

Tests shall include simulation of fire conditions in each zone to prove the efficiency of all aspects of the system to the satisfaction of the Client and *Project Manager*.

All equipment, material, etc., which may be necessary for these tests shall be supplied by the *Contractor*, including a suitable smoke generator.

The *Contractor* shall do his own complete commissioning tests before the actual first take-over tests are done. This is to satisfy himself that everything is working and is in accordance with the specification.

13 DOCUMENTATION & DRAWINGS

13.1 Block Plan

- An approved block plan, indicating the zones and appropriate zone reference numbers, shall be installed at all control panels.
- The block plan shall be discussed with the Fire Prevention Officer of the Department before manufacturing takes place.
- The block plan shall have a professional appearance. Text shall be in English and at least one other official language to be decided in conjunction with the Department and the User Department. A freehand drawing or badly finished plan will not be acceptable.
- The block plan shall clearly indicate the position of the zone in which a fire has started, when read together with the displays and indications on the control panel.
- Non-fading material shall be used for the artwork. The block plan shall be mounted in a frame behind glass, or shall be covered with a transparent stick-on material, to protect the artwork.
- The block plan shall be mounted in an approved position at the control panel.
- For an addressable system, the addresses of all field devices shall be shown on the block plan.

13.2 Training Programme

Tenderers shall allow in their tender prices for a training course, to train on site at least four (4) persons, as nominated by the Client from his own operating personnel. The training shall be adequate for the installation, to ensure that operating staff fully understand the system. During this period, the personnel shall be made fully conversant with the operation of, and daily maintenance required for, each item of equipment of the system. The training, especially on computer equipment and control panels, shall be of such a standard that will enable the client to carry out his own in-house training of other personnel.

The training course shall start only after first take-over inspection of the system.

The training course shall be carried out in English.

The O&M Manual of the contract shall include a full description of the contents of the training course, as referred to in clause above.

13.3 Operating Instructions

Instruction cards, clearly indicating the procedure to be followed in the event of a "FIRE" alarm, shall be supplied, and framed under Perspex in approved teak or non-ferrous material frames. The instruction cards shall be in English and at least one other official language to be decided in conjunction with the client. The frame shall be neatly mounted on the walls alongside the control panel and external indicator panels respectively, where they can be clearly read.

In the case of the control panel, the instruction card shall also clearly state the procedure to be followed in the event of a "FAULT" alarm.

14 LIST OF DRAWINGS

14.1 GENERAL

The layout drawings listed in this section, which form part of and shall be read in conjunction with this document, are the current construction drawings and are to be used for the Fire Detection system installation only.

The Contractor shall ensure that the drawings being used on site during the construction stage are clearly marked "FOR CONSTRUCTION", and shall ensure that work is carried out to the latest drawing issue on site.

14.2 MECHANICAL DRAWINGS

This is a list of mechanical drawings, which shall be read in conjunction with this specification

Drawing No.	Rev.	Description
XCTE0007-M-TBH106N62100-01	.A	Fire Suppression Layout Ground Floor
XCTE0007-M-TBH106N62100-02	.A	Fire Suppression Layout First Floor
XCTE0007-M-TBH106N62100-03	.A	Fire Suppression Layout Site Plan
XCTE0007-M-TBH106N62100-04	.A	Fire Detection Layout Ground Floor
XCTE0007-M-TBH106N62100-05	.A	Fire Detection Layout First Floor
XCTE0007-M-TBH106N62100-06	.A	Emergency Evacuation and Signage Layout Ground Floor

Transnet SOC Limited

Project Number: PLZ/ENG00051

Description of the works: Installation of New Fire Detection System for Port of Port Elizabeth Fire Service Building Upgrade



XCTE0007-M-TBH106N62100-07	.A	Emergency Evacuation and Signage Layout First Floor

SCOPE OF WORKS SUPPORTING ANNEXURES:

**Annexure L: Mechanical Technical Specifications Water
Reticulation System**

REPORT	
For:	Technical Specification for Supply, Delivery, Installation and Commissioning of Internal Water Reticulation
Project Name:	National Fire Service Building Upgrade Port of Port Elizabeth
Project Number:	PLZ/ENG00051
Author:	Kyle Hankey
Owner:	Transnet
Client:	Transnet National Port Authority
Project Sponsor:	Transnet National Port Authority
Project Manager:	Carlin Van Aswegen
Revision Number:	0A
Approved by:	Aslam Haffejee
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Distribution	
Name	Title
Khethelo Mhlanga	Engineering Manager



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Prepared by:



 Kyle Hankey (Engineer) 13-12-2022
 Date

Reviewed by:



 Aslam Haffejee (senior Engineer) 13/12/2022
 Date

Approved by:



 Aslam Haffejee (Senior Engineer) 13/12/2022
 Date

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Accepted by:



 (Eng. Manager) 11/06/2024
 Date

Accepted by:

 (Senior Project Manager) Date

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Accepted by:

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Accepted by:

 Date



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1 Introduction

This technical specification is for the supply, delivery and installation of hot and cold-water reticulation at the National Fire Service Building Upgrade Port of Port Elizabeth. The clauses referred to herein are clauses of standard specification. Relevant clauses not specifically mentioned shall also apply. All equipment and installations shall comply in all respects with the requirements of the Occupations Health and safety Act No. 85 of 1993.

2 Water Supply System Descriptions

2.1 Domestic Cold-Water Supply

The water supply is through to the showers, all wash hand basins, wash troughs, toilets and kitchens, as well as appliances requiring water connection as indicated in the *Employers* drawings. This water will be supplied from the main line located in The Port of Port Elizabeth boundaries, as displayed on the *Employers* drawings, directly into the main header supply for the building. The position, excavation and backfill must be coordinated with the Contractor, via the civil engineering layouts for connection to the internal supply line. Isolation valves, pressure gauges to be installed for the maintenance and troubleshooting.

All domestic water pipes underground pipework shall be HDPE CLASS 12 unless otherwise indicated. All pipework above ground shall be Class1 copper.

2.2 Hot water solution

2.2.1 Ablutions Hot Water Solution

Hot water is to be supplied to the showers and washbasin as stipulated within the drawings only. This hot water system is fed from a vertical hot water cylinder with a capacity of 1000 litres positioned in the cleaner's room on the ground floor as depicted in the *Employers* drawing. Access to this cylinder would be via the cleaner's room for maintenance and troubleshooting, a connected door to the outside of the building will allow for installation access. The system will accommodate a heat pump and heat exchanger system situated in the inside of the cleaner's room, connected to the air-conditioning system, as depicted in the *Employers* drawings.

2.2.1.1 Hot Water Cylinder

The hot water storage cylinder supplied shall be one with a high-efficiency tank complete with an enlarged heating spiral, for use in heat pump systems. It shall include enamelling to DIN 4753 T3, with magnesium anode, complete with thermometer and mounts. The unit shall include a service opening and 1 ½" sleeve for the optional installation of an electric auxiliary heater or a ribbed-pipe heat exchanger.

The unit shall be manufactured to allow for CFC-free heat insulation and have the following permissible operating conditions: Drinking water max. 95 °C/10 bar, heating water max. 110 °C/10 bar. The unit shall meet the energy efficiency class limit values valid from 2017 and include installation for units up to 500 litres, with a rECOflex insulation, and from 500 litres up should be of polyester fibre fleece.

An auxiliary electric heating element for backup purposes shall be supplied, installed and tested with the hot water storage tank, which shall meet the following requirements;

- a) Safety temperature limiter (STB) 120 °C
- b) Control lamp used as pilot light
- c) Degree of protection IP 54
- d) Shall allow for semi-continuous usage, in emergency situations.
- e) Water hardness max. 14 ° dH

2.2.1.2 Heat Pump/Heat Exchanger

2.2.2 Kitchen Hot Water Solution

The Contractor shall ensure that each kitchen area, as depicted on the drawings, be fitted with an automatic hot water equipment to allow for the heating up of water for staff use.

The Contractor shall ensure that the above-mentioned hot water solution meets the following requirements:

Twin chamber instant boiling water heater while providing water within 1°C of boiling point. The system needs to be able to separate the cold-water supply from the boiling chamber, while internal condensing system retains steam within the heater.

Temperature controls sensors need to ensure automatic cut off the power in the event of temperature control failure, boil dry cut-out or a blocked vent pipe. High temperature thermal insulation with provision for service access to the boiling. Ensure that the tap is cool to the touch when dispensing boiling water, it should have a ready-to-use status indicator. Concealed plumbing and electrical connections need to be provided, accompanied with thermostat of capillary type. Boiling chamber Crevice-free stainless-steel chamber with removable stainless steel access ports top and bottom. Outer Case Stainless steel or corrosion-resistant, white enamelled steel. Insulation Compressed high temperature insulation panels which would allow for quick access to boiling chamber ports.

The Contractor shall ensure the following safety features, thermal cut-out integrated on to the heating element, thermal cut-out on vent tube. The system shall have the following approvals from WRAS and CE. The system shall come complete with a two-year on-site warranty including parts and labour.

The Contractor shall ensure that the unit be installed over a draining board (sink run-off), or over a work top fitted with a drip tray – tap spout should be no higher than necessary to fill large pots. Minimum tap height above draining board for on wall maintenance is 200mm. Leave minimum clearance of 150mm above, 65mm left and 20mm right. Hanging and fixing screws supplied with wall plugs. The unit should be connected directly to a potable cold-water supply with a minimum pressure of 1 bar and a maximum pressure of 7 bar. A pressure reducing valve must be installed if water supply pressure is likely to exceed 7 bar. An isolating valve should be installed between the water supply and the heater. For concealed plumbing connections, connect inlet and vent pipes from the rear via 15 mm capillary elbows. Venting The vent must discharge to a safe visible position as, under certain conditions, the vent may discharge cold or boiling water and/or steam. The vent pipe outlet must be connected via a tundish to a 15mm copper vent pipe which has a continuous fall, is no more than 3

metres long and has no more than 3 right angle bends. The bug screen supplied must be fitted to the end of the vent tube.

3 Insulation

The Contractor shall insulate all hot water and hot water return piping and equipment with preformed fiberglass, mineral wool or armaflex insulation.

The piping directed to the relevant sanitary fittings, must be insulated Mepla piping from Geberit or stainless steel from steelpress/SS crimplink, or similar approved. All hot water pipework chased in wall shall be wrapped in kraft paper prior to plastering. Pipework shall be insulated with Fibreglass insulation with a minimum density of 96 kg/m³. All underground hot water piping shall be HDPE CLASS 12 and shall be buried to a minimum depth of 600 below ground.

4 Piping, Valves and System Fittings

4.1 Piping material

All domestic water pipes underground pipework shall be HDPE CLASS 12 unless otherwise indicated. All pipework above ground shall be Class 1 copper.

4.2 Painting

All exposed piping and brackets to be degreased and painted over its entire length in accordance with the standard specification.

4.3 Pipe Hangers and Brackets

Pipe hangers and supports shall be installed at the following maximum centres:

Pipe Bore:	Distance Between Supports:
(Millimetres)	(Meters)
Up to 10	1,0
12 to 15	1,25
22	1,8
28 up to 50	2.5
65 to 100	3.0

Additional supports shall be installed where dictated by structural details:

4.4 Valves

All valves to be ball valves with stainless steel bodies and balls and PTFE or Teflon seals. They shall be suitable for a working pressure of 1000 kPa gauge. Valves shall be fitted into the pipeline by means of capillary hard soldered joints containing silver.

5 Operating And Maintenance Manuals

5.1 General

At the completion of the project the contractor shall supply three copies of "Operating and Maintenance

5.2 Manuals

Manuals should contain the following information:

- f) A general description of the systems.
- g) Plant operating instructions.
- h) Details of the major equipment suppliers and contact telephone numbers.
- i) Leaflets and general information on all installed major equipment.
- j) Regular and routine maintenance schedules.
- k) Final commissioning data.
- l) 'As-Built' drawings and electrical wiring and control diagrams.

In addition, copies of the diagrams shall be framed and mounted in the individual plant rooms. All the above documents shall be bound into a durable plastic 'ring binder' file, and suitable indexed and titled.

The documents shall also be provided in software on a computer disc.

6 Equipment Identification and Signage

The Contractor shall supply and install Identification Labels to all equipment hot water storage, controls and gauges. The labels shall be fabricated in black plastic sheet and shall be engraved clearly in white, to indicate the equipment controlled.

All exposed pipes shall be provided with neat signs or signboards describing or naming the particular function or duty in each instance, together with arrows indicating the direction of the water flow in pipes, e.g., Hot water storage, Heat pump

The contractor shall detail all such signage, wording and terminology and submit the same to the Engineer for approval prior to installation.

7 Commissioning And Testing

7.1 Commissioning

Upon the 'Practical Completion of the Contract Works', the contractor shall efficiently test and commission all relevant items of equipment before setting such equipment into regular operation.

Each item of equipment shall be set to produce the required designed capacity when operating against the calculated duty of the relevant system, i.e.: Specified pressures and temperatures.

7.2 Testing

When the above commissioning of the installation has been completed to the satisfaction of the Engineer, the contractor shall, initially, set the water and air temperature controls to give specified conditions.

8 Standards

SANS 460 – Copper tubes for domestic plumbing services.

SANS 966 – HDPE tubes for domestic plumbing services.

The contractor shall provide all protective devices, etc. and arrange for all inspections, tests, certificates, etc. necessary to comply with the said Acts, Regulations and By – Laws, whether specified herein or not.

9 System Submittals

- The installing contractor shall submit the following design information and drawings for approval prior to starting work on this project:
- Field installation layout drawings having a scale of not less than 1:100, detailing the water reticulation system including pressure valves, pipework, heat pump, circulating, control panels, fittings and etc.
- Separate layouts, or shop drawings, shall be provided, (i.e. water reticulation floor plan) and for mechanical and electrical work.
- Electrical shop drawings shall show the location of all devices and include point-to-point conduit runs and a description of the method(s) used for detector mounting.
- Separate drawing providing symbol legend to identify all symbols used.
- Hot water generating system Certificate of Compliance (COC).

10 Mechanical Drawings

This is a list of mechanical drawings, which shall be read in conjunction with this specification

Drawing No.	Rev.	Description
ENG-00042-M-TBH.106.O4-59-06	.A	Water Reticulation Ground Floor
ENG-00042-M- TBH.106.O4-59-07	.A	Water Reticulation Second Floor

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure M: Mechanical Technical Specification HVAC System

REPORT	
For:	Technical Specification for Supply and Installation of Air-Conditioning and Ventilation System
Project Name:	TNPA National Fire Service Upgrade Port of Port Elizabeth
Project Number:	PLZ/ENG-00051
Author:	Bongane Mngomezulu
Owner:	Transnet
Client:	Transnet National Port Authority
Project Sponsor:	Transnet National Port Authority
Project Manager:	Carlin Van Aswegen
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1 General

1.1 The Scope of Work

1.1.1 Design, manufacture, supply, delivery, install, commissioning, testing and handing over in complete working order ready for immediate use and subsequent maintenance for a period of twelve (12) months of all plant equipment necessary for the installations described herein and as indicated on the accompanying drawings, of which:

- 1.1.1.1 The words “handing over in complete working order” in the clause above shall mean not only the major items of plant and equipment covered by the Specification but also the incidental sundry component’s necessary for the complete execution of the work and for the proper operation of the installation.
- 1.1.1.2 The words “subsequent maintenance for a period of twelve months” in the clause above, shall mean that such period shall commence from the date the installations are accepted and after “practical completion” has been confirmed in writing by the Engineer.
- 1.1.1.3 The words “described herein” in the clause above shall mean all sections or part of this Specification and drawings”.

2 Principal Items of Work Include

- a) Ventilation wall/window fans serving the cleaner’s room, female toilets, male toilets, kitchen lift shaft, workshop, double apparatus bay, equipment room, female changeroom and male change room as depicted on HVAC drawings.
- b) Explosion gas proof fan system servicing the storeroom. The system shall extract the accumulation of flammable gases from the storeroom on the ground floor.
- c) Ducted axial extract air fans servicing the laundry room and paraplegic ablution, as depicted on HVAC drawing layout.
- d) Fresh air supply ventilation system, with ducted axial supply air fans and sound attenuators servicing all offices spaces, boardroom, Gym, rest rooms, reception, printer room and all other areas as depicted on HVAC drawing layout.
- e) Sheet metal duct systems including flexible duct connections, air balancing dampers air volume controllers, fire dumpers, etc.
- f) Pipe and duct insulation and finishes over insulation, etc.
- g) Air filtration equipment comprising washable filters, bag type filters, self-supported pocket filters, and ducted particulate filters, etc.
- h) Air diffusion equipment including ceiling diffusers and plenum boxes, door grilles, wire mesh screens and louvers, etc.
- i) All vibration isolators, supports, hangers, brackets and accessories to complete the installations as specified.
- j) Miscellaneous air extract system including fans, sound attenuators, cowls etc.
- k) Temperature control system including safety controls, etc.

- l) Electrical work including wiring between switchboards, motors, electric heaters, and unit mounted thermostats/sensors, control devices, etc., and wiring between controllers and remote sensors, remote set point adjusters and wiring between room thermostat and air diffusers.
- m) VRF/VRV type system air-conditioner including insulated suction piping, drain piping, insulated liquid piping, insulated Gas piping, piping supports, support for trays, remote air-cooled condensers, heat recovery units, Hydro kit, finned heat exchanger and wiring between the outdoor and indoor units with hard wired remote controllers.
- n) Painting of plant and equipment.
- o) As-built CAD drawings, framed wiring and control diagrams, framed plant layout drawings, operating and maintenance manuals properly indexed to differentiate between plants and systems.
- p) Commissioning and testing of the installations herein specified.
- q) Maintenance and guarantee for twelve (12) months after “practical completion” date of the completed installation, or sections thereof. This is the date confirmed in writing by the Engineer.
- r) Training of the Employer’s maintenance staff in the operation and maintenance of the installations during the contractual twelve (12) month maintenance and guarantee period.

3 Exclusions

The following work is excluded from this Contract and will be carried out by others:

3.1 Building Work

- 3.1.1 All service areas, masonry and concrete, drywall work.
- 3.1.2 Forming of holes in walls or windows and making good thereafter. However the HVAC Contractor shall be responsible for co-ordinating with “other contractors” and provide requirements such as dimensions and positions of hole for the HVAC works including but not limited to Mechanical equipment and ducting.
- 3.1.3 Concrete bases, plinths, or concrete castings inside Sheet metal preformed sub-bases or inertia bases, except where otherwise specified.
- 3.1.4 Supply and fitting of timber frames where necessary for the fixing of the side wall louvers, door grilles and supply/return air ductwork.

3.2 Electrical Work

- 3.2.1 Supply and install of electrical main cables and isolators adjacent and within 1.5meters of air-handling unit switchboards, air-cooled chillers switchboard, air fans, hydro kit, heat recovery units, remote air-cooled condensers for the cassette and ducted type air-conditioners. The air-conditioning selected Contractor shall complete all wiring from such isolators to the air-conditioning equipment.

3.3 Fire Alarm

- 3.3.1 Provision of fire services interlock wiring to fire services terminal inside the integral air-handling unit switchboards for the purposes of stopping the supply air fan on receipt of a fire alarm signal.

3.4 General

- 3.4.1 Painting and plant room walls, ceilings and floors.
- 3.4.2 Supply of water and electricity for testing and commissioning period prior to “practical completion” of installations.
- 3.4.3 Supply of electricity for testing and commissioning period prior to “practical completion” of installations.
- 3.4.4 Any other item specifically hereinafter mentioned as being delivered, supplied and fitted etc. by others.

4 DESIGN CONDITIONS

The following design conditions were used in designing the air-conditioning requirements for this project:

4.1 External Condition

Summer ambient	: 29.9°C Dry Bulb Maximum
Winter ambient	: 11°C Minimum
Humidity	: Average 80%
Altitude	: 63 m above sea level

4.2 Internal Condition

Summer	: 22.5°C Dry Bulb – 55% Relative Humidity
Winter	: 22.5°C Dry Bulb – 55% Relative Humidity

4.3 Tolerances

Temperature	: $\pm 1,5$ °C

4.4 Thermostats

Shall be set to maintain the required conditions within a tolerance of $\pm 1,5$ °C. Notwithstanding this tolerance the average temperatures shall not vary from the required conditions in any of the air conditioned areas.

Humidity	:: $\pm 5\%$

No positive humidity control is required (except for server room units) but the cooling equipment shall be selected to indirectly control humidity within the comfort range of 45% - 55% relative humidity.

4.5 Design Conditions

The *Contractor* shall test, commission and adjust the air-conditioning and ventilation installations so that they will maintain the inside design conditions specified above, subject to the capacity limits hereinafter specified during hours of operation.

4.6 Noise Levels

Maximum noise levels caused by the operation of the air-conditioning or ventilation plant shall not exceed OHS Act 85 of 1993 and regulations.

The specified noise levels shall be those that read at a distance of not more than 2 metres from any air outlet, return air grille or opening.

Further 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. The *Contractor* shall ensure that the complete installation does not exceed the specified noise levels.

The Contractor shall also be responsible to ensure that where ducts and pipes pass through concrete, brick or other structural members and finishes. This is achieved without transmission of noise and vibration

4.7 Plant Room / Service Areas

Tenderers are required to check whether the plant rooms and/or service area shown on the drawings are large enough to accommodate the equipment offered by them. It will not be possible to alter the plant room and/or service areas, and Tenderers must ensure that equipment offered can fit into the plant room and/or service area shown, allowing for access, maintenance, etc. Passages and walkways must be kept clear.

4.8 Specialist Firms

- 4.8.1 Insulation shall be carried out by specialist firms regularly engaged in this type of work.
- 4.8.2 Such specialist firms shall in addition be required to show completed installations to the Selected Subcontractor and Engineer, to prove that they are specialists in their field.
- 4.8.3 When starting on site, the insulation specialist shall be required to insulate certain piping, valves, fittings, ductwork etc. for approval by *the Engineer*. After approval by the Engineer the insulation specialist may proceed with the work under this Selected Subcontract.
- 4.8.4 Should the sample insulation be of an unacceptable standard, the Selected Subcontractor will engage another firm, whose standard of work is acceptable, without any extra cost to the Employer.
- 4.8.5 Where in the opinion of the Engineer, the standard of work produced by the Insulation Specialist deteriorates below acceptable or approved standards, then the Selected Subcontractor shall remove all such unacceptable work and appoint another insulation firm to complete the work under this Subcontract to a satisfactory standard, at no additional cost of the Employer.
- 4.8.6 The Selected Subcontractor shall be held responsible for the supervision of the workmen engaged in all insulation work and shall act on all instructions given by the Engineer or his

authorised representative.

4.9 Adhesives

- 4.9.1 Use mastic and liquid sealants and adhesives that comply with the relevant requirements of SANS 1238 and that, in addition (to obviate fire hazards when used on site in the wet stage), have a flash point determined in accordance with ASTM D 93. To prevent fire hazards, ensure that proper ventilation is provided during the application of insulation on the inside of ducts or other enclosed spaces.

4.10 Metal Bands, Wires

- 4.10.1 Metal band insulation to piping. Bands shall be aluminium with wing seals, 13mm wide and 0,5mm thick, for piping which is not sheet metal or aluminium clad.

4.11 Equipment Insulation

4.11.1 Drip Trays

- 4.11.1.1 Controls and indicating instruments shall, where sweating occurs due to condensation, be insulated. Pay particular attention to binder fittings.
- 4.11.1.2 Use insulation as specified in section 4.12.3 where possible, otherwise non-drip tape applied in sufficient layers. Paint non-drip tape after application.

4.12 Refrigerant Piping

- 4.12.1 The contractor shall install isolation valves on the refrigerant piping as shown in the HVAC drawing layout. The isolation valves shall be of the type and make recommended and approved by the OEM of the VRV/VRF system.

- 4.12.2 Thicknesses of insulation shall be as follows:

Nominal Pipe Size (mm)	Insulation Thickness in (mm)
6.35 – 9.53	19
12.7 up	25

- 4.12.3 The insulation properties shall be as follows:

Physical properties and Specification	
Type	Flexible elastomeric foam, Closed cell / EPDM
Thermal Conductivity	$\leq 0.033 \text{ W/(m.K)}$
Temperature range	-50°C - 110°C
Fire rating	Self-extinguishing, Zero spread of flame and zero Drip. FM Approved
Water vapour resistance	$\mu \geq 10000$
Fungi resistance	No fungal growth, Anti-microbial behaviour

4.13 Drain Piping

- 4.13.1 Insulate all drain piping from cassette units and air-handling units drip trays with a minimum of 19mm thick, see section 4.12.3. for insulation properties.
- 4.13.2 Drain should be installed in vertically upward and the down slope must be less than 1/50~1/100.
- 4.13.3 Flexible hose must be used between the indoor unit and drain pipe. Drain pipe must not be connected to the waste pipe.
- 4.13.4 Air vents should be installed at intervals of 10 meters. Air vent shall be higher than the common Pipe.
- 4.13.5 Install U-trap to prevent bad smell from entering indoor

4.14 Ductwork

- 4.14.1 Ducting and plenums shall be manufactured, installed and commissioned to the following standards: -
- 4.14.2 SANS (South African National Standards) 1238 – Manufacture Air-conditioning Ductwork.
- 4.14.3 SANS (South African National Standards) 10173 – Installation and Commissioning.
- 4.14.4 All ductwork on the upstream side of Operations Room air-handling units shall be constructed to the pressure classification equal to 1½ times the recommended terminal filter change-out (dirty) pressure differential. All ductwork shall be flanged, with longitudinal and transverse joints made airtight with Hard-cast Sealing and Jacketing System. Final connections shall be sheet

metal.

- 4.14.5 All bolts and nuts for flanged joints shall be cadmium plated.
- 4.14.6 All ductwork otherwise shall be supported on hot-dip galvanised brackets complete with adjustable hanger rods. Duct sizes indicate clear inside dimensions. Round ducting to be of the spiral wound type unless indicated otherwise.
- 4.14.7 During construction, all duct systems **shall be protected** from ingress of dust, dirt and foreign matter particularly for systems serving operating theatres. Strict compliance with this requirement will be enforced and internally soiled ducts will not be accepted as part of acceptance tests.
- 4.14.8 Flexible ducting to have a class 1 fire rating complying with sabs 0177 part 3 and to be less than 1.5m in length. ends are to be sealed and fixed with jubilee type clamps. flexible ducting shown connected to small fans is to be 1,5m long of the acoustic type for noise reduction.
- 4.14.9 Flexible round ducts shall only be used for connecting Air conditioning, diffusers and grilles to the supply, return and extract air ducts. Therefore, final bends to the air conditioning units and various diffusers shall be by means of flex ducting and not galvanized sheet metal ducting. Bends shall be of the maximum possible radius without flattening or distorting the duct.

4.15 Duct Insulation

- 4.15.1 All air-conditioning supply and return air ducting inside ceilings shall be externally insulated with 25 mm insulation with a density of 18kg/cubic metre, K-value 0.038w/m.k covered with aluminium foil reinforced Vapour barrier. Insulation shall comply with the latest SANS 428.
- 4.15.2 The insulation shall be mechanically fastened by means of Clipfas nylon pins and washers, glued to ducting with adhesive suitable for bonding between glass wool blanketing and galvanized sheet metal and shall, in addition, be mechanically secured at maximum intervals of 400 [mm] with nylon strapping, or by means of spot welded pins with securing washers/heads of diameter not less than 30 [mm]. and sealed along all longitudinal and transverse overlapping joints with approved adhesive to provide a vapour seal. Overlapping joints shall be approximately 120mm wide. Insulation thickness shall be carried over flanges or other upstands to prevent sweating due to condensation.
- 4.15.3 The insulation shall also be strapped with plastic straps at regular intervals spaced not more than 400 mm apart. Where necessary, especially at bends, transformation pieces, branches, etc., use adhesive, tape and straps to ensure that insulation is vapour sealed. Tears in duct insulation shall be taped over with aluminium type duct tape.
- 4.15.4 Insulation thicknesses shall be carried over duct flanges and sound attenuators.
- 4.15.5 Duct wrap insulation shall be non-combustible and conform to SABS 0177 Part 5 with a fire index that conforms to SABS 0177 Part 3 Class A. Ductwrap shall have a density of 40kg/m³ with SABS Class 1 Fire rating.
- 4.15.6 All air ducts carrying heated or cooled air, except where specifically excluded in the Supplementary Specification shall be thermally insulated.
- 4.15.7 Flexible ducts conveying conditioned air shall be of the insulated type.

4.16 FIRE STOPPING

- 4.16.1 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.
- 4.16.2 All products used for fire stopping shall be SABS approved and/or be in accordance with other recognized 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.
- 4.16.3 The purpose of fire stopping is to ensure that, should any fires occur, the fire and smoke will be localized and contained and not propagate via any electrical and/or electronic infrastructure. The Contractor shall fully comply with these requirements.

4.17 SOUND ATTENUATORS

- 4.17.1 Sound attenuators shall be the product of manufacturers regularly engaged in the production of such products and of which catalogue and selection data is available.
- 4.17.2 Casings shall be constructed of galvanised mild steel sheet, flanged for connection to ductwork, complete with matching counter flanges. The metal gauge for the casing shall not be less than the thickness specified for ductwork of the same dimensions. All casing joints shall be made airtight with Hardcast Sealing and Jacketing System or have soldered joints.
- 4.17.3 Sound attenuators in the supply and return air ducts shall have sound absorbing infill materials covered with Melinex or Hostaphan or other approved material.
- 4.17.4 All sound attenuators shall be labelled on the outside of the casing with aluminium identification tags, fastened to casing with pop rivets. Identification shall state type of sound attenuator, size, airway spacing, etc. Tags shall not be painted over.
- 4.17.5 Sound levels in the air-conditioned and ventilated spaces shall be as follows, when the air supply and return systems to which they are connected are operational:-
 - 4.17.5.1 General Air-conditioned Areas: Room Criteria (RC) Neutral (N) Level 35-40
 - 4.17.5.2 At 1.5 Metres Distance from Ducted Air Intake / Exhaust Air Louvres: RC (N) Level 50-55
 - 4.17.5.3 Air conditioning Units: As Per Manufactures Ratings
- 4.17.6 Air pressure drop through attenuators shall not exceed the following when delivering the air volumes:
 - 4.17.6.1 General Air-conditioning Areas:
35 Pascal (Supply Air)
- 4.17.7 Sound attenuators make, type and size indicated on the drawings are for tender purpose only,

and shall be reselected by the supplier of the sound attenuators based on final fan selections and contractors working drawings.

4.18 Air Filters

4.18.1 Air filters for air-handling plants shall be as follows with average dust spot efficiencies of:-

4.18.1.1 Primary filtration: 25% based on ASHRAE, G4 classification minimum.

4.18.1.2 Primary filtration shall be installed upstream of the supply air fan.

4.18.2 Secondary filtration units shall be of self-supported pocket filters designed and equipped to permit safe removal, disposal, and replacement of filters, without introducing contamination into the delivery system or the area served.

4.18.3 During construction, openings in ductwork and air terminals shall be sealed to prevent intrusion of dust, dirt, and hazardous materials, aiding growth of infectious agents.

4.18.4 Air filters shall be the product of suppliers regularly engaged in the manufacture of air filtration equipment and who publish filter data from which selections can be made.

4.18.5 Each filter shall be suitable for the space available and shall be installed without damage to the building, building equipment or the filter. Filters shall be constructed and installed so as to prevent the passage of unfiltered air. Felt, rubber, or neoprene gaskets shall be provided between filter frames and unit casings, etc.

4.18.6 Steel filter parts shall be protected against corrosion by baked on enamel, epoxy resin, zinc coated, cadmium plating, or two coats of oil paint, or two coats of lacquer or coated with alkyd paint after phosphate cleaning.

4.18.7 Filter elements and media shall be protected against dirt during construction and shall not be operated until system is thoroughly cleaned. No fan system shall be operated without filters. Filters must be put in regular operating conditions before the fans to which they are connected are operated for any purpose, such as temporary ventilation or adjusting. After all adjustments, etc., are completed and before the filters are accepted for regular operation, they shall be cleaned and provided with additional new media to put them in 'new' condition.

4.18.8 Each filter bank or terminal filter shall be provided with an identification plate, mounted in a location where it will be visible after installation. The plates shall show serial number, model number, and all other data necessary for ordering renewal media.

4.18.9 Unless otherwise specified filter pressure differential gauges shall be fitted across all filter banks and where such banks comprise two or more sets of filters in series, gauges shall be fitted across each individual set of filters. Tertiary filter terminals shall be provided with pressure differential tapping's for measurement of filter resistances and shall also include pressure differential gauges. Each differential pressure gauge shall be suitable for the type of filter pressure range. The tubing to each switch shall include connector tees for connecting to a portable Magnehelic gauge. Dirty filter condition shall be indicated on the associated switchboard by a red pilot light.

4.18.10 The gauges shall be connected to static pressure taps for approved design so that they will correctly indicate the resistance of filters to air flow. Connections shall be made with copper tubing and shall be provided with a 3-way cocks. Gauges shall be carefully levelled and

adjusted.

4.18.11 Side withdrawal filter banks shall be contained by extruded aluminium glide-tracks with woven pile 'fingers' surrounding a plastic air barrier to prevent air bypassing along the tracks.

4.18.12 Front withdrawal filter banks shall be fitted to built up frames supplied by the manufacturers of the media and being designed specifically for the media used. Adequate precautions must be taken to prevent bypassing of the filter media or frames. Where necessary filter frames shall be suitably strengthened to ensure complete rigidity of the filter bank.

4.19 Electrical Wiring

4.19.1 The entire installation shall be wired in accordance with the latest version of SANS 10142-1.

4.19.2 After completion of the installation and prior to the acceptance thereof the following documentation must be submitted to the Engineer:

- a) All original certificates as required by SANS10142-1.
- b) A copy of the wiring diagrams marked up with wire colours, core numbers, alterations, corrected motor loads, etc.
- c) A cable schedule showing cable sizes, types, cable numbers, etc.
- d) A schedule of all components and switchgear use.

4.19.3 Electrical Compliance Certificates are required by the latest revision of SANS 10142-1 are to be produced before power is applied to the specified switchboards and installation.

4.19.4 DO NOT alter wiring diagrams, switchgear selections, cable sizes, cable types, equipment positions etc., without permission.

4.20 Air Terminals, Dampers & Louvre's

4.20.1 Refer to detailed drawings and schedules on which air terminals, dampers, louvers, etc., are indicated giving type, capacity, size and make, and shall be of the following type or other approved:

4.20.1.1 Supply Air Diffusers

4.20.1.1.1 Shall be as specified in the schedule (or similar approved) with plenum unless indicated differently on the drawing complete with concealed fixing to duct spigots. The diffusers shall be externally insulated to prevent condensation forming on external flanges, etc.

4.20.1.2 Louvres

4.20.1.2.1 Shall be as specified in the schedule (or similar approved) with stainless steel wire mesh screen and masonry sub-frame as indicated on the drawings.

4.20.1.3 Fire Dampers

4.20.1.3.1 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:

- 4.20.1.3.2 Dampers shall be actuated by fusible link, electrical solenoid or pneumatic means, as specified on the drawing.
- 4.20.1.3.3 Fire dampers shall be flanged both sides and access panels shall be provided in the ducting at each fire damper on the upstream side.
- 4.20.1.3.4 Each fire damper shall be clearly marked as per Clause 4 of SANS 193.
- 4.20.1.3.5 Fire dampers shall have at least the resistance rating of the wall
- 4.20.1.3.6 The open or closed status of the damper shall be clearly indicated outside the casing for inspection purposes.
- 4.20.1.3.7 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.
- 4.20.1.3.8 Dampers shall be installed to form part of a continuous barrier to the passage of fire when in a closed position.
- 4.20.1.3.9 Sheet metal sleeves shall be provided for housing the fire dampers where a fire damper is mounted in a wall.
- 4.20.1.3.10 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.
- 4.20.1.3.11 Dampers shall be self-supporting, to provide for the case of duct destruction due to heat.
- 4.20.1.3.12 Care shall be exercised that the frame is set so that the closing device is accessible.
- 4.20.1.3.13 Suitable hand openings shall be provided, with tightly fitted covers to make dampers accessible for inspection and maintenance.
- 4.20.1.3.14 Retaining angles shall be installed on four sides of the fire damper sleeve and on each side of the wall.
- 4.20.1.3.15 Angles shall be fastened to the sleeves only, and not to the wall.
- 4.20.1.3.16 Retaining angles shall lap the masonry by a minimum of 35 mm around the entire opening.
- 4.20.1.4 Door Grilles
 - 4.20.1.4.1 Shall be fitted by the Principal Contractor. The Selected Subcontractor shall however check that the door grilles indicated on the drawings are installed.
- 4.20.1.5 Finishes
 - 4.20.1.5.1 Aluminium louvers or transfer grilles shall be natural anodized aluminium and painted to match the colour of structure its fitted to.
 - 4.20.1.5.2 All ductwork and flexible ducting which is visible through air terminals shall be painted matt

black.

4.21 Toilet / Kitchen Ventilation Fans

Refer to the drawings

Mechanical ventilation shall comply with SANS 10400.

4.21.1 All ventilation fans shall be as specified on drawings (or equal approved) and installed in positions indicated on the drawings and shall be of sizes and capacities given in the schedules.

4.21.2 The fan should remain switched off when there is no person in the toilet, change room and shower rooms. An artificial ventilation system required in terms of 4.3.2.4 (SANS 10400-O) should remain in the 'on' position for a period after the room is vacated. This is to ensure that any residual moisture is removed from the room so that a damp environment does not develop.

4.22 Apparatus bay

Refer to the drawings

Mechanical ventilation shall comply with SANS 10400.

4.22.1 The fans in the apparatus Bay shall be controlled by a CO detector, this is to remove the build up of Diesel fumes and other toxic fumes in the space.

4.23 Equipment Supports

4.23.1 Steel or Timber Rafters & Purlins:

4.23.1.1 Any attachment to any structural steelwork or timber rafters or purlins shall be by means of clamps and/or drilling, and no cutting, welding, etc. of timber roof trusses and structural steelwork will be allowed. If extra purlins or structures are required, due to manufacturer requirement of equipment being installed, they shall be added to the structure to accommodate said equipment.

4.23.1.2 Any bolts and nuts, washers, clamps, threaded rods, etc., used for fixing to structural steelwork, rafters and purlins shall be electro-zinc painted to BS 1706 of 1990.

4.23.1.3 Plant layout drawings, indicating point loads, at rafters and purlins, shall be submitted to the Structural Engineer for approval so that rafter and purlins are approved by the Structural Engineer prior to installation of ductwork.

4.23.2 Slabs

4.23.2.1 Any mechanical fixings to any concrete shall in no way damage such concrete.

4.23.2.2 All mechanical fixings shall be the product of recognised manufacturers, such as Hilti, or other approved manufacturer.

4.23.3 Painting

4.23.4 The paint colour scheme shall comply fully with the SABS requirements.

4.23.5 Thoroughly descale, clean and degrease.

4.23.6 Paint all exposed metalwork and equipment which is not a specified manufactured product as follows:

4.23.6.1 Black Metalwork:

- a) One coat of PA10 primer.
- b) One universal undercoat.
- c) Two coats of high floss enamel to ensure complete corrosion protection

4.23.6.2 Galvanised Metalwork:

- a) Degrease and prepare surfaces with a wash specifically designed for pre-treatment of galvanised iron.
- b) One coat of calcium plumbate.
- c) One universal undercoat.
- d) Two coats of high gloss enamel to ensure complete corrosion protections.

4.23.6.3 Factory Painted Equipment:

- a) Damaged and scratched paint surfaces shall be touched up with identical colour paint.
- b) All packaged unit supporting steelwork shall be painted.
- c) Paint shall be of the highest quality and shall be applied strictly in accordance with the manufacturer's specification.

4.24 Testing, Commissioning & Balancing

4.24.1 Shall be carried out by an independent firm employing competent technicians familiar with the testing, adjusting, and balancing of air-conditioning plants. Such firm shall forward all test results to the Engineer and Selected Subcontractor, for approval.

4.24.2 Commissioning of the VRV/VRF unit/s shall be carried out by the manufacturers of the units, to ensure that system performs and designed and specified duties and functions and that all temperature and control monitoring / adjustment are in place and also functioning correctly.

4.24.3 Testing, adjusting, and balancing of the systems shall generally be in accordance with Chapter 34 of 1995 ASHRAE HANDBOOK (Testing, Adjusting, and Balancing).

4.25 Operating & Maintenance Manuals

4.25.1 Four Sets of Operating and Maintenance Manuals shall be prepared in the form as suggested in Chapter 59 of 1987 ASHRAE HANDBOOK (HVAC System and Applications).

4.25.2 All as built drawings shall be supplied on CD with four sets of hard copies.

4.25.3 Plant schematics and wiring diagrams shall be the latest revision and shall be framed behind glass and displayed adjacent to switchboards.

4.26 Maintenance

- 4.26.1 Allow for the maintenance of the complete installation for a period of TWELVE (12) MONTHS after 'practical' completion certificate has been issued by the Engineer. Visit the installation once a month on the basis of a proper preventive programme approved by the Engineer.
- 4.26.2 Report to an official nominated by the Client on arrival and again on leaving their premises on the occasion of each visit. Such person, who has been nominated by the Client, shall sign a Service Report giving details of corrected temperature and humidity readings taken, etc.
- 4.26.3 At each service visit, maintenance personnel shall, inter alia, perform the following duties in addition to any other which may be necessary.
 - 4.26.3.1 Check all fans and variable speed drives, lubricate moving part and tighten where applicable, belts, as required, and check all lock-out stops. Check air-handling cooling coils, drip trays, drainage systems for cleanliness and correct functioning. Check air-handling units for condensation.
 - 4.26.3.2 Check all air filters, etc, replacing filter media or filter panels as required. Check differential pressure gauges and switches, etc.
 - 4.26.3.3 Check all switchboards. Tighten connections, check switchgear for burnt contacts, check overload settings, phase failure relays, etc. Relays etc. Replace defective voltmeters, ammeters, transformers, pilot lights, hour meters, timers, time switches, etc.
 - 4.26.3.4 Check all control systems and safety devices, air flow switches, manometers, etc. for correct functioning and replace defective items or any other items as necessary.
 - 4.26.3.5 Check VRV units for correct functioning. Check refrigerant system for leaks, refrigerant dryness, sufficient oil level, and all safety controls and settings, etc. and correct and top-up as required.
- 4.26.4 Make good any defects as required in items of the guarantee given for the plant in terms of the specification.
- 4.26.5 Attend to any complaints made with respect to the installed plant by the authorised person mentioned in the foregoing. No other person shall have any right to instruct the Selected Subcontractor or make any complaint.
- 4.26.6 Instruct the Client's maintenance personnel on the attention required to any item requiring more frequent attention during the service visits.
- 4.26.7 A major service shall be executed in the sixth and twelfth month of the maintenance period shall be to the satisfaction of the Engineer. This major service shall include all annual servicing functions as recommended by the manufacturers of material and equipment supplied and/or installed under this contract.

4.27 Guarantee

- 4.27.1 The contractor shall guarantee the materials, apparatus and workmanship delivered and installed by him. The guarantee shall be valid for a period of twelve months starting on the date when the practical completion certificate is issued. The complete installation shall be guaranteed against defects as a result of patent and latent defects of the apparatus, as well as against faulty materials and workmanship. Fair wear and tear is excluded from the guarantee.

- 4.27.1.1 The guarantee shall provide for all parts, spares and appurtenances which become defective during the guarantee period, to be replaced free of charge to the Client. All costs of labour, out-of-town allowances, materials and transportation required to replace such part of a defective installation shall be borne by the Selected Subcontractor and shall be included in his guarantee. The Selected Subcontractor shall cede to the Client the remainder of any equipment guarantee which he has received from his suppliers and which may extend beyond the period of twelve months mentioned herein.

4.28 Extended Guarantee

- 4.28.1.1 Where certain equipment have supplier's standard guarantee clauses of which do not correspond with the guarantee Clause 4.27, the *Contractor* shall allow in the tender price for the extension of guarantees and additional charges thereof, in order to comply with guarantee clause.

4.29 List Of Drawings

- 4.29.1 The following drawings accompany this Specification and Tenderers shall verify that they are in the possession of these drawings. Should any of the listed drawings be missing from the Tender Documents, the onus will be on the Tenderer to notify the Engineer accordingly and obtain such drawings.

Description		
Drawing No.	Rev.	Description

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure N: Mechanical Technical Specification Lift

REPORT	
For:	Technical Specification for Lift
Project Name:	National Fire Service Building Upgrade Port of Port Elizabeth
Project Number:	PLZ/ENG00051
Author:	Kyle Hankey
Owner:	Transnet
Client:	Transnet National Port Authority
Project Sponsor:	Transnet National Port Authority
Project Manager:	Carlin Van Aswegen
Revision Number:	0A
Approved by:	Aslam Haffejee
Release Date:	
Print Date:	11/05/2023
Template Date:	01/05/2012
Document No:	XCT.0007-ENG-M-SP-0005

Distribution	
Name	Title
Khethelo Mhlanga	Engineering Manager

DOCUMENTATION DISTRIBUTION, REVISION AND APPROVAL HISTORY

REVISION NUMBER	DATE	DISTRIBUTION/ REVISION	PREPARED BY	REVIEWED BY	APPROVED BY
0A	11/05/2023	CLIENT REVIEW	K.H	A.H	A.H

Prepared by:



Kyle Hankey (Engineer)

11/05/2023

Date

Reviewed by:



Aslam Haffejee (senior Engineer)

11/05/2023

Date

Approved by:



Aslam Haffejee (Senior Engineer)

11/05/2023

Date

ADDITIONAL SIGNATORIES:

Accepted by:

(Eng. Manager)

Date

Accepted by:

(Senior Project Manager)

Date

ADDITIONAL SIGNATORIES (TNPA):

Accepted by:

Date

Accepted by:

Date

ELEVATOR:	630 KG / 8 PERSON PASSENGER ELEVATOR
Rated Capacity	630 kg / 8 person
Speed	1.00 m/s
Stops	2 Stops, 2 Openings
Floor Designation	0, 1.
Travel	+ - 3750 mm
Entrance Width	900 mm wide
Opening	2 panel center opening sliding door
Car Size	1100 mm wide x 1400 mm deep x 2200 mm high
Door Dimensions	900 mm wide x 2000 mm high
Hoist Dimensions (min)	1650 mm wide x 1775 mm deep
Counter Weight	Side Drop
Pit Depth	1175 mm
Overhead (min)	3450 mm
Side Walls	Brushed Stainless Steel
Rear Wall	Brushed Stainless Steel
Landing Doors & Cabin Doors	Brushed Stainless Steel
Frames	Stainless Steel with 50 x 50 Box Frames
Ceiling	Stainless Steel
Lighting	4 LED Spot lights, per the standard product line
Flooring	Non-Slip Black Rubber
Handrails	35 mm round – Rear and side walls
Mirror	Top Half – Rear Wall
Kick Plates	Standard per the product line
Car Operating Panels	2 CO (center opening panel doors)
Starts per Hour	240

ELECTRICAL POWER REQUIREMENT

Traction Machine type	Gearless
Hoisting Motor type	Permanent Magnet Motor
Motor Drive	VVVF Control
Hoisting Motor Power (PMN)	8kW
Nominal Current (INN)	21.90A
Starting Current (INA)	25.10A
Fuse	25A
Power Factor	0.98
Supply	380V, 3phase, 50Hz
Shaft Reference drawing	PLZENG-1-000-S-LA-1004-01-D

EMERGENCY OPERATIONS & FEATURES

	Car lighting which turns on immediately when power fails, providing a minimum level of lighting within the car. (Choice of dry-cell battery or trickle-charge battery.)
	Upon activation of a key switch or a building's fire alarm, all calls are canceled, all cars immediately return to a specified evacuation floor and the doors open to facilitate the safe evacuation of passengers.
	During a fire, when the fire operation switch is activated, the car calls of a specified car and all hall calls are canceled, and the car immediately returns to a predetermined floor. The car then responds only to car calls which facilitate fire-fighting and rescue operation.
	Upon power failure, a car equipped with this function automatically moves and stops at the nearest floor using a rechargeable battery, and the doors open to facilitate the safe evacuation of passengers. (Maximum allowable floor-to-floor distance is 11 meters)
	Upon power failure, predetermined car(s) uses the building's emergency power supply to move to a specified floor, where the doors then open to facilitate the safe evacuation of passengers. After all cars have arrived, the predetermined car(s) resume normal operation.
	The car shall come equipped with a intercom which shall relay to a desired emergency location, the car shall also come equipped with a camera to be connected to the security network.

DOOR OPERATION FEATURES

	Door load on each floor, which can depend on the type of hall doors, is monitored to adjust the door speed, thereby making the door speed consistent throughout all floors
	When excessive door load has been detected while opening or closing, the doors immediately reverse
	A buzzer sounds and the doors slowly close when they have remained open for longer than the preset period. With the AAN-B or AAN-G feature, a beep and voice guidance sound instead of the buzzer.
	Failure of non-contact door sensors is checked automatically, and if a problem is diagnosed, the door-close timing is delayed and the closing speed is reduced to maintain elevator service and ensure passenger safety.
	Door open time is minimized using the Multi-beam Door Sensor feature that detects passengers boarding or exiting.
	When the button inside a car is pressed, the doors will remain open longer to allow loading and unloading of baggage, a stretcher, etc.
	Multiple infrared-light beams cover some height of the doors to detect passengers or objects as the doors close.
	Closing doors can be reopened by pressing the hall button corresponding to the traveling direction of the car.
	Should an obstacle prevent the doors from closing, the doors will repeatedly open and close until the obstacle is cleared from the doorway.
	The sensitive door edge detects passengers or objects during door closing.

OPERATIONAL & SERVICE FEATURES

	Fully loaded car bypasses hall calls in order to maintain maximum operational efficiency.
	If one car cannot carry all waiting passengers because it is full, another car will automatically be assigned for the remaining passengers
	An operation by car controllers which automatically maintains elevator operation in the event that a microprocessor or transmission line in the group controller has failed
	When a car has responded to the final car call in one direction, the system regards remaining calls in the other direction as mistakes and clears them from the memory
	If there are no calls for a specified period, the car ventilation fan will automatically turn off to conserve energy
	A car which is experiencing trouble is automatically withdrawn from group control operation to maintain overall group performance

	Exclusive operation where a car is withdrawn from group control operation for independent use, such as maintenance or repair, and responds only to car calls.
	If the elevator doors do not open fully at a destination floor, the doors close, and the car automatically moves to the next or nearest floor where the doors open.
	A buzzer sounds to alert the passengers that the car is overloaded. The doors remain open, and the car will not leave that floor until enough passengers exit the car.
	If a car has stopped between floors due to some equipment malfunction, the controller checks the cause, and if it is considered safe to move the car, the car will move to the nearest floor at a low speed and the doors will open.
	A system which allows communication between passengers inside a car and the building personnel.
	A click-type car button which emits electronic beep sounds when pressed to indicate that the call has been registered
	The car shall come equipped with a ventilation fan, if there are no calls for a specified period, the car ventilation fan shall automatically turn off to conserve energy.
COMMISSIONING, TESTING & QUALITY STANDARDS	
	Commissioning of New and Modernised installations and Testing shall comply with with Lift Regulation 828 (clause 6) for Passenger Lifts (Traction and Hydraulic), Escalators and Passenger Conveyors, Access Goods Only Lifts, Stair Lifting Platforms and Vertical Lifting Platforms, which will include the mandatory 24 month regulatory inspection of all new installations. Mandatory Comprehensive Inspections as required when there is a change in the competence Service Provider or after any equipment failure has occurred. All work to be performed during the installation of the new lift shall be performed in line with the Occupational Health & Safety Act 85 of 1993, Lift/ Escalator/ and Passenger Conveyor Regulation R 828 and the South African National Standards. On testing and commissioning, a competent person with any of the following affiliations or similar; • South African National Accreditation System (sanas lift 0011) • Department of Labour (lepc isp 0011) • Engineering Council Of South Africa (ecsa reg. no. 200811004) • Lift Inspectors Association of South Africa (liasa 177)

	The competent personal shall insure all certificates of conformance (CoC) and quality standards, shall be supplied and adhered to in accordance to the following: • SANS 1545 • ISO 9001 & ISO 14001 • SANS 1545-2 2015 3.4 Safety rules for the construction and installation of lifts — Part 2 : Hydraulic lifts • Occupational Health and Safety Act 85 of 1993 • Lift, Escalator and Passenger Conveyor Regulations R828 • South African National Standards for Lifts , Escalators and Passenger Conveyors. • Employment Equity Act • Basic Conditions of Employment Act • Workman's Compensation Act

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure O: Mechanical Design Report

REPORT	
For:	Design Report
Project Name:	TNPA National Fire Service Upgrade Port of Port Elizabeth
Project Number:	PLZ/ENG-00051
Author:	Kyle Hankey & Bongane Mngomezulu
Owner:	Transnet
Client:	Transnet National Port Authority
Project Sponsor:	Transnet National Port Authority
Project Manager:	Carlin Van Aswegen
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Name	Title
Khethelo Mhlanga	Engineering Manager

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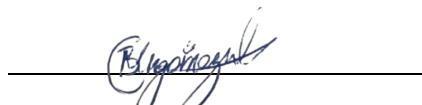
REVISION NUMBER	DATE	DISTRIBUTION/ REVISION	PREPARED BY	REVIEWED BY	APPROVED BY
0A	13/12/2022	CLIENT REVIEW	K.H	A.H	A.H

Prepared by:


 Kyle Hankey (Engineer)

13-12-2022

Date


 Bongane Mngomezulu (Engineer)

13-12-2022

Date

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1 BACKGROUND

Based on the recommendations of the Fire Protection Association of Southern Africa (FPASA) study and the long-term vision of the TNPA Fire and Emergency Services department the primary objective of this project is to provide infrastructure to the Fire Services Department at the Port of Port Elizabeth to address the identified inadequacies.

The proposed upgrade will provide the Fire Services department with a facility to operate from and allow them to effectively contain and prevent the escalation of any emergency event until the arrival of the respective Local Authority Emergency Services.

2 CURRENT STATUS

The Employer seeks to acquire the services of a suitably qualified and resourced Multidisciplinary Engineering Contractor to undertake project execution work and all engineering related activities, procure all material and equipment and execute the Works. The Works must be in accordance with Employers designs.

3 PURPOSE

The purpose of this report is to detail all mechanical engineering work; design calculations, used to determine equipment selection, in conjunction with standards and specifications used to ensure proper and safe functioning of mechanical installation for the new Port of Port Elizabeth Fire Services department facility building.

4 SCOPE OF WORK

The Mechanical scope of works for the new Port of Port Elizabeth Fire Services department facility building includes design drawings for Tender, along with specification for HVAC, fire suppression and fire detection, and potable cold-water system upgrade within the building.

5 PROJECT DELIVERIES

5.1 Technical Drawings

- Manual Fire Suppression System Layout Ground and First Floor
- Automatic Fire Detection System Layout Ground and First Floor
- HVAC System Layout Ground Floor
- HVAC System Layout First Floor
- Water Reticulation Layout Ground Floor
- Water Reticulation Layout First Floor

5.2 Technical Specifications

- Technical Specification for Fire Suppression System
- Technical Specification for Fire Detection System
- Technical Specification for HVAC System

- Technical Specification for Water Reticulation System

5.3 Design Criteria

5.4 Design Report

5.5 Works Information

5.6 Bills of Quantity and Cost Estimate

6 REFERENCE STANDARDS AND SPECIFICATIONS

Standard No.	Description
NFPA 13	Standard for the Installation of Sprinkler Systems
SANS 10252	Water supply and drainage for buildings Part 1 and Part 2
SANS 10400-T	The application of the National Building Regulations Part T: Fire protection
SANS 10400-O	The application of the National Building Regulations Part O: Lighting and ventilation
SANS 10139	Fire detection and alarm systems for buildings - System design, installation and servicing
SANS 1200HC	Corrosion Protection of Structural Steelwork
SANS 1200 L	Medium Pressure Pipeline
SANS 10400	The Application of the National Building Regulations
SANS 659:2007	Cold water - Copper
SANS 1545	Safety rules for the construction and installation of lifts
SANS 4344	Steel wire ropes for lifts – minimum requirements
SANS 347: 2012	Categorization and conformity assessment criteria for all pressure equipment
SANS 32/SANS121	Hot Dip Zinc (galvanised) Coatings
SANS 10254: 2017	The Installation, maintenance, replacement and repair of fixed electric storage water heating systems
SANS 10139: 2012	Fire detection and alarm systems for buildings
SANS 10064	The preparation of steel surfaces for coating
SANS 763	Hot-dip (galvanised) zinc coatings
SANS 1091	National colour standards for paint
SANS 5493	Code of practice for protective coating of iron and steel structures against corrosion
SANS 10400 XA	Energy usage in buildings
SANS 1910	Portable refillable fire extinguishers

SANS 543	Fire hose reels
SANS 10400W	The application of the National Building Regulations Part W: Fire installation
SANS 1200 LB	Bedding (pipes)
SANS 10142	Code of Practice for the Wiring of Premises.
SANS 10147	Code of Practice for Refrigeration and air-conditioning installations
SANS 1238	Air conditioning ductwork
SANS 10173	Code of Practice for the installation, testing and balancing of air conditioning duct work
SANS 1387:2009	galvanized mild steel, medium weight
SANS 62	Pipes suitable for threading and of nominal size not exceeding 150 mm
SANS 1186	Standard signs and general requirements
SANS 1128-1:2010	Components of underground and above-ground hydrant systems
SANS 1461	Major hazard installation - Risk assessments

7 MECHANICAL DESIGN

7.1 Overview

The design for the fire suppression and detection, HVAC, and water reticulation systems were done in order to provide a detailed overview of the type of fire suppression and detection, HVAC and water reticulation system required as well as develop a cost for the project. The Contractor shall complete the all workshop and detailed drawings/designs of the fire suppression detection, HVAC and water reticulation systems before construction commences.

7.2 Fire Protection

Manual Fire suppression and automatic fire detection protection for the building was done as per the requirements of SANS 10400 and NFPA 14. Due to the nature of the operations within the building and the risk profile, it was recommended to the client that a fire suppression and detection system be provided for the building in order ensure easy access to protect against a large-scale fire spreading quickly, as well as early warnings of a potential large-scale fire, and causing damage to the building and lives of those within the area and port. This was adopted in addition to the minimum requirements as per the SANS codes.

The fire system for the building comprised of the following elements:

- Fire Hose Reels with Hydrant Connection Points within the building as depicted on the drawings.
- Fire extinguishers within the building, varying per areas within the building.
- Fire detection comprising of the following:
 - a. Smoke/Heat Detectors
 - b. Sirens/Alarms
 - c. Call Points
 - d. Fire Control Panel

7.2.1 Fire Hose Reel/Hydrant and Piping Design

The fire suppression and detection system were based on the NFPA 14 standard and SANS 10400. The fire hose reel to be 1 per 500m² with a 30m hose, hose length, thus each hose reel must have the ability to cover a length of 30m from its location, a 9kg and 4.5kg for the office area (G1) shall be located under each hose reel, and at one 9kg DCP per 100m²

Hydrants will be placed at each hose reel in accordance with 1 per 1000m² need to be capable of providing fire protection. The hydrants are also equipped with 30m hoses and need thus hydrants are situated to reach an area with a radius of 30m. they will also be located at best points of easy access for fire fighters entering the building.

SANS 10400 requires that a single hydrant should be capable of delivering a water flow of at least 1200 l/min, at a running pressure of 300kPa. Where two hydrants are required to be operated simultaneously, a flow of 1200 l/min is required to be delivered, at 300kPa running pressure, per hydrant.

The approach used to determine the pressure required by the system, and thus the pressure losses, was to assess various points in the connected pipeline using the below Bernoulli equation, where the conditions are known.

$$h_o + \frac{P_o}{\rho g} + \frac{v_o^2}{2g} + \Delta h_p = h_1 + \frac{P_1}{\rho g} + \frac{v_1^2}{2g} + \Delta h_f + \Delta h_m \quad \text{Eq. 1}$$

Where: h Head loss
 hp Head loss due to pumps
 hm Head loss due to fitting/geometry, etc. (minor losses)
 hf Head loss due to pipe friction
 P Pressure
 v Velocity
 ρ Density
 g Gravity

Losses within the pipeline are determined by 2 main factors which are the head loss due to pipe friction (frictional losses) and head loss due to fitting/geometry, etc. (minor losses)

To determine the frictional losses within the pipeline, one needs to determine the friction factor within the selected pipe. This is dependent on an additional 3 factors, the Reynolds number, the pipe material roughness, as well as the selected pipe diameter for each section. As piping for various sections of the pipeline have various diameters, it leads to different Reynolds numbers and thus velocities, thus each pipe sections pressure losses need to be calculated separately.

Below is the process used to determine the frictional losses within a pipeline:

The piping diameters are determined by the flow requirements of the system using the below formula:

$$A = \frac{Q}{v} \quad \text{Eq. 2}$$

Where: Q Volumetric Flowrate of the fluid
 v Velocity
 A Cross-sectional area of the pipe

The diameter of the pipe chosen will then influence the pressure losses within the system, and thus be changed to determine the desired pressure losses as well as sound velocity requirements within the system.

Frictional losses due to pipe properties is calculated use the Darcy-Weisbach equation, as seen below.

$$\Delta h_f = f \frac{L}{D} \frac{v^2}{2g} \quad \text{Eq. 3}$$

Where: f Friction Factor
 L Pipe Length
 v Velocity
 g gravity

The friction factor used in the above equation is calculated using the explicit approximation of the Colebrook Correlation, as seen below.

$$f = \frac{1.325}{\left[\ln \left(\frac{\varepsilon/D}{3.7} + \frac{5.74}{Re^{0.9}} \right) \right]^2} \quad \text{Eq. 4}$$

Where: f Friction Factor
 ε Relative material roughness
 Re Reynolds Number
 D Pipe diameter

The Reynolds number is thus needed to be determined, which is characterised as a the ratio of internal forces to viscous forces. The Reynolds number thus a dimensionless number used to categorize the fluids systems in which the effect of viscosity is important in controlling the velocities or the flow pattern of a fluid, by the following equation.

$$Re = \frac{\rho v D}{\mu} \quad \text{Eq. 5}$$

Where: Re Reynolds Number
 ρ Density
 v Velocity
 D Pipe diameter
 μ Dynamic Viscosity of the Fluid

The Reynolds number is used to determine whether a fluid is in laminar or turbulent flow. Based on the API 13D recommendations, it is assumed that a Reynolds number Flow-through pipes are classified into three main flow regimes.

- Laminar flow – $R < 2100$
- Critical flow – $R > 2100$ and $R < 4000$
- Turbulent flow – $R > 4000$

Finally the Minor Losses are calculated using the form of the Darcy-Weisbach equation as shown below.

$$\Delta h_m = \Sigma K \frac{v^2}{2g} \quad \text{Eq. 6}$$

Where: Δh_m Minor Losses
 ΣK Sum of all the loss coefficients in the length of pipe
 v Velocity
 g gravity

7.2.2 Fire Detection System

Fire Detection System to comprise of the following elements:

- Optical Smoke Detectors

- Heat detectors
- Sirens
- Fire Control Panel
- Manual Call Points

7.2.3 Optical Smoke/Heat Detectors

Allows the detector to distinguish between smoke particles and non-combustible particles by estimating the relative difference in particle size, by calculating the ratio of two scattered light sources of different wavelengths

This is achieved by a pulsing infra-red LED light source and the infrared receiver obstructed by the means of baffle plates in the light proof housing which allows free ingress of smoke. Dual LED optical sensors can be used, which contain both red and blue LED to distinguish smoke conditions.

The rational to determine the spacing of these detectors are as follows:

- Horizontal distance of not more than 15m between projected beams
- One half (7.5m) of that spacing between projected beams and the side wall of the room/or space.
- On smooth ceilings the detectors will be mounted within 600mm from the ceiling surface.
- If there are too many obstruction the beam is to be mounted at least 3m from the floor to avoid said construction.
- For sloped ceiling detectors will be placed at the peak and intervals up the slope as well.

The recommended ceiling height per detectors are depicted below:

Detector Type	Generally applicable maximum ceiling height (m)
Heat detectors conforming to SANS 50054-5 – Class A1	9
Heat detectors – other Classes	7.5
Point Smoke detectors	10.5
Carbon monoxide detectors	10.5

Optical beam smoke detectors	25
ASD system approved to EN54 part 20	10.5
ASD system with at least 12 class C holes or at least 5 Class B holes	15
ASD system with at least 15 class C holes or at least 5 Class B holes	25
Other fire detectors	As specified by the manufacturer

7.2.4 Sirens

All indoor sirens to be of the same tone and frequency, while those in the outside will have increased tone and frequency.

While ensuring that two sounders are provided in the detection system,

7.2.5 Fire Control Panel

An addressable control panel will be fitted to allow for the following within the building:

- Point indication of fire within buildings
- Zoning by means of loop isolators and software programming
- Accommodation of addressable sounders
- Self monitoring, testing and maintenance of the system.
- Provision of input and output models to control air conditioning, and gas monitoring system

Addressable control panels allow for pin point locating of devices within the system. This then allows one to be able to identify the device on the addressable panel LCD screen.

HVAC system will be connected to the addressable panel and thus it will turn off all supply and extract fans when a fire alarm is detected.

7.3 Potable Water Reticulation

The design for the water reticulation systems were done using SANS 10252-1 to ensure sufficient supply of to all taps and toilets. The design flowrate as per Table 3 section 4.2.2.2 of SANS 10252-1 for the taps, showerheads, and toilets were 9L/min, 10L/min and 65L/min respectively, with the toilets being assumed as flush valves requiring a high pressure of 170kPa.

The total design flowrate for the probable demand was based of the diversity factor of 0.8, by classifying the building as factory ablutions, to account for the 3 shift changes

within 24hr, and thus allowing all other water points within the ablutions block to function concurrently when multiple water points are being used.

The process of determining the piping diameter and pressure losses within the system, follows the same process from **Error! Reference source not found.** to **Error! Reference source not found.**

The Contractor shall follow the detailed designs of the potable water reticulation systems and ensure that workshop drawings are provided before construction commences.

7.3.1 Hot Water Equipment

The heat pump system shall be connected to heat recovery units of the air-conditioning system, the heat pump should be that of the same OEM brand as the air-conditioning system, this heat pump will be connected to a heat exchanger which will interface with the hot water cylinder, and be fitted with a circulating pump. This heat pump and heat exchanger has been specified to provide heating for 1x500 litre storage tank. The storage tanks will be fitted with a circulating pump, which will be used by a high efficiency mechanical heat pump located in the service alley.

7.3.1.1 Components and Importance of Efficient Use

The hot water heat recovery system shall comprise of the following:

Shall be specially for producing hot and cold water in multi-compressor systems. The system shall produce water temperatures up to 50 °C or 80 °C (High Temperature kit, for heating mode only). The system shall be of galvanised steel housing painted in a warm grey tone and is intended for indoor use. The system shall be fitted with a high-efficiency heat exchanger which will be insulated and diffusion resistant.

The system shall work with refrigerant to refrigerant the heat exchange, which will be connected to a second heat exchanger, that will interface with the hot water storage tank, which shall be tubed to allow for refrigerant to heat stored water, control panel, backup elements, fittings, and R410a included in a very high efficiency heat pump to be located in the cleaners room connected via insulated copper pipework amour flex lagging to hot water storage tanks located in the same cleaners room. The storage tank to be insulated with high quality removable fleece jacket with foil shell Insulation.

The hot water heat recovery is designed to save energy as follows:

A refrigerant fluid is pumped around in a circuit where it evaporates on one side of the circuit and condenses at the other. In an air-conditioner, evaporation absorbs heat whilst condensation releases heat. In a heat pump, heat is absorbed from heat recovery units of the main air-conditioning system into the refrigerant fluid; the fluid is pumped around to the other side of the circuit where the absorbed heat is released in the within multiple heat exchangers to heat up water. Hence, a heat recovery system uses approximately 40-50% of the energy that conventional systems do.

7.4 Heating Ventilation and Air Conditioning

The HVAC has been designed to include fresh air intake unit and Ceiling units. The cooling system will be served by a high efficiency mechanical condenser located outside of the building on the west side wall. The HVAC system is designed to ensure comfortable working environment.

The Design Condition for the air-conditioned area as follows:

Office Spaces

External Conditions:

Summer ambient	:29.9 °C Dry Bulb Maximum
Winter ambient	:11°C Minimum
Winter ambient	:80%
Altitude	:63 m above sea level

Internal Conditions:

Summer	:22.5 °C Dry - 55% Relative Humidity
Winter	:22.5 °C Dry - 55% Relative Humidity

Typical Heat Loads:

Sensible Heat / Person	:75W
Latent Heat / Person	:45W
Fresh air / person	:7.5l/s or 2 ACH
Lighting load	:20.66 W/m ²
Plug Load	:10 W/m ²
Outside air quantity	:up to 10 air changers per hour in areas
Glass shade factor	:0.81
Toilet ventilation	:as per SANS 10400-O
Gym ventilation	:as per SANS 10400-O
Double apparatus bay ventilation	:as per SANS 10400-O
U' values - Glass (all façades)	:5.89 W/m ² K
Outside walls (all façades)	:1.127 W/m ² K
Partitions	:1.091 W/m ² K
Roof	:0.227W/m ² K

7.4.1 Components and Importance of Efficient Use

The cooling and heating system comprise of Variable Refrigerant Flow (VRF) system consisting of high efficiency air cooled condensers to be located outside the building, connected via a mode control/heat exchanger unit, with insulated refrigerant pipework to internal ceiling mounted units located in the building, this will allow for simultaneous heating and cooling in different areas within the building without wasting energy.

Conditioned air will be delivered to the occupied spaces (offices/gym/control rooms/etc) via ceiling mounted air conditioning units. Where the insulated piping shall run within the ceiling along with drainage pipes which will be routed to the nearest drainage point.

7.4.2 High efficiency condenser comprises the following to minimize energy consumption:

- Inverter Scroll Compressors
- Dual digital converter allowing compressors to run simultaneously.
- Vapor injection system to assist the increase flowrate of the refrigerant

7.4.3 Ventilation Systems

The ventilation systems within the building are designed to provide filtered air to multiple spaces within the building. These systems include providing dedicated fresh air intake fans to ensure that good indoor air quality is maintained by reducing the build-up of indoor air pollutants.

The indoor ventilation system comprises of the following:

- fresh air supply diffusers,
- door grills,

- extract air disc diffusers,
- wall/window mounted fans located in selected areas,
- returning air, via the ceiling mounted air conditioning units which will clean air before releasing said air as cooled and conditioned air.

The air-conditioning system is designed to introduce 7.5 litres per person, or the required air changes per room designation as highlighted in SANS 10400 – O, by using adjustable fresh air supply diffusers with plenum boxes to control the fresh air intake through the ceiling.

7.4.3.1 Duct & Fan Sizing

The Equal Friction Method was used when sizing air ducts and determining fans size and static pressure. The method can be summarized to

- Select suitable velocities for main and branch ducts from the table below
- Find the sizes of main and branch ducts from the air flow rates and the velocities by using Eq. 7 and the charts below
- From velocities and duct dimensions - find the frictional pressure loss in the main and branch ducts using the ASHRAE 2009 friction chart
- Add minor dynamic loss
- Keep the Pressure loss in the duct under 1 Pa/m

The required velocity within ducting depends on application and environment. The table below indicate commonly used velocities:

Type of Duct	Comfort System (m/s)	Industrial System (m/s)	High Speed System (m/s)
Main ducts	4 - 7	8 - 12	10 - 18
Main branch ducts	3 - 5	5 - 8	6 - 12
Branch ducts	1 - 3	3 - 5	5 - 8

Sizes of ducts are then given by the D'arcy Equation equation like:

$$\Delta P = \frac{\mu l}{d} \times \frac{1}{2} \rho v^2 \quad \text{Eq. 7}$$

Where:

ΔP	Pressure loss (Pa)
ρ	Density of the fluid (kg/m ³)
l	Length of duct (m)
v	Mean velocity of air flow (m/s)
d	Internal duct diameter (m)

Pressure loss paths are evaluated along the ducting system, while keeping the pressure per meter under 1 Pa/m, which fit the criteria of the building and the layout from the supply air fan. Pressure loss for each path from fan to each outlet point is calculated to achieve the static pressure required by the fan, dampers are added to

balance the pressure losses within the system. The flowrate and static pressure are then used to identify the operational point on manufacture fan curves, to select the correct supply or extract fan.

Fitting loss coefficients are taken from the fitting database see the ASHRAE Duct Fitting Database (ASHRAE 2009).

7.4.4 Dedicated exhaust systems have been designed for each of the following:

- Female and male showers/toilets: Extract “dirty air” directly to the outside of the build and to keep the space in negative pressure compared to the rest of the building.
- Storage room: Remove flammable gases from the space and exhaust directly to the outside of the building.
- Kitchen: Extract “dirty air” directly to the outside of the build and to keep the space in negative pressure compared to the rest of the building.
- Gym: Extract “dirty air” directly to the outside of the build and to keep the space in negative pressure compared to the rest of the building.
- Equipment room: Extract “dirty air” directly to the outside of the build
- Double Apparatus Bay: mechanical ventilation shall be installed in the space to reduce vehicle exhaust fumes such as carbon monoxide. The system shall reduce the concentrations of these elements to safe levels. carbon monoxide detection and control system was specified for the space. The detectors will allow the system to sense if the level of carbon monoxide starts rising and once it reaches the set point of 25ppm the control system shall switch on the ventilation. Once the level of Carbon Monoxide has dropped below the limit, the ventilation system will run for a further 30minutes and then switch off. This will ensure the system only operates when required and is highly energy efficient.

7.4.5 Intended Operation of the System

To improve air quality and in accordance with health and safety act the ventilation has been designed to increase fresh air intakes and cross ventilation within the building as measures against the minimum code standards depicted in Table 2 - Air requirements for different types of occupancies, clause 4.3.2.11 of SANS 10400-O.

8 Energy Reduction Strategies

The main energy saving features of the mechanical systems are as follows:

8.1 Ventilation System

By using occupancy sensor to control extractor fans within the ablutions, energy consumption can be reduced as both male and female toilets will only be occupied during shift change and on short occasions during the day. These areas will also be extract by their own fans allowing more control of which fan goes on when the occupancy sensor is activated

8.2 Air-conditioning System

The dual inverter in an VRF air conditioner is used to control the speed of the compressor motor to drive variable refrigerant flow in an air conditioning system to control the conditioned-space temperature. With a mode control/heat recovery unit attached additional savings are made, allowing multiple areas within a building to run at different temperatures and transferring and exchanging any wasted energy and using it somewhere else in the building. The benefits of a dual inverter air conditioning compared with a non-inverter air conditioning:

- improves heating and cooling efficiency by 30% with lower energy consumption.
- Far quicker to achieve desired temperature.
- No temperature fluctuations, maximizing comfort level; during extreme high and low temperatures.

9 Annexures

All Annexures will be attached as different documents

9.1 HVAC Heating and Cooling Calculations

9.2 Ventilation Supply and Extract Ducting and Flow Calculations

9.3 Water Reticulation Calculations

9.4 Fire Line Reticulation Calculations

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure P: Transnet Health and Safety Project Specification

Health and Safety Specification:

Fire infrastructure and equipment upgrade for Port of Elizabeth

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1. Project Description

The strategic initiator of the TNPA National Fire Services Infrastructure and Equipment Upgrade Project originated from a study of the existing capabilities of the Fire and Emergency Services of TNPA conducted at the Ports of Cape Town, Saldanha, Richards Bay, East London, Ngqura and Port Elizabeth. The study was conducted by the Fire Protection Association of Southern Africa (FPASA). To date the audit findings are still relevant and sufficient because they emphasize the space limitation and response time posed by the current location of the Fire station within the Port of Port Elizabeth.

The need to upgrade the infrastructure of the Fire Services Department at Port of Port Elizabeth arises mainly from the current inadequate operational space, because:

The current infrastructure does not meet the requirements for proper firefighting, as the current building is too small, and it is shared with other service providers in the port.

The infrastructure does not cater for the new fire services equipment.

The current infrastructure does not have training facilities.

The current Fire Services buildings does not have, Proper change room facilities, Parking garages for equipment, Controls rooms, Lecture rooms and adequate staff kitchen.

The building is not centrally located and does not meet the response time throughout the Port.

2. Scope and Purpose

The scope of this project entails internal architectural, structural, civils, electrical etc.

The building will be constructed from the ground and there will be some demolishing works done on an existing building to create more space for the new fire infrastructure building.

There will be some camera installation in and around the building to enhance security measures. This Health and Safety Specification will be reviewed and updated periodically as and when necessary to address and / or include:

- Changes in legislation;
- Client requirements;
- Leading practices; and
- Lessons learnt from incidents.

3. Definitions

Acceptable Risk

A risk that has been reduced to a level that can be tolerated having regard for the applicable legal requirements and the Health and Safety Policy adopted for the project.

ALARP (As Low As Reasonably Practicable)

The concept of weighing a risk against the sacrifice needed to implement the measures necessary to avoid the risk. With respect to health and safety, it is assumed that the measures should be implemented unless it can be shown that the sacrifice is grossly disproportionate to the benefit.

Applicant (Permit to Work)

A person requesting permission to perform work for which a Permit to Work is required. Applicants must be authorised (in writing) to receive (or accept) Permits to Work and must be competent to do so by virtue of their training, experience and knowledge of the area or plant in which the work is to be performed.

Authorised Person (Permit to Work)

A person (typically a Project employee or an employee of the client) who has been authorised (in writing) by the nominated project management representative to issue Permits to Work within the scope of his designation. A person may only be appointed to issue Permits to Work if he has undergone training and has been assessed and found competent in systems, plant and equipment operation within the scope of his designation.

Barricade

A temporary structure that is erected as a physical barrier to prevent persons from inadvertently coming into contact with an identified hazard.

Battering

Sloping the sides of an excavation to a predetermined angle (usually less than the natural angle of repose) to ensure stability.

Benching

The creation of a series of steps in the sides of an excavation to prevent collapse.

Consequence

The outcome of an event expressed qualitatively or quantitatively.

Contractor

An employer performing construction work, or providing related or supporting services, on a project site.

Competent Person

A person who has in respect of the work or task to be performed the required knowledge, training, experience and as per OHS Act, 1993 (Act 85 of 1993) and Construction Regulations 2014.

Construction Supervisor

A competent person responsible for supervising construction activities on a construction site

Clearance Certificate

A signed declaration by an Isolation Officer that a specified hazardous energy source associated with a particular system, plant or item of equipment has been isolated in accordance with an approved Isolation and Lockout Procedure.

Discipline Lock (many locks with a restricted number of identical keys)

Attached at a Lockout Station or at a Local Isolation Point in order to lock out a system, plant or equipment. A Discipline Lock (e.g. A Low Voltage Electricity Discipline Lock) is owned by an Isolation Officer who has been authorised in writing to isolate and lockout a particular hazard (e.g. Low voltage electricity).

Equipment Lock (many locks with one unique key)

Attached directly to pieces of equipment in order to lock them out. Equipment Locks may only be used by Isolation Officers who have been authorised in writing to perform isolation and lockout procedures. The key must have a solid key ring that fits over an Isolation Bar.

Excavation

Any man-made cut, cavity, pit, trench, or depression in the earth's surface formed by removing rock, sand, soil or other material using tools, machinery, and / or explosives. Tunnels, caissons and cofferdams are specifically excluded and are not addressed in this standard.

First-Aid Injury (FA)

A first-aid injury is any one time treatment and any follow up visit for observation of minor scratches, cuts, burns, splinters and the like which do not normally require medical care. Such treatment is considered to be first aid even if administered or supervised by a medical practitioner. First aid includes any hands on treatment given by a first aider. (E.g. Band-Aid, washing, cleansing, pain, relief). The following procedures are generally considered first aid treatment:

- Application of Antiseptics.
- Application of Butterfly adhesive dressing or sterile strips for cuts and lacerations.
- Administration of tetanus shot(s) or booster(s). However, these shots are often given in conjunction with more serious injuries, consequently injuries requiring these shots may be recordable for other reasons.
- Application of bandages during any visit to medical personnel.
- Application of ointments to abrasions to prevent drying or cracking.
- Inhalation of toxic or corrosive gas, limited to the removal of the employee to fresh air or the one time administration of oxygen for several minutes.
- Negative X-Ray diagnosis.
- Removal of foreign bodies not embedded in the eye if only irrigation is required.
- Removal of foreign bodies from a wound if procedure is uncomplicated, for example by tweezers or other simple technique.
- Treatment for first degree burns.
- Use of non-prescription medications and administration of single dose of prescription medication on first visit for any minor injury or discomfort.

Hazard

A source of potential harm in terms of human injury or ill health, or a combination of these.

Hierarchy of Controls

A sequence of control measures, arranged in order of decreasing effectiveness, used to eliminate or minimise exposure to workplace health and safety hazards:

- Elimination – Completely removing a hazard or risk scenario from the workplace.
- Substitution – Replacing an activity, process or substance with a less hazardous alternative.
- Isolation (Engineering) Controls – Isolating a hazard from persons through the provision of mechanical aids, barriers, machine guarding, interlocks, extraction, ventilation or insulation.
- Administrative Controls – Establishing appropriate policies, procedures and work practices to reduce the exposure of persons to a hazard. This may include the provision of specific training and supervision.
- Personal Protective Equipment – Providing suitable and properly maintained PPE to cover and protect persons from a hazard (i.e. Prevent contact with the hazard).

Isolation and Lockout Procedure

A plant or equipment-specific procedure that describes the method, and sequence to be followed, for rendering equipment, plant and systems safe to work on.

Isolation Bar

A device used at a Lockout Station to which anyone is able to attach a Personal Lock making it impossible for an Isolation Officer to remove the key to the Equipment Locks, thus preventing the de-isolation of a system, plant or equipment while it is still being worked on. A Discipline Lock must always be the first lock attached to an Isolation Bar and last to be removed.

Isolation Officer

A person (typically a Project employee or an employee of the client) who has been authorised (in writing) by the nominated project management representative to perform isolation and lockout procedures. A person may only be appointed as an Isolation Officer if he has undergone training and has been assessed and found competent in the isolation and lockout of systems, plant and equipment within the scope of his designation.

Incident

An event (or a continuous or repetitive series of events) that results or has the potential to result in a negative impact on people (employees, contractors and visitors), the environment, operational integrity, assets, community, process, product, legal liability and / or reputation.

Likelihood

A description of probability or frequency, in relation to the chance that an event will occur.

Lost Time Injury (LTI)

Any occurrence that resulted in a permanent disability or time lost from work of one day/shift or more.

If an employee is injured and cannot return to work in the next shift (will ordinarily miss one whole shift), and the department brings the employee in to only receive treatment by the Supervisor/ Return to Work Coordinator in that shift, this is still considered an LTI.

Lost Time Injury Frequency Rate (LTIFR) - Number of LTI's multiplied by 1 million or 200,000 and divided by labour hours worked.

Light Vehicle

A vehicle that:

- Can be licensed and registered for use on a public road;
- Has four or more wheels, and seats a maximum of 12 adults (including the driver);
- Requires the driver to hold only a standard civil driving licence; and
- Does not exceed 4.5 tonnes gross vehicle mass (GVM), which is the maximum loaded mass of the motor vehicle as specified by:
 - ♦ The vehicle's manufacturer; or
 - ♦ An approved and accredited automotive engineer, if the vehicle has been modified to the extent that the manufacturer's specification is no longer appropriate.

Examples of light vehicles include passenger cars, four-wheel drive vehicles, sports utility vehicles (SUV's), pick-ups, minibuses, and light trucks.

Any vehicle falling outside of this definition must be considered mobile equipment.

Medical Treatment Injury (MTI)

A work injury requiring treatment by a Medical Practitioner and which is beyond the scope of normal first aid including initial treatment given for more serious injuries. The procedure is to be of an invasive nature (e.g. Stitches, removal of foreign body).

The following procedures are generally considered medical treatment:

- Application of sutures (stitches).
- Cutting away dead skin (surgical debridement).
- Loss of consciousness due to an injury or exposure in the work environment.
- Positive X-Ray diagnosis (fractures, broken bones etc.).
- Removal of foreign bodies embedded in the eye.
- Removal of foreign bodies from the wound by a physician due to the depth of embedment, size or shape of object or the location wound.
- Reaction to a preventative shot administered because of an occupational injury.
- Sprains and strains - series (more than one) of hot and cold soaks, use of whirlpools, diathermy treatment or other professional treatment.
- Treatment of infection.
- Treatment for second or third degree burns
- Use of prescription medications (except a single dose administered on first visit for minor injury or discomfort.)

Mobile Equipment

A vehicle (wheeled or tracked) that generally requires:

- The driver to hold a specific state or civil license; or
- The operator to hold a nationally recognized certificate of competency.

Examples of mobile equipment include, but are not limited to, dump trucks, water trucks, graders, dozers, loaders, excavators, forklifts, tractors, back-actors, bobcats, mobile cranes, tele-handlers, drill rigs, buses and road-going trucks.

Near-Miss

An incident that has occurred that did not result in any injuries, illnesses, environmental or property damage but had the potential to cause an injury, illness, environmental or property damage.

Personal Lock

A single lock with one unique key controlled by the owner. Used for personal protection.

Regulation

In the context of this guideline, 'Regulation(s)' refers to the Construction Regulations, 2014 required by Section 43 of the Occupational Health and Safety Act 85 of 1993, published under Government Notice R 84 in Government Gazette 37305 of February 2014.

Risk

A combination of the likelihood of an occurrence of a hazardous event or exposure and the severity of injury or ill health that can be caused by the event or exposure.

Risk Assessment

A process of evaluating the risk arising from a hazard, taking into account the adequacy of any existing control measures, and deciding on whether or not the risk is acceptable.

Risk Management

The systematic application of management policies, processes and procedures to identifying hazards, analysing and evaluating the associated risks, determining whether the risks are acceptable, and controlling and monitoring the risks on an ongoing basis.

4. Abbreviations

DSTI - Daily Safety Task Instruction

CR – Construction Regulations

HIRA - Hazard Identification and Risk Assessment

IMS - Integrated Management System

MS - Management System

OHS Act - Occupational Health and Safety Act

SOC - Safety Observation and Conversation

VFL - Visible Felt Leadership

OHS - Occupational Health and Safety

SACPCMP - The South African Council for Project and Construction Management Professions, here in refer to as the registrar of Health and Safety Professionals

5. Contractor Health and Safety Management Plan

The contractor must prepare, implement and maintain a project-specific Health and Safety Management Plan. The plan must be aligned with the requirements set out in this specification as well as all relevant/applicable legislation. It must cover all activities that will be undertaken as part of the Project from mobilisation and set-up to rehabilitation and decommissioning.

The plan must demonstrate the contractor's commitment to health and safety and must, as a minimum, include the following:

- A copy of the contractor's **Health and Safety Policy**; in terms of the OHS Act section 7
- Procedures concerning **Hazard Identification and Risk Assessment**, including both Baseline and Task-Based Risk Assessments;
- Arrangements concerning the identification of applicable **Legal and Other Requirements**, measures to ensure compliance with these requirements, and measures to ensure that this information is accessible to relevant personnel;
- Details concerning **Health and Safety Objectives** – a process must be in place for setting objectives (and developing associated action plans) to drive continual improvement;

- Details concerning **Resources, Accountabilities and Responsibilities** – this includes the assignment of specific health and safety responsibilities to individuals in accordance with legal or project requirements, including the appointment of a Project Manager, Health and Safety Officers, Supervisors, Health and Safety Representatives, and First Aiders;
- Details concerning **Competence, Training and Awareness** – a system must be in place to ensure that each employee is suitably trained and competent, and procedures must be in place for identifying training needs and providing the necessary training;
- **Communication, Participation and Consultation** arrangements concerning health and safety, including Safety Observations and Coaching, Toolbox Talks, Daily Safe Task Instructions, project health and safety meetings, and notice boards;
- **Documentation and Document Control** – project-specific documentation required for the effective management of health and safety on the project must be developed and maintained, and processes must be in place for the control of these documents;
- Processes and procedures for maintaining **Operational Control**, including rules and requirements (typically contained in Safe Work Procedures) for effectively managing health and safety risks, particularly critical risks associated with working at heights, confined spaces, mobile equipment and light vehicles, lifting operations, hazardous chemical substances, etc.;
- **Emergency Preparedness and Response** procedures;
- **Management of Change** – a process must be in place to ensure that health and safety risks are considered before changes are implemented;
- **Sub-contractor Alignment** procedures – a process must be in place for the assessment of sub-contractors and suppliers with regard to health and safety requirements and performance (before any contract or purchase order is awarded);
- **Measuring and Monitoring** plans, including a plan for the measuring and monitoring of employee exposure to hazardous substances or agents (e.g. Noise, dust, etc.) In order to determine the effectiveness of control measures;
- **Incident Reporting and Investigation** procedures describing the protocols to be followed with regard to incident reporting, recording, investigation and analysis;
- **Non-conformance and Action Management** procedures concerning the management of corrective actions;
- **Performance Assessment and Auditing** procedures concerning health and safety performance reporting, monthly internal audits to assess compliance with the project health and safety requirements, and daily site health and safety inspections; and
- Details concerning the **Management Review** process followed to assess the effectiveness of health and safety management efforts.

Prior to mobilisation, the Health and Safety Management Plan must be forwarded electronically, and as a hard copy, to the nominated TRANSNET project management representative for review. The plan will be audited for completeness and, if found to be adequate, will be accepted (typically “with comments”). Work may not commence until the plan has been accepted.

Once the plan has been accepted, the contractor must action and resolve any issues within 30 days from the start of work.

If the issues requiring corrective action are not resolved within this 30 day period, the contractor will be required to stop any work related to the outstanding actions until they have been resolved.

Any proposed amendments or revisions to the contractor's Health and Safety Management Plan must be submitted to the nominated project management representative for acceptance.

Should it be identified that the contractor has overlooked a high risk activity, and as a result has omitted the activity and associated control measures from the Health and Safety Management Plan, the plan will not be approved.

6. Policy

The contractor must develop, display and communicate a Health and Safety Policy that clearly states the contractor's values and objectives for the effective management of health and safety as required by OHS Act of 1993, 7(3). These values and objectives must be endorsed by the contractor's management representatives and must be consistent with those adopted for the project.

The policy must be signed and dated, and must be reviewed annually.

The policy must commit to:

- Compliance with all applicable legal requirements in the TRANSNET regulatory universe;
- The effective management of health and safety risks;
- The establishment of measurable objectives for improving performance, and the provision of the necessary resources to meet these objectives;
- The prevention of incidents; and
- Achieving continual improvement with regard to health and safety performance.

All employees of the contractor as well as the employees of any sub-contractors that may be appointed by the contractor must be made aware of the policy. This must be done through Health and Safety Induction Training and Toolbox Talks (refer to Sections 10 and 11).

A copy of the policy must be displayed in each meeting room and on each notice board.

7. Hazard Identification and Risk Assessment

Detailed hazard identification and risk assessment processes must be followed for all work to be performed as well as for all associated equipment and facilities as required by the Construction Regulation of 2014, Regulation 9(1) – (7).

The Client will provide a baseline risk assessment informing the contractor on the hazards and risks on site. The Contractor must ensure that effective procedures and risk assessment systems are in place to control hazards and to mitigate risks to levels that are as low as is reasonably practicable.

The risk assessment processes must be applied to:

- The full life cycle of the project;
- Routine and non-routine activities;
- Planned or unplanned changes;
- All employees, sub-contractors, suppliers and visitors; and
- All infrastructure, equipment and materials.

The risk assessment processes and methodologies must be appropriate for the nature and scale of the risks, and must be implemented by competent persons.

The process of analysing and managing risk must include the following:

- Establishing the context of the risk assessment;
- Identifying hazards and determining possible risk scenarios (unwanted events);
- Evaluating risks and assigning ratings (classification);
- Recording the risk analysis in a risk register;
- Managing risks according to their classification (prioritising for action);
- Identifying and implementing control measures (through the application of the Hierarchy of Controls) to ensure that risks are managed to levels that are as low as is reasonably practicable (ALARP);
- Developing action plans for reducing risk levels (where possible);
- Verifying the completion of actions;
- Re-evaluating the risks and classifications as appropriate; and
- Reviewing and updating the risk register.

7.1 Baseline Risk Assessments

Prior to site establishment, TRANSNET (the Client) will conduct a Baseline Risk Assessment identifying foreseeable hazards and risks scenarios associated with the contractor's scope of work on the project site(s) as required by Construction Regulations of 2014, regulation 5(1)(a). Details concerning proposed control measures must be included. The risk assessment process must be facilitated by a competent person who has been appointed in writing and must involve the participation of the contractor's site management representatives, supervisory personnel and technical experts. An attendance register must be completed and retained for reference purpose. The Baseline Risk Assessment must be reviewed and approved by the Project Health and Safety Manager and Project Construction Manager.

A Risk Register comprised of all significant risks (i.e. Risks rated as major or catastrophic) identified for the project will be compiled using the information contained in the project Baseline Risk Assessment as well as the contractor's Baseline Risk Assessment. Key control measures for managing each of these risks will be specified in the register.

For the significant risks in particular, action plans will be developed for reducing the risk levels (where possible).

The project Risk Register will be reviewed and, if necessary, updated:

- On a quarterly basis during construction;
- When changes are made to a design and / or the construction scope, schedule, methods, etc. That result in a change to the risk profile; and
- Following an incident.

The contractor must ensure that the hazards, risk scenarios and control measures identified in the contractor's Baseline and Task-Based Risk Assessments are taken into consideration when developing, implementing and maintaining the various elements of the contractor's health and

safety management system for the project (e.g. Competence, training and awareness requirements).

All persons potentially affected must be made aware of the hazards, risk scenarios and control measures identified in the contractor's risk assessments. This must be done through training, Toolbox Talks, and Daily Safe Task Instructions.

7.2 Task-Based Risk Assessments

The contractor must carry out detailed project-specific Task-Based Risk Assessments which must be reviewed and approved by the Client's Project Health and Safety Manager/Agent and Project Construction Manager prior to the commencement of any work.

The risk assessment process must be facilitated by a competent person who has been appointed in writing in terms Construction Regulations 9, clause (1). The contractor's site management representatives, supervisory personnel, technical experts (as required) and workforce personnel directly involved with the task being examined must participate in the risk assessment process. An attendance register must be completed and retained.

Please Note: Under no circumstances may a Contractor Health and Safety Officer perform a risk assessment in isolation. The active participation of all persons referred to above is mandatory.

A Task-Based Risk Assessment must at least:

- Be accompanied by a Work Method Statement (describing in sufficient detail how the specific job or task is to be performed in a logical and sequential manner);
- Provide a breakdown of the job or task into specific steps;
- Identify the hazards and potential risk scenarios associated with each step;
- Include consideration of possible exposure to noise, heat, dust, fumes, vapours, gases, chemicals, radiation, vibration, ergonomic stressors, or any other occupational health hazard or stressor;
- Describe the control measures that will be implemented to ensure that the risks are managed to levels that are as low as is reasonably practicable; and
- Assign an initial risk rating (without taking any control measures into consideration) and a residual risk rating (taking the identified control measures into consideration) to each risk scenario.

A Task-Based Risk Assessment must be reviewed and, if necessary, updated:

- On an annual basis (as a minimum);
- When changes are made to the associated Work Method Statement; and
- Following an incident.

7.3 Pre-Task Hazard Assessments

A pre-task hazard assessment must be completed whenever a change is identified while carrying out an activity. Any deviation from what was discussed during the Daily Safe Task Instruction (prior to the activity commencing), or anything that was not discussed, constitutes a change.

Before carrying out the particular task that involves the identified change, a few minutes must be spent identifying the hazards and risks associated with that task as well as suitable control measures.

8. Legal and Other Requirements

The Contractor must comply with the requirements of all applicable health and safety legislation as well as TRANSNET project-specific standards and procedures as amended from time to time.

The Contractor must compile and maintain a register of all legal and other requirements applicable to the work that will be carried out and / or services that will be provided. This register must be updated regularly to ensure that it remains relevant.

Applicable laws and standards must be appropriately communicated to all employees of the contractor (as well as the employees of any sub-contractors that may be appointed by the contractor) through training, Toolbox Talks, and Daily Safe Task Instructions.

9. Health and Safety Objectives

In order to drive continual improvement, the contractor must set project-specific health and safety objectives, and must develop improvement action plans to achieve these objectives. The contractor's objectives must be aligned with the objectives set for the project as a whole as required by the Construction Regulations of 2014.

Eliminating health and safety hazards, minimising health and safety risks, preventing incidents, injuries and illnesses, and ensuring legal compliance must be the primary considerations for setting objectives.

When setting objectives, consideration must be given to the following:

- Leading indicators such as inspection findings, audit findings, hazard reporting, and observations;
- Lagging indicators (i.e. Incidents including Near Hits);
- Leading practices and lessons learnt; and
- Injury frequency rates with due understanding that the goal is "no harm".

The objectives must be specific and measurable. The improvement action plans must specify the resources (both human and financial) required to achieve the objectives, the person's responsible, and realistic timeframes for completion. The contractor must ensure that adequate resources are allocated and that progress towards meeting the objectives is monitored regularly.

The objectives and associated improvement action plans must be documented and must be communicated to all contractor employees. Furthermore, to ensure that the objectives remain relevant, they must be reviewed on a quarterly basis and whenever significant change has taken place on the project (i.e. Changes to activities, scope of work, operating conditions, etc.).

10. Resources, Accountabilities and Responsibilities

The Contractor must adequately allocate resources, responsibility and accountability to ensure the effective implementation, maintenance and continual improvement of the contractor's health and safety management system on the projects required by Construction Regulation Of 2014, regulation 7(2)(c).

For each role that carries health and safety accountability and / or responsibilities (including legislative requirements), a role description detailing the accountability and / or responsibilities must be documented.

All health and safety appointments (i.e. the assignment of specific health and safety responsibilities to individuals in accordance with legal or project requirements) must be done in writing. Documented proof of each appointment (i.e. a signed appointment letter) must be retained.

Contractor should not discharge any legal responsibilities to employees who are not legally appointed.

The contractor must comply with the requirements of all applicable legislation concerning health and safety related appointments and delegations for the project.

A health and safety organisational chart specific to the project must be documented and maintained. All roles that carry health and safety accountability and / or responsibilities must be included, and all individuals that carry health and safety appointments must be clearly identified.

The provision of dedicated health and safety professionals on the project must be appropriate for the nature and scale of the work to be carried out.

The contractor is solely responsible for carrying out the work under the contract whilst having the highest regard for the health and safety of all persons on the project site(s).

Health and safety is the responsibility of each and every individual on the project site(s), but in particular, it is the responsibility of the contractor's management team who must set the tone.

Visible commitment is essential to providing and maintaining a safe workplace. The contractor's managers and supervisors at all levels must demonstrate their commitment and support by adopting a risk management approach to all health and safety issues. These individuals must consistently take immediate and firm action to address violations of health and safety rules, and must actively participate in day to day activities with the objective of preventing harm.

The contractor's management representatives are responsible and accountable for health and safety performance on the project. Key responsibilities include the following:

- Preparing, implementing and maintaining a risk-based Health and Safety Management Plan specific to the work that will be carried out;
- Establishing, implementing and maintaining health and safety programmes and procedures to ensure that all work is carried out in compliance with the requirements of this specification, the contract, and all applicable legislation;
- Establishing, implementing and maintaining effective hazard identification and risk management processes and procedures to ensure that all reasonably foreseeable hazards are controlled in order to minimise risk;
- Providing the resources necessary to meet the requirements of this specification;
- Ensuring that all contractor employees have clearly defined responsibilities with regard to health and safety, and that these responsibilities are clearly communicated and understood;
- Establishing, implementing and maintaining a system for on-going training and assessment of skills and competence;
- Establishing, implementing and maintaining procedures to ensure that only qualified and competent personnel are permitted to work on the project site(s);
- Establishing, implementing and maintaining effective communication and consultative processes concerning health and safety for the duration of the contract;

- Maintaining operational control for the protection of all persons on the project site(s) as well as the public;
- Establishing, implementing and maintaining effective emergency preparedness and response procedures;
- Establishing, implementing and maintaining effective management of change processes and procedures;
- Establishing, implementing and maintaining effective incident reporting and investigation processes and procedures;
- Establishing, implementing and maintaining effective auditing and inspection processes and procedures; and
- Formally reviewing the contractor's Health and Safety Management System annually to ensure that the system continues to be effective in managing health and safety performance and meeting project requirements.

All costs associated with meeting these responsibilities shall be borne by the contractor.

Any cost associated with any work stoppage due to non-compliance with a health and safety requirement shall be for the contractor's account.

10.1 Contractor Construction Manager

The Contractor must appoint a full-time, competent and registered Construction Manager per construction site who shall be responsible for the successful and safe completion of all work to be carried out by the contractor as required by the Construction regulations of 2014, regulation 8(1). Construction Manager must be professionally registered with SACPCMP in the category of CM.

The contractor's Construction Manager shall be responsible for:

- Ensuring that a Health and Safety Policy that clearly states the contractor's values and objectives for the effective management of health and safety on the project is in place and is communicated to all contractor and sub-contractor employees;
- Ensuring that all applicable legal and project health and safety requirements are identified and complied with at all times;
- Ensuring that effective hazard identification and risk management processes are established and implemented for all work to be carried out by the contractor;
- Participating in the Baseline Risk Assessment for the contractor's scope of work (prior to site establishment);
- Participating in (and approving) all Task-Based Risk Assessments conducted for the work to be carried out by the contractor;
- Driving the achievement of agreed health and safety objectives;
- Ensuring that the necessary resources are made available for the effective implementation of the contractor's Health and Safety Management Plan;
- Ensuring that all work is adequately and competently supervised;
- Ensuring that all contractor employees have clearly defined responsibilities with regard to health and safety (assigned in writing), and that these responsibilities are clearly communicated and understood;

- Ensuring as far as is reasonably practicable that each contractor and sub-contractor employee is competent to perform his role, and has received appropriate workplace health and safety training and instruction;
- Managing all appointed sub-contractors with regard to health and safety performance;
- Establishing and maintaining effective communication and consultative processes to ensure that all contractor and sub-contractor employees are kept up to date with regard to health and safety information (e.g. Incidents and lessons learnt, leading practices, hazards, risks and control measures, etc.) And that feedback is provided promptly regarding issues and / or concerns raised;
- Participating in the project's Visible Felt Leadership (VFL) programme;
- Chairing monthly Contractor Health and Safety Meetings and attending monthly Site Health and Safety Meetings;
- Implementing programmes that encourage continual improvement and providing recognition for suggestions made by contractor and sub-contractor employees;
- Implementing the contractor's Health and Safety Management Plan and associated Safe Work Procedures;
- Acting consistently and strictly against any contractor or sub-contractor employee who transgresses a health and safety rule or requirement;
- Ensuring that an effective management of change process is in place;
- Implementing, testing and maintaining an effective Emergency Response Plan for all contractor and sub-contractor activities, and ensuring that the plan is adequately resourced;
- Ensuring that workplace exposure of contractor and sub-contractor employees to hazardous substances or agents is measured and monitored to determine the effectiveness of controls and compliance with legal (and project) requirements;
- Ensuring that all incidents are reported without delay and are investigated thoroughly;
- Participating in investigations into significant incidents;
- Ensuring that accurate health and safety statistics are maintained, and that health and safety performance reports are compiled as required;
- Providing the necessary resources for regular health and safety audits and inspections to be conducted, and supporting the auditing process;
- Participating in health and safety audits, and carrying out workplace inspections;
- Ensuring that corrective actions (arising from incident investigations, audits, inspections, etc.) Are implemented, and that adequate resources are provided for this purpose; and
- Participating in an annual review of the contractor's Health and Safety Management System.

10.2 Contractor Construction Health and Safety Officer(s)

The contractor must appoint a full-time Construction Health and Safety Officer for the duration of the contract who is registered with the SACPCMP (The South African Council for Project Construction Management Professions). The project site(s) (directly or through sub-contractors), must appoint full-time Construction Health and Safety Officers, the number of which depending

on the scope, complexity, budget and high risk activities involved, as required by the Construction regulations of 2014, regulation 8(5).

The Construction 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 sub-contractors) have been completed. A Construction Health and Safety Officer must be present during all shifts, so if work is carried out over more than one shift per day, the contractor must make provision for additional Construction Health and Safety Officers.

Each Contractor Construction Health and Safety Officer shall be responsible for:

- Reviewing all applicable legal and project health and safety requirements and providing guidance to contractor and sub-contractor personnel (particularly the contractor's Project Manager) to help ensure compliance at all times;
- Assisting with the implementation of effective hazard identification and risk management processes for all work to be carried out by the contractor;
- Participating in the Baseline Risk Assessment for the contractor's scope of work (prior to site establishment) and ensuring that identified control measures are implemented;
- Participating in all Task-Based Risk Assessments conducted for the work to be carried out by the contractor and ensuring that identified control measures are implemented;
- Conducting contractor health and safety induction training for all contractor and sub-contractor personnel;
- Compiling and maintaining all health and safety related documents and records required of the contractor;
- Communicating relevant health and safety information to contractor and sub-contractor personnel (e.g. Incidents and lessons learnt, leading practices, hazards, risks and control measures, etc.);
- Carrying out Safety Observations and Coaching (one per day);
- Evaluating (on a daily basis) the content of the Daily Safe Task Instructions (DSTI's) conducted by the contractor's appointed supervisors, and attending at least one DSTI each day;
- Attending monthly Contractor and Site Health and Safety Meetings;
- Assisting with the implementation of the contractor's Health and Safety Management Plan and associated Safe Work Procedures;
- Carrying out Planned Task Observations on an ad hoc basis;
- Assisting with the implementation, testing and maintenance of an effective Emergency Response Plan for all contractor and sub-contractor activities;
- Responding to workplace incidents (as appropriate);
- Participating in incident investigations;
- Maintaining accurate health and safety statistics (for the contractor and all sub-contractors), and compiling health and safety performance reports as required;
- Auditing the health and safety management system and workplace activities of the contractor and each sub-contractor on a monthly basis to assess compliance with the project health and safety requirements; and

- Tracking and reporting on the implementation of corrective actions (arising from incident investigations, audits, inspections, etc.).

The contractor must ensure that each Construction Health and Safety Officer is adequately equipped to enable him to perform his duties effectively. Each Construction Health and Safety Officer must be provided with the following:

- A computer with access to all necessary systems, including access to e-mail and the internet;
- A mobile telephone on contract or with adequate pre-paid airtime; and
- A vehicle where required or instructed by a nominated project management representative (depending on the size and location of the project site(s)).

A Construction Health and Safety Officer must over and above the SACPCMP registration as an Officer; be computer literate, fluent in English, and must have the following minimum qualifications, training and experience:

- At least 5 years' experience as a Construction Health and Safety Officer on construction projects;
- National Diploma in Safety Management, Environmental Health or an equivalent NQF 6 qualification to health and safety management as the minimum requirement.
- Experience and appropriate training with regard to implementing and maintaining a health and safety management system compliant with national legislation or an international standard;
- Experience and appropriate training with regard to construction related hazard identification and risk management processes;
- Competence, experience and relevant training with regard to incident investigation procedures and causation analysis;
- Health and safety auditing experience and training;
- A valid First Aid certificate of competency;
- Fire prevention and protection training; and
- A valid Driving Licence (light motor vehicle).

The Client will stipulate whether a CHSO or CHSM is required depending on the size of the project and on the risks. Before placing a Construction Health and Safety Officer on the project site(s), the contractor must forward a copy of the person's CV to the nominated TRANSNET Project Management Representative or to the Health and Safety Manager for review and acceptance. A proposed candidate may be rejected should he/she not meet the experience and/or qualification requirements, or due to poor work performance on previous projects.

10.3 Contractor Construction Supervisors

The contractor must ensure that all project and/or construction works are supervised at all times by an adequate number of qualified, competent and appointed Construction supervisors who have experience in the type of work being carried out as required by Construction regulations of 2014, regulation 8(7) and 8(8).

No work may be carried out without an appointed Construction supervisor being physically present in the work area(s) and without a daily safety task instruction having been completed.

Each Contractor Construction Supervisor shall be responsible for:

- Ensuring that all work carried out under his supervision is done so in accordance with the requirements of all applicable legislation, rules, standards, specifications, plans and procedures;
- Participating in Baseline and Task-Based Risk Assessments;
- Ensuring that all employees under his supervision are made aware of the hazards, risk scenarios and control measures identified in relevant risk assessments;
- Ensuring that the control measures stipulated in all relevant risk assessments are in place and are implemented fully for all work carried out under his supervision;
- Ensuring that all employees under his supervision conduct pre-task hazard assessments when necessary;
- Driving the achievement of health and safety objectives set for his team;
- Ensuring that the necessary written appointments are in place for each employee under his supervision (e.g. First aider, mobile crane operator, etc.);
- Ensuring that all employees under his supervision attend all required training;
- Ensuring that no employee carries out any work that he is not competent to perform or has not been appointed to perform;
- Identifying training needs within his team;
- Carrying out Safety Observations and Coaching (one per day);
- Conducting a weekly Toolbox Talk with his team;
- Leading a Daily Safe Task Instruction discussion with his team;
- Attending Health and Safety Meetings as required;
- Maintaining a Health and Safety Management Information Notice Board in the work area for which he is responsible;
- Recording, on a daily basis, a description of the day's activities as well as a breakdown (by occupation) of the personnel on site under his supervision (e.g. 5 bricklayers, 2 carpenters, 3 welders, 22 general workers, and 1 supervisor);
- Ensuring that all Safe Work Procedures applicable to the work carried out under his supervision are adhered to and are fully implemented;
- Maintaining discipline and taking the necessary action whenever an employee under his supervision does not adhere to a rule or requirement;
- Carrying out Planned Task Observations (one per day);
- Ensuring that emergency response procedures are understood by all employees under his supervision and that these procedures are followed in the event of an emergency;
- Reporting all incidents immediately, participating in incident investigations, communicating the lessons learnt to all employees under his supervision, and implementing corrective actions where required; and
- Carrying out workplace health and safety inspections.

Each Construction supervisor must accept these responsibilities in writing as part of his appointment.

Each Construction supervisor must be equipped with a mobile telephone to ensure that effective communication can be maintained for the duration of the contract.

10.4 Health and Safety Representatives

The team of employees on site must have a health and safety representative deployed on the project site(s). A Health and Safety Representative must be elected and appointed. Taking into consideration the number of employees deployed, the geographical area in which the work is taking place, the different work disciplines, and the shift pattern (if applicable), the contractor must ensure that an adequate number of Health and Safety Representatives (at a minimum ratio of one Health and Safety Representative per 20 employees) are elected and appointed to effectively represent all site personnel as required by the OHS Act 85 of 1993, section 17 - 18.

Each Health and Safety Representative must attend an accredited training course for health and safety representatives. The cost of this training shall be for the contractor's account.

The contractor must make the necessary allowances for the Health and Safety Representatives to carry out their duties as specified in the applicable legislation.

The contractor must ensure that an appropriate sticker is affixed to the safety helmet of each Health and Safety Representative for identification purposes.

10.5 First Aiders

At least one trained and competent First Aider must be in place and must be appointed for the project site(s). Taking into consideration the number of employees deployed, the geographical area in which the work is taking place, the different work disciplines, and the shift pattern (if applicable), the contractor must ensure that an adequate number of First Aiders (at a minimum ratio of one First Aider per 50 employees) are in place and have been appointed to administer first aid treatment should this be required.

First Aid training must be done through an accredited training institution. The cost of this training shall be for the contractor's account.

The contractor must ensure that an appropriate sticker is affixed to the safety helmet of each First Aider for identification purposes.

10.6 Duties of Client

The duties of the Client, Transnet are as per the Construction regulations of 2014, regulation 5(1) – (8).

A construction work permit is required for this project as contemplated in CR 3(1). The client will therefore appoint a competent person in writing as a Construction Health and Safety Agent to act as his or her representative. The duties that are imposed by these Regulations upon a client, apply as far as reasonably practicable to the appointed Agent.

10.7 An agent contemplated in CR sub-regulations (5) and (6) will manage health and safety on a construction project for the client. ; Duties of the Designer

The duties of the Designer are as per the Construction regulations of 2014, regulation 6(1) &(2). Health and Safety Design Consideration

A design team must be established to review all health and safety issues that may affect the safety of the structure during construction and ensure that all HAZOP recommendations are considered by the appointed principal contractor. The team must consider plans, calculations, specifications, instructions or drawings for a structure, including variations to a plan or changes to a structure or making decisions for a design that may affect the health or safety of persons during construction, occupy, use or carry out other activities in relation to the structure.

10.8 Duties of Principal Contractor

The duties of the Principal Contractor are as per the Construction regulations of 2014, regulation 7(1) – (8).

10.9 Duties of Contractor

The duties of the Contractor as per Construction Regulations of 2014, Regulations 7(2).

10.10 Management and supervision of Construction work

Management and supervision of construction work is as per Construction Regulations, 2014, Regulations 8. Construction Health and Safety Agent

The Client, TRANSNET, will appoint a Professional Construction Health and Safety Agent for the project whose main responsibility, amongst others, is to obtain a construction work permit before commencement of any construction activities.

The Agent will manage the health and safety on a construction project for Transnet, including the preparation and coordination of the necessary documentation to facilitate effective execution of the works and project close-out.

11. Competence, Training and Awareness

Each employee (including sub-contractor employees) must be suitably trained and competent, and must understand the health and safety hazards, risks and control measures associated with his work as required by the OHS Act 85 of 1993.

The contractor must implement systems and procedures to ensure that:

- The necessary competencies required by employees are identified (by occupation), along with selection, placement and any training requirements;

Please Note: Specific competency profiles and selection criteria (fitness for work) must be developed for all roles where significant health or safety risk exists.

Please Note: A formal training needs analysis must be carried out based on the competency profiles and a training matrix must be developed for the project.

Roles requiring technical certification, registration or licensing are identified and documented, and these roles are filled only by suitably qualified personnel;

- Minimum core health and safety skills required by employees in leadership and supervisory roles are identified and suitable training is provided including hazard identification and risk assessment, incident investigation, and health and safety interactions (i.e. Observation and coaching techniques);
- Competency-based training is provided and it includes operational controls (procedures and work instructions), management of change, and emergency response;

- All employees hold and maintain the required competencies (including appropriate qualifications, certificates and licences) and are under competent supervision;
- A site-specific induction and orientation programme that highlights health and safety requirements, procedures, and significant hazards, risks and associated control measures is in place for all new employees and visitors (understanding must be assessed);
- Personnel are trained and / or briefed on new or amended standards, rules, safe work procedures, risk assessments, etc.;
- Refresher training is carried out as required (e.g. Re-induction following an absence from site);
- Records of education, qualifications, training, experience and competency assessments are maintained on site for all employees; and
- The effectiveness of training is reviewed and evaluated.

Prior to the commencement of any work, including mobilisation and site set-up activities, the contractor must provide, to the satisfaction of the nominated project management representative, current documentation verifying that the contractor's employees, as well as the employees of any appointed sub-contractors, are competent and have the necessary qualifications, certificates, licences, job skills, training and experience (as required by this specification and applicable legislation) to safely carry out the work that is to be performed.

The Contractor and sub-contractor must ensure that the following training takes place:

- health and safety induction training pertaining to the hazards prevalent on the site at the time of entry
- training for all persons required to erect, move or dismantle temporary works structures and instruction to perform those operations safely
- training of employees working from a fall risk position
- training to work or to be suspended on a platform which includes at least:
 - how to access and egress the suspended platform safely;
 - how to correctly operate the controls and safety devices of the equipment;
 - information on the dangers related to the misuse of safety devices; and
 - information on the procedures to be followed in the case of-
 - o an emergency;
 - o the malfunctioning of equipment; and
 - o the discovery of a suspected defect in the equipment;
 - o an instructions on the proper use of body harnesses.
- Training for all operators of construction vehicles and mobile plant.

A contractor must at all times keep on his or her construction site records of the health and safety induction training and such records must be made available on request to an inspector, the client, the client's agent or the principal contractor.

Please Note: Only certified copies of certificates, licences, etc. will be accepted.

An Employee Profile (dossier) must be completed for each employee who will be performing work on site. All documentation pertaining to an employee's competence (i.e. certified copies of

qualifications, certificates and licences as well as proof of job skills, training and experience) must be maintained in this dossier.

If it is determined through observation that an employee is not yet competent to carry out a particular task in a safe and capable manner, the employee will be required to cease work immediately and must either be reassigned or be retrained at the contractor's expense.

The contractor must provide proof that the training institutions and trainers that are used are appropriately registered with a governing authority (a trainer's registration certificate or registration number alone will not be adequate). The following must be made available for verification purposes:

- Proof of registration of the training institution including the training programmes that the institution is accredited to provide; and
- For each trainer, proof of competency and registration for the specific training programmes presented.

Foreign qualifications held by employees in health and safety critical roles must be verified against the requirements of local legislation.

11.1 Health and Safety Induction Training

Each employee must attend all mandatory Health and Safety Induction Training applicable to the project. No employee will be permitted to enter any project work site until he has attended this training. Each employee must carry proof that he has completed the induction training and may be removed from a site if such proof cannot be produced on request, this as required by the Construction regulations of 2014, Regulation 7(5).

Furthermore, employees must attend (where applicable) Area-Specific Health and Safety Induction Training pertaining to the particular hazards identified in the area(s) where the employees will be working. No employee will be permitted to enter a work area until he has attended the relevant area-specific training.

All visitors must receive a visitor induction briefing before entering any project work site. However, this induction does not permit a visitor to enter a site unescorted. Visitors must be accompanied at all times by an appropriately senior employee who has been fully inducted.

11.2 Specific Training and Competency Requirements

The following specific training and competency requirements must be complied with, where applicable to the project.

Please Note: An employee must be trained, assessed and found competent before he will be given authorisation to perform certain tasks or fill certain roles.

Table 12-1: Specific Training and Competency Requirements

Training	Applicable To
Health and Safety Induction	All employees
Safety Observations and Coaching (Safety Interactions)	All employees
Risk Assessment*	All managers and supervisors
Incident Investigation*	All managers and supervisors
Safety Leadership	All managers and supervisors
Legal Liability*	All managers and supervisors
Health and Safety Rep*	All elected Health and Safety Representatives
First Aid Levels 1, 2 and 3*	All nominated First Aiders

Training	Applicable To
Fire Fighting*	All appointed fire fighters
Working at Height*	All employees working at elevated positions where using a safety harness is required
Brick laying*	All brick laying works
Permit to Work	All Authorised Persons (i.e. Permit issuers) and all Applicants (i.e. Employees who will be applying for permits)
Isolation and Lockout	All Authorised Persons (i.e. Persons who authorise work that requires Isolation and Lockout), all Isolation Officers, and all Applicants (i.e. Persons who request permission to work on systems or equipment requiring Isolation and Lockout)
Mobile Equipment Site Licence*	All mobile equipment operators
Steel fixing*	All steel fixers employees
Carpentries	All form work, roof work and other structural assemblers
Painting	All designated painters

Training requirements marked with an * must be arranged by the contractor through accredited external training institutions and not limited to the above table.

12. Communication, Participation and Consultation

The contractor must establish and maintain effective communication and consultative processes (allowing for a two-way dialogue) for the duration of the project to ensure that:

- All personnel are kept up to date with regard to health and safety matters (e.g. Hazards and risks, incidents and lessons learnt, leading practices, performance against objectives, etc.);
- General health and safety awareness levels are kept high;
- Prompt feedback is given to personnel with regard to health and safety issues or concerns that they raise; and
- Relevant, and often critical, health and safety related information (e.g. Design changes, instructions, reporting of hazardous conditions or situations, etc.) is effectively disseminated.

This must be achieved as follows:

12.1 Visible Felt Leadership (VFL) and Safety Observations and Conversations (SOCs)

The contractor's supervisory personnel (i.e. Managers and supervisors) must participate in the project's Visible Felt Leadership (VFL) programme. Each manager and each supervisor must, as part of his normal duties, perform Safety Observations and Coaching (SOCs). The intention of this programme is to encourage interaction between supervisors and workers concerning health and safety matters in order to:

- Reinforce behaviours consistent with standards, procedures and management system requirements;
- Correct behaviours inconsistent with standards, procedures and management system requirements; and
- Verify whether employees have the necessary training, certification, equipment, etc. To perform the work that they are carrying out.

Each manager, construction supervisor, safety personnel has a required number of SOC's to be completed per week. All SOC's that are recorded must be submitted to the nominated project management representative on a weekly basis.

The information that is gathered must be analysed and any trends that are identified must be acted on to correct unsafe behaviour or conditions.

12.2 Toolbox Talks

The contractor must prepare a Toolbox Talk on a weekly basis and must share it with all personnel for which the contractor is responsible (including all sub-contractors). Toolbox Talks must address health and safety issues that are relevant to the work performed on the project site(s) and must include information and / or knowledge sharing, lessons learnt from incidents that have occurred, information concerning specific hazards and / or risks and control measures to prevent injury, etc.

Attendance records must be kept and maintained in the contractor's health and safety file.

12.3 Daily Safe Task Instructions (DSTIs)

A Daily Safe Task Instruction (DSTI) is a pre-start discussion amongst the members of a work team, led by the appointed supervisor, aimed at anticipating hazards and potential risks associated with the activities planned for the day or shift, and ensuring that the necessary control measures are in place to prevent incidents.

At the start of each day or shift, prior to the start of any work, each appointed supervisor must inspect the work area for which he is responsible and ensure that it is safe. He must then conduct a DSTI with his work team specifically concerning the tasks that they will be performing during the course of the day or shift. The relevant Task-Based Risk Assessment for the activity must be used as the basis for the discussion. The correct work method must be reiterated and the identified hazards, risks and control measures must be discussed with the team (each team member must be given the opportunity to contribute and participate in the discussion).

Any team member arriving late must first be taken through the information that was discussed (work method, hazards, risks and control measures) before being permitted to start working. If the work method changes after activities have already begun, the DSTI must be revisited, updated and re-communicated with the team, and the changes must be signed off by the relevant Contractor Health and Safety Officer.

Every member of the work team must sign the DSTI attendance register. The attendance records must be kept and maintained in the contractor's health and safety file.

The contractor's Health and Safety Officer must evaluate the content of the DSTI's daily to ensure that they are task-specific. Furthermore, the Health and Safety Officer must attend the DSTI discussion but must not lead the DSTI discussions, as this is the responsibility of the appointed supervisor.

12.4 Health and Safety Suggestions

All employees must be encouraged to submit suggestions to enhance health and safety management on the project site(s). A process must be in place for documenting, evaluating, implementing (as appropriate), archiving and recognising the improvement ideas.

12.5 Health and Safety Meetings

12.5.1 Contractor Health and Safety Meetings

The contractor must schedule and consistently hold monthly health and safety meetings. These meetings must be chaired by the contractor's Project Manager and the following persons must be in attendance:

- Contractor and sub-contractor management representatives;
- Contractor and sub-contractor supervisors;

- Contractor and sub-contractor appointed Health and Safety (Employee) Representatives;
- Contractor and sub-contractor Construction Health and Safety Officers; and

The meeting must address the following as a minimum:

- New incidents for the period and corrective actions taken or to be taken;
- Implementation status of outstanding actions associated with previous incidents;
- SOCs, PTOs and DSTIs carried out for the period and action required to correct trends identified;
- Results of any audits, inspections (including H&S Rep inspections) or site visits carried out;
- A look ahead to ensure that appropriate health and safety planning and preparation is done for upcoming work;
- Risk Assessments, Safe Work Procedures, etc. That are outstanding or due for review (as well as the quality of these documents); and
- Any other health and safety related matter.

The contractor must compile minutes of each meeting and such minutes must be signed off by the Chairperson as a true reflection and attendance records must be kept. These records must be maintained in the contractor's health and safety file.

12.5.2 Site Health and Safety Meetings

In addition to the Contractor Health and Safety Meetings, the Project will schedule monthly Site Health and Safety Meetings that the contractor must attend. These meetings will be chaired by the Project Construction Manager and the following persons must be in attendance:

- Contractor management representatives;
- Contractor Health and Safety Officers;
- The Project Health and Safety Manager;
- Project Health and Safety Advisors; and
- Client representatives (ad hoc).

The meeting will address the following as a minimum:

- Feedback from the contractor concerning health and safety performance for the period;
- New incidents for the period and corrective actions taken or to be taken;
- Implementation status of outstanding actions associated with previous incidents;
- SOCs, PTOs and DSTIs carried out for the period and action required to correct trends identified;
- Results of any audits, inspections or site visits carried out;
- A look ahead to ensure that appropriate health and safety planning and preparation is done for upcoming work;
- Risk Assessments, Safe Work Procedures, etc. That are outstanding or due for review (as well as the quality of these documents); and
- Any other health and safety related matter.

12.6 Health and Safety Performance Boards

The contractor must provide and maintain a Health and Safety Performance Board to be approved by the nominated project management representative and to be positioned at the entrance to the contractor's site office area. This board must display the following information as a minimum:

- The contractor's logo;
- Current manpower (heads) on site;
- Man-hours worked for the current month and project to date;
- Lost Time Injury Frequency Rate (LTIFR);

- Dates of last injuries (FAI, MTI and LTI);
- Number of hours worked since the last recorded LTI; and
- Names and contact telephone numbers for the appointed Project Manager and the Health and Safety Officers.

12.7 Health and Safety Management Information Notice Boards

The contractor must provide, for each construction site, a portable Health and Safety Management Information Notice Board to be placed in the work area. The following information and documentation, as a minimum, must be posted on these boards:

- The relevant Method Statements, Risk Assessments and Safe Work Procedures for the work that is being performed that day;
- The DSTI for the day;
- The most recent Toolbox Talk;
- Where applicable, all required permits and permissions for the work that is being performed;
- Safety Data Sheets (SD's) for any chemical substances being used;
- The health and safety objectives for the work team;
- Details of the last incident involving the work team;
- The most recent weekly health and safety report;
- Emergency procedures;
- A site plan indicating evacuation routes and emergency assembly point locations;
- First Aider and Health and Safety Representatives names, contact telephone numbers as well as recent photo; and
- The appointed supervisor's contact details.

12.8 Involvement (Other)

The participation of all contractor (and sub-contractor) employees in activities that promote improvements in health and safety performance must be encouraged. In particular, this must include their appropriate involvement in:

- Hazard identification, risk analysis and determining control measures;
- Incident investigation; and
- Reviewing policy and objectives.

All regulations, instructions, signage, etc. Must be communicated in a language understood by all employees.

Health and safety personnel must be actively involved in planning activities so that they have the opportunity to highlight hazards and risks associated with upcoming work well in advance to ensure sufficient time to arrange and / or implement the necessary control measures.

13. Documentation and Document Control

The contractor must develop and maintain project-specific documentation required for the effective management of health and safety on the project.

All documents related to the contractor's health and safety management system must be effectively controlled.

The document control process must:

- Provide for the review, revision and version control of documents;
- Uniquely identify documents (as appropriate) to control their use and function;
- Require approval of the documents for adequacy prior to issue;
- Clearly identify changes and record the status of any revisions to documents; and
- Provide for the effective distribution of documents to, and where necessary the timely removal of obsolete documents from, all points of issue and use.

The contractor must establish a process for the systematic control of health and safety records and related data. Controls must be in place for the creation, receipt, secure storage, maintenance, accessing, use and disposal of such records and data.

Each record must be legible, identifiable and traceable, and must contain adequate information and data for its purpose.

The confidentiality and security of records and data must be maintained in a manner that is appropriate for the nature of the records and data, and in accordance with any applicable data or privacy protection legislation.

Personal information originating from medical surveillance and occupational hygiene monitoring must be reported in a form that respects the privacy of the individual, but enables management to fulfil their duty of care obligations to employees. The names of individuals must not be disclosed without their written authorisation.

Retention periods for all records (based on legal requirements and / or knowledge preservation considerations) must be established and documented in accordance with applicable legislation.

13.1 Contractor Health and Safety File Requirements

The contractor must compile and maintain a file containing all necessary health and safety related documentation. The contents of the file will be audited by a Project Health and Safety Practitioner on a monthly basis.

Required documentation includes, but is not limited to, the following:

- Valid Letter of Good Standing from the Workman's Compensation Commissioner;
- Proof of Public Liability Insurance;
- Scope of Work under the contract;
- List of Contacts and their Telephone Numbers;
- Health and Safety Policy;
- Health and Safety Management Plan;
- Legal Register;
- Organisational Chart for the project;
- Appointment Letters (appointment of the contracting company, and appointments for all persons with health and safety related responsibilities);
- 37.2 Agreements
- Notifications to the relevant authorities that construction work is in progress;
- Baseline and Task-Based Risk Assessments;
- Safe Work Procedures, Work Instructions and Work Method Statements;
- Planned Task Observations;
- Fall Protection Plan (where applicable);
- A dossier (Equipment Profile) for each fuel-driven vehicle or machine;
- Inspection Registers, Forms and Checklists (e.g. For portable electrical tools, ladders, safety harnesses, light vehicles, mobile equipment, lifting equipment and lifting tackle, first aid boxes, fire extinguishers, etc.);
- PPE Issue Registers;
- Safety Data Sheets;
- Emergency Response Procedures;
- Incident Procedures and Records;
- A dossier (Employee Profile) for each employee containing:
- A copy of the employee's Identity Document or Passport;

- Certificate of Fitness (Pre-Employment Medical Examination);
- Proof of Induction Training;
- Other Training Records;
- Copies of Qualification Certificates and / or Certificates of Competency; and
- Copies of Licences;
- Health and Safety Meeting Minutes;
- Health and Safety Performance Reports;
- Copies of Inspection and Audit Reports; and
- Daily Safe Task Instructions (DSTIs) and Toolbox Talks.

The contractor must ensure that an equivalent file is compiled and maintained by each appointed sub-contractor.

A copy of the Construction Work Permit will be made available to the Contractor for inclusion into the Health and safety file as well as to display at the entrance of the construction site.

14. Construction Work Permit (CWP)

Transnet appointed Construction Health and Safety Agent will obtain Construction Work Permit prior commencement of any construction work on the project and the permit will be issued to the Principal Contractor. The Principal Contractor must conspicuously display the permit at the entrance to the site for which that number is assigned.

The Principal Contractor must keep a copy of the permit in the health and safety file for inspection.

NB: No construction work must commence or carried out before the CWP and number has been issued and assigned. A site specific number is not transferrable.

15. Project Construction Control

For project operations and activities, the contractor shall implement and maintain:

- Operational controls, as applicable to the organization and its activities;
- The organization shall integrate those operational controls into its overall OH&S Management System;
- Controls related to purchased goods, equipment and services;
- Controls related to contractors and other visitors to the workplace;
- Documented procedures, to cover situations where their absence could lead to deviations from the OH&S policy and the objectives;
- Stipulated operating criteria where their absence could lead to deviations from the OH&S policy and objectives.

15.1 Safe Work Procedures

The contractor must develop, document and implement Safe Work Procedures for all activities involving significant health or safety risk. These procedures must detail the control measures required to effectively manage the health and safety risks associated with the work activities.

Each Safe Work Procedure must be consistent with the Task-Based Risk Assessment completed for the activity.

Every person engaged in an activity for which a Safe Work Procedure has been developed must receive suitable training on the procedure.

Furthermore, the contractor must develop, document, communicate and implement formal procedures, work instructions and / or programmes for the operation, maintenance, inspection and

testing of all plant and equipment (including protective systems and devices) brought onto the project site(s).

15.2 Planned Task Observations

All contractor, management supervisors must perform Planned Task Observations (PTOs) to verify that the control measures that have been identified in Safe Work Procedures (and associated Risk Assessments) are being adhered to and are being properly implemented, and to provide guidance where deviations are noted.

Each supervisor must complete at least two PTO per week involving one or more employees in his work team. This number of PTOs is at the discretion of TRANSNET's Project Manager or appointed Representative.

When an unsafe act or condition is identified, the supervisor must coach the work team to correct the act or condition in line with the Safe Work Procedure.

Where valid changes to the work method are identified, the supervisor must ensure that the Safe Work Procedure and Risk Assessment are updated to reflect the current practice.

Project representatives will carry out PTOs on contractor employees on an ad hoc basis. Should deviations from the contractor's Safe Work Procedures be observed, the work may be stopped until these deviations are rectified.

15.3 General Rules of Conduct

All persons are required to conform to the following rules of conduct while on the site.

The following acts are prohibited:

- Engaging in practical jokes, horseplay, scuffling, wrestling, fighting, or gambling;
- Assault, intimidation, or abuse of any person;
- Insubordination towards any supervisor or manager;
- Refusing to carry out a reasonable and lawful instruction concerning health and safety;
- Entry into any restricted area (including barricaded areas), unless authorised to do so by the responsible person;
- Unauthorised use / operation of any equipment or machinery;
- Negligently, carelessly or wilfully causing damage to any property;
- Destroying or tampering with safety devices, signs, or signals;
- The use of water from fire hydrants or hose reels for any purpose other than extinguishing a fire;
- The wilful and unnecessary discharging of fire extinguishers;
- Refusing to give evidence or deliberately making false statements during incident investigations;
- Bringing alcohol, drugs, or any other intoxicating substance onto site;
- Bringing a firearm, ammunition, or any other offensive weapon onto site;
- Bringing animals onto site;
- Running, except in an emergency;
- The use of cell-phones (or similar devices) whilst working on site;
- Sleeping on the job;
- Building fires on site, unless in a suitably constructed barbequing facility; and
- Pouring / pumping / flushing any substance (chemical / hydrocarbon / waste water) into a storm water drain, onto bare soil, or into any area where the substance is not effectively contained.

Any of the above actions may result in the temporary or permanent removal of the offending person(s) from site, as well as possible prosecution. The decision of the nominated project management representative shall be final and binding in respect of any dispute that may arise from the interpretation of these requirements.

TRANSNET will not get involved in contractor disciplinary rules and procedures. The contractor will simply be informed (with reasons) that the offending employee(s) will be denied access to the project site. Once the contractor has been informed, the employee(s) must be removed from the site immediately.

15.4 Site Access

The contractor may not hire any security services for the project site unless authorisation has been obtained in writing from a nominated project management representative.

15.4.1 Access Control

The contractor must comply with all access control, procedures and systems applicable to the project site.

Failure to comply with these requirements will be viewed as a serious safety breach and may result in the permanent removal of the individual(s) / contracting company from site or suspension without payment.

Access will be controlled as follows:

Contract period access – an access card valid for the full contract period will be issued to an individual once the following requirements have been met:

- Completion of a pre-employment medical examination which states that the employee is fit for duty;
- Completion of all required project induction training;
- Completion of special training / licensing if applicable (e.g. Driving/operating Licence).

Note: No access card will be issued unless proof of identification is provided (i.e. an identity document or a valid passport). For foreign labour, an access card will only be issued if a valid work visa is produced.

Note: A driving licence will not be accepted as proof of identification.

15.4.2 Trespassing

The contractor must ensure that no employee (including sub-contractor employees) trespasses on any land lying beyond the boundaries of the project site.

If instructed by a nominated project management representative to do so, the contractor must remove any employee who fails to comply with this requirement from the project.

The contractor's activities must be confined to the specified construction areas, and access to these areas may only be by means of specified routes.

All required barricading (fencing) must be erected and maintained by the contractor.

15.4.3 Visitors

Visitors (including reps and suppliers) must be advised in advance of the mandatory Personal Protective Equipment (PPE) requirements for the site, and must arrive with all of this PPE.

Upon arrival, all visitors must report to the Contractors designated Site Office where they must sign in.

All visitors must undergo a visitor induction briefing before entering the site.

Whilst on site, visitors must be accompanied at all times by an appropriately senior employee who has been inducted fully. The visitor(s) must be met at the designated Site Office, and when the visit is over, must be escorted back to the Site Office.

Note: Visitors are not permitted to perform any work on site.

Note: Any request (typically made by a government official) to carry out a site inspection must be referred to the nominated project management representative. The contractor must not arrange any such inspection without prior approval from the nominated project management representative.

15.4.4 Alcohol, Drugs and Other Intoxicating Substances

The contractor must ensure that all personnel under his authority do not at any time enter the site or perform any work whilst under the influence of alcohol, a drug, or any other intoxicating substance.

Selling or possessing drugs, alcoholic beverages or any other intoxicating substance on the site is strictly prohibited.

A drugs and alcohol testing program will be implemented. Persons entering the site will be daily/ randomly tested. Any person who tests positive for alcohol or drug consumption will be subject to disciplinary action and shall be permanently removed from the site.

Any person have the opportunity to rather report that he/she is under the influence before accessing the project site – in these case the employee may only be send home for the day by the responsible project manager representative but will then be tested for the following five days (each day) on his return to the project site. If it is found that the same person is frequently reporting that he/she is under the influence before even accessing the project site, It shall be the responsibility of the nominated project management representative to take disciplinary action and remove such a person's form the project site.

Should the actions and / or demeanour of an employee suggest possible narcosis or drunkenness, the employee must be removed from the site. This may be done without testing.

Note: All personnel involved in an incident / accident must immediately be subjected to an alcohol test and a drug test as part of the investigation.

15.4.5 Firearms, Ammunition and Offensive Weapons

Firearms, ammunition, and offensive weapons of any kind are strictly prohibited. No person may enter /shall not be permitted to enter the site carrying any such item.

15.5 Construction Vehicles

Construction vehicles, such as transportation vehicles, vehicles being used by the Contractors team, that is brought onto site must meet safety requirements. Each vehicle to be used on site must be inspected and approved by the nominated project management representative before a site access permit will be issued for the vehicle / equipment. No vehicle shall be permitted to enter the site unless it is duly authorised. Access permits are vehicle-specific and may not be transferred between vehicles.

The contractor must allow any vehicle that is brought onto site (including privately owned vehicles) to be searched at any time while on the premises, or when entering or leaving the premises.

The contractor is solely responsible for the safety and security of all vehicles (including private vehicles) that is brought onto the site. All road-going vehicles used by the contractor on the site must be roadworthy and registered with the relevant traffic authority.

A vehicle will not be permitted to enter the site in an un-roadworthy condition. Access will be denied if, for example, but not limited to:

- The vehicle has a defective exhaust system;
- A serious oil or fuel leak is evident;
- The vehicle has unsafe bodywork or is carrying an unsafe load;
- The vehicle is fitted with extraneous or non-standard equipment;
- Passengers are not seated properly;
- The vehicle is not fitted with a seat belt for each occupant; or
- The vehicle has any obvious mechanical defect;
- Pre-inspection requirements are not met.

Overloaded vehicles will not be permitted to enter the site. The driver / operator of any vehicle / mobile equipment must carry a copy of his appointment with him at all times. Each driver / operator must:

- Comply with all site / project rules and regulations pertaining to traffic and the safe operation of vehicles / mobile equipment;
- Obey all road signs;
- Obey all instructions given by security or emergency services personnel;
- Remain within the boundaries of the site; and
- Ensure that the vehicle that he is operating is never overloaded, and that loads are always properly secured.

In the interest of safety, only the minimum number of vehicles required by the contractor to complete the work under the contract will be permitted to enter the site. When not in operation, the contractor's vehicles / mobile equipment must be parked within the boundaries of his lay-down area or yard.

Parking is only permitted in designated parking areas. All cars are parked on site at the owner's risk.

In the event of a vehicle accident on site, the driver(s) must report the incident immediately and must remain at the scene until a nominated project management representative arrives, or until a nominated project management representative authorises him to leave (unless, of course, the driver requires medical attention).

15.5.1 Mobile Equipment

All Contractors must ensure that mobile equipment and light vehicles comply with relevant/applicable legislation.

Each contractor must provide evidence to the nominated project management representative that all light vehicles and mobile equipment to be used on the project (including, but not limited to, lift and carry cranes (or mobi-lifts), mobile cranes, forklifts, mobile elevating work platforms (e.g. Cherry pickers), tractors, dozers, dump trucks, haul trucks, graders, excavators, loaders, back-actors, drill rigs, and road-going cars, light delivery vehicles, and trucks) comply with the requirements of relevant/applicable legislation. This evidence must be provided prior to the equipment being brought onto the project site. The contractor remains responsible for meeting this requirement even if the equipment to be used is leased or provided by a sub-contractor (i.e. not owned directly by the contractor).

An Equipment Profile (dossier) must be compiled for each light vehicle and each item of mobile equipment to be used on the project site. All mobile equipment and light vehicles (used for work purposes) must be subject to a risk assessment. The assessment must:

- Involve operators and maintenance personnel who will use and work on the equipment; and
- Address all aspects of safe operation including but not limited to handling, driver vision, brake failure, tyre blow out, and access and egress for operators and maintenance personnel.

Each light vehicle and each item of mobile equipment must be serviced and maintained as prescribed by the manufacturer of the vehicle or equipment. No major repairs or services may be carried out on site. No repairs may be carried out by a driver or operator. Only suitably qualified and competent persons may carry out repair work.

An appropriate pre-operation safety check based on a risk assessment must be carried out for each light vehicle or item of mobile equipment driven or operated for work purposes. For each vehicle or equipment type, an approved checklist must be in place (and must be used). The pre-operation check must include, but not be limited to, inspection and / or testing of the following safety critical features:

- Brakes (testing method must be provided);
- Wheels and tyres (including the spare);
- Lights and indicators;
- Steering;
- Seats and seat belts; and
- Windscreen and windows, including windscreen wipers and washers.

Should any critical feature be defective or damaged, the vehicle or equipment may not be operated until it has been fully repaired.

Supervisors must review the completed checklists on a daily basis to satisfy themselves that there are no major deficiencies that could place a driver or operator at risk. No person may drive or operate any light vehicle or item of mobile equipment without authorisation. All drivers and operators must be appointed in writing by the contractor's Project Manager.

No driver or operator may be appointed without proof that the individual has been trained, tested and found competent, or is currently licensed. The appointment letter must specify the type of vehicle or equipment for which authorisation is being given and must clearly confirm that the driver or operator:

- Is 18 (eighteen) years of age or older;
- Has undergone a medical examination and has been declared fit for work by an occupational medical practitioner; and
- Has received suitable training and has been found competent, or is in possession of a valid driving licence issued by a state, provincial or civil authority that is applicable to the class of vehicle or equipment that is to be driven or operated.

The principal accountability for preventing accidents and incidents lies with the driver or operator of a light vehicle or item of mobile equipment, as he is in full control of any given situation at any given time. It must be stressed to each driver and each operator that safety is his prime responsibility – this must be clearly instructed and understood.

Drivers and operators must be empowered to stop driving or operating immediately should an unsafe condition arise, and refuse to drive or operate any light vehicle or item of mobile equipment

that is defective and / or has any inoperative safety features. Similarly, a supervisor must never force a driver or operator to drive or operate a defective vehicle or item of equipment.

If a driver or operator does not adhere to the site rules and regulations, his appointment must be withdrawn and he must not be permitted to continue with his duties. If necessary, site access will be denied (either temporarily or permanently) to any driver or operator who is deemed to not be adhering to site requirements.

No person may drive or operate a light vehicle or item of mobile equipment if he suffers from a medical condition that places both him and those around him at risk of injury. A fit-for-work policy must be in place. Daily alcohol testing and random drug testing must be carried out.

Supervisors must regularly check on the physical condition of drivers and operators during the course of a shift. A system must be in place to manage driver fatigue. No eating or drinking is permitted while driving or operating a light vehicle or item of mobile equipment.

A mobile phone, whether hands-free or not, may not be used by the driver or operator of a light vehicle or item of mobile equipment unless the vehicle/equipment is parked in a safe location and not operational. Behaviour-based observations and coaching must include the operation of light vehicles and mobile equipment.

A site-specific traffic management plan must be compiled and submitted to the nominated project management representative for approval. The plan must include, but not be limited to, (where relevant to the scope of work) the following:

- Segregation of pedestrians, light vehicles, and mobile equipment where possible (using barriers where feasible);
- Systems to control the movement of mobile equipment in areas accessible to pedestrians, the movement of mobile equipment into and out of workshops, and pedestrian and light vehicle movement around mobile equipment;
- Setting of appropriate speed limits for vehicle types, road surfaces and environmental conditions;
- Installation and maintenance of road traffic control signs;
- Right-of-way rules (including overtaking restrictions);
- Overtaking protocols;
- Clear communication protocols for interactions between all vehicles and equipment;
- Procedures for light vehicles and / or mobile equipment entering hazardous or restricted areas;
- Standards for safe following distances based on operational circumstances, environmental conditions and near sight (blind spot) limitations of mobile equipment;
- The minimum safe distance to be maintained between light vehicles and mobile equipment (i.e. 50 metres unless positive contact is made);
- Designated parking areas for mobile equipment and light vehicles, including parking associated with maintenance areas;
- Parking procedures (e.g. Safe parking distances, safe parking locations, requirements for reverse parking, etc.);
- Systems to control approaching, refuelling, parking, boarding and disembarking mobile equipment (a driver or operator must exit the cabin and must disembark the vehicle or equipment entirely when his direct involvement with maintenance or servicing is not required);
- Guidelines for abnormal road conditions (e.g. Heavy rain, fog, or high winds) providing "go / no go" criteria and contact details for the person(s) responsible for making the "go / no go" decisions;
- Truck loading and unloading procedures to avoid material or objects falling from the vehicle;
- Guidelines for wide or abnormal loads including offsite transport; and

- Systems to control mobile equipment use in the vicinity of overhead power lines.

The Traffic management Plan must be reviewed/revised where changes to the works areas require. A risk assessment must be carried out prior to any changes being made to traffic movements or road systems.

Designated walkways (both indoors and outdoors) must be provided for pedestrians, and pedestrians must make use of these walkways. Good lighting must be provided along all walkways, particularly at road junctions. Wherever possible, rigid barricading must be used to separate pedestrians from moving light vehicles and / or mobile equipment.

All personnel must be transported to site and must be dropped off at a designated area. Controls must be in place to ensure the safety of people working on roads, including those working on broken-down vehicles.

High visibility clothing must be worn at all times whilst on the project site. Speed limits and traffic rules must be reviewed regularly and must be rigorously enforced. Local traffic rules must be complied with at all times.

Pedestrians must give way to light vehicles and / or mobile equipment except at pedestrian crossings. All light vehicles and mobile equipment must give way to emergency vehicles. Pedestrians and light vehicle drivers must be made aware of the blind spots associated with mobile equipment.

The driver or operator of a light vehicle or item of mobile equipment must stop the vehicle or equipment and sound the horn before proceeding at blind corners, where his view of the path or intended path is obstructed, and when entering or leaving a building. Whenever a light vehicle or item of mobile equipment is stopped or parked, the handbrake (if applicable) must be applied.

No light vehicle or item of mobile equipment may be left unattended with the engine running or with a key in the ignition. No light vehicle or item of mobile equipment may be parked so as to cause an obstruction to any roadway, passage or access way. No light vehicle or item of mobile equipment may be parked within 50 metres of a loading or off-loading point.

All loads must be secure and must be within the load limit of the vehicle or equipment. A load must be properly secured before the vehicle or equipment is set in motion. Adequate precautions must be taken for any overhanging load. No unauthorised light vehicle or item of mobile equipment may enter a restricted area or building.

15.5.2 Light Vehicles

All Contractors must ensure that Light vehicles have the following minimum safety features:

- Fixed seats and suitable seat (safety) belts for all occupants (i.e. Driver and all passengers);
- Roll-over protection for all vehicles intended to be driven on dirt or steep roads;
- Cargo barriers and load restraints for all vehicles designed for carrying loads (other than passengers), or that are unable to have cargo separated from the occupant-carrying space of the vehicle; and
- An air bag on the driver's side, and where available as a manufacturer fitted item, a passenger's air bag;
- A Reverse Alarm.

All Contractors must ensure that Light vehicles that interact with mobile equipment are equipped or fitted with:

- Systems that enable positive communication with the equipment operators (e.g. A two-way radio);
- A high visibility flag (e.g. A whip flag or buggy whip);
- An amber flashing light (revolving or strobe);
- Reflective taping; and
- High visibility signage (i.e. Vehicle call numbers) facilitating easy and positive identification from a reasonable distance.

All Contractors must ensure that Light vehicles carry:

- Emergency roadside triangles or beacons (three of either);
- Chock blocks for preventing uncontrolled movement of the vehicle when parked;
- A flashlight;
- A fire extinguisher (2.5kg DCP);
- A first aid kit; and
- Survival or emergency equipment (e.g. a vehicle recovery kit) suitable for the operating environment.

A change management process must accompany all vehicle modifications, including the attachment of any equipment. Examples of changes or modifications include, but are not limited to, any change or modification:

- Made to the overall structure or design of the vehicle body;
- Made to the original manufacturer-fitted type of tyres or wheels;
- Made to the suspension system of the vehicle;
- Made to the mechanical system of the vehicle;
- That may adversely alter the centre of gravity of the vehicle;
- That alters the load carrying capacity of the vehicle; and
- That may affect the ability of the vehicle to withstand a crash (e.g. the fitment of a "bull bar").

Vehicle selection must be based on a risk assessment where consideration is given to the tasks, the application, the environment, roll-over protection and the rating of sturdiness in the event of a crash.

All Contractors must have a formal inspection and preventative maintenance system in place to ensure that vehicles are maintained in a safe and roadworthy condition at all times and, as a minimum, are serviced in line with the vehicle manufacturer's service schedule.

Should any safety critical feature be defective or damaged, the vehicle must be withdrawn from service until it has been fully repaired. Inspection and maintenance must be undertaken on critical features such as:

- Wheels and tyres (including the spare);
- Steering, suspension and braking systems;
- Seats and seat belts;
- Lights, indicators and reflectors;
- Windscreen and windows, including windscreen wipers and washers;
- The vehicle structure itself; and
- Other safety-related items on the vehicle body, chassis or engine, including instrumentation.

Persons may only be transported in vehicles equipped with manufacturer fitted or approved seats and seat belts. Seat belts must be worn by all occupants of a light vehicle (i.e. the driver and all passengers) at all times.

Only the driver and one passenger are permitted in the cab (front) of a light delivery vehicle. No personnel may be transported in the load-bin of a light delivery vehicle, even if the vehicle is fitted with a canopy. Only tools and equipment may be transported in the load-bin. Furthermore, no persons may be transported in a trailer behind a vehicle.

A pre-operation vehicle safety check and familiarisation system must be in place and must be used by the driver. An approved checklist must be used. All vehicle faults that are recorded must be attended to immediately.

Light vehicle running lights (low-beam headlights) must be switched on at all times when the vehicle is in operation.

All Contractors must have a system in place to ensure that drivers receive adequate training to ensure that the vehicle intended to be operated or driven can be operated or driven safely. As a minimum, training must include:

- Behaviour-based defensive driving principles;
- Vehicle familiarisation, taking into account the handling dynamics of the vehicle, maximum number of passengers, load limits and various features;
- Loading and restraining principles where the vehicle to be operated is designed for carrying cargo loads;
- Education and awareness concerning driving and travel risks that may be encountered within the environment where the vehicle may be operated or driven, and the requirements pertaining to traffic rules and speed limits;
- Securing (locking) equipment to prevent unauthorised use;
- Emergency crash and breakdown procedures; and
- Basic mechanical principles, including how to change a tyre and perform an adequate pre-operation check.

15.5.3 Machinery

The contractor must ensure that all plant and equipment brought onto the site is:

- Appropriate for the type of work to be performed.
- Approved, inspected, tested, numbered and tagged (if appropriate) before being brought onto site.
- Properly maintained in accordance with the manufacturer's recommendations; and
- Placed on a register and checked at least once per month or as required by the applicable legislation.

Items of plant or equipment brought onto site by the contractor or his sub-contractors may be inspected by a nominated project management representative. Should the nominated project management representative determine that any item is inadequate, faulty, unsafe or in any other way unsuitable for the safe and satisfactory execution of the work for which it is intended, the contractor must, on instruction from the nominated project management representative, immediately remove the item from the site and replace it with a safe and adequate substitute.

15.5.4 Training and Licensing

No person may drive a light vehicle or operate an item of mobile equipment unless he has been trained, tested and found competent, or is currently licensed to drive or operate that specific vehicle or item of equipment. The training must address hazards and risks assessed for that specific vehicle; and the tasks for which it is to be used.

No person may be appointed to drive a light vehicle or operate an item of mobile equipment unless he is in possession of a valid medical certificate of fitness (issued by an occupational medical practitioner).

Each person required to drive a light vehicle or operate an item of mobile equipment on the project site must have a project-specific site licence or appointment to drive or operate that vehicle or item of equipment.

The Contractor must ensure that Licenses and Operators' competency certificates are valid for the duration of their activities on site. No training of drivers or operators may be carried out on site unless authorised by a nominated project management representative.

15.5.5 Rail line safety

There is an existing rail line behind the location where the fire infrastructure building will be constructed and that rail line has overhead track equipment which the principal contractor should take cognisance of during construction phase.

Principal Contractor shall be obliged to comply with all rail related compliance requirements to ensure safe and hazards free environment to its employees and contractors. Crane operation and other suspended activities should be in line with the allowable clearance to rail and OHTE, necessary switching shall be applied for and be in place before encroaching to rail limited space.

15.6 Access Road to Project Site

The contractor shall ensure that trained flagman are placed at strategic positions that may be identified along the access roads where high risk activities are being undertaken and/or at points of traffic interface.

The project access roads may not be closed without permission from a nominated project management representative.

15.7 Signs and Notices

The contractor must ensure that all required safety signs and notices are prominently displayed in accordance with the applicable legislation and good safety practice. Signs and notices must be in English as well as any other language(s) commonly spoken on the project site.

All symbolic signs must comply with the applicable national standards. No person may deface or damage any safety sign or notice. No person may remove or alter any safety sign or notice unless authorised to do so.

15.8 Barricading

Barricading requirements found within the Construction Regulations, 2014 as well as TRANSNET's barricading standards, but not limited to, must be complied with at all times.

Each contractor required to erect barricading on the project site(s) must develop, document and implement Safe Work Procedures that are aligned with the requirements of this standard.

Barricading must be erected to:

- Prevent persons from making contact with an identified hazard;
- Provide warning of the existence of a hazard;
- Prevent unauthorised access (by people, vehicles and mobile equipment) into an area where a hazard exists or where a hazardous activity is being carried out;
- Define the boundaries of a hazardous location and / or restricted area; and
- Allow a work team to perform hazardous tasks without persons unfamiliar with the hazard(s) accessing the area.

Although not limited to these situations, barricading must be erected or installed:

- Around excavations (trenches, pits, etc.);
- To protect openings and edges (to prevent persons from falling, all openings and edges associated with floors, stairs, and the open sides of buildings and structures during the course of construction must be protected by sturdy, rigid barriers capable of withstanding a force of at least 110 kilograms applied in any direction at any point);
- To prevent access into areas where overhead work is in progress;
- To route vehicles safely through (or around) construction areas; and
- To protect members of the public who may be in the vicinity of a work or construction site (by preventing access).

In all cases, the erection of barricading must be a temporary measure. It must only remain in place until the hazard is eliminated or the potentially dangerous situation is rectified.

A barricade must present a sturdy physical barrier to entering an area. Therefore, plastic cones, post and chain systems, "danger tape" and "snow netting" will not be accepted as barricading and may only be used for the purposes of low risk demarcation.

For example, snow netting may be used for the demarcation of lay down areas.

Acceptable forms of barricading include:

- Hoarding panels (no less than one metre in height) that can be securely fastened together to form a fence line may be used. Hoarding panels may be constructed from a variety of materials (e.g. wooden board, steel sheeting, wire mesh on a steel frame, etc.)
- Wire mesh fencing (no less than one metre in height with sturdy posts spaced at intervals of no more than 3 metres) may be used in certain circumstances, e.g. Around excavations.
- Sturdy, rigid, and securely fixed (i.e. bolted, welded, clamped, etc.) metal guard rails may be used, particularly for protecting openings, holes and edges associated with floors, platforms, walkways, etc. The top rail must be positioned at a height of one metre above the working surface, and a mid-rail must be provided.
- Concrete Jersey barriers must be used for the routing of traffic and when work is being conducted in or alongside a roadway.

Regardless of the type of barricade used, the following requirements must be met:

- The installation, alteration and removal of barricades must be supervised by a competent person;
- The barricading must be uniformly and intelligently configured;
- The barricading must be stable, conspicuous and effective;
- The barricading must completely surround the work or hazardous area;
- General access requirements around the work or hazardous area (such as pedestrian walkways, operational access, or general thoroughfares) must be taken into consideration when erecting a barricade;

- The extent of the area that is barricaded must be kept to a minimum so as not to unnecessarily restrict access to other areas. If access routes to other areas are blocked by the barricade, alternative routes must be identified and signposted.
- All barricaded areas must have properly designated points of entry and exit for persons and / or vehicles. Each pedestrian access point must be fitted with a self-closing gate. A sign indicating, "DESIGNATED ACCESS POINT – AUTHORISED PERSONNEL ONLY", must be fitted to each gate;
- Additional signage providing warning of specific hazards (e.g. falling objects, electricity, etc.) Including, "NO UNAUTHORISED ENTRY", must be attached to all gates and, where required, to the barricading itself. The signage must be visible from all angles and must be large enough to be read from a distance of 10 metres;
- Barricading must be clearly visible at all times (day and night). If necessary, flashing warning lights must be used;
- Tags must be attached to the barricading displaying the name and cell phone number of the person responsible for the barricade, and specifying the reason for the barricading and the date on which it is scheduled to be removed;
- Should a person require access to a barricaded area, authorisation must be obtained from the person responsible for the erection of the barricade. The hazards that are present and the Personal Protective Equipment that must be worn within the barricaded area must be communicated to the person seeking access;
- Each barricade must be listed in a register, and each must be inspected daily to ensure that it is still intact and that its positioning is still effective;
- All barricades must be properly maintained and repaired as required;
- When the work has been completed and the hazard has been eliminated, all barricading must be removed without delay. A barricade may not be left in place if no hazard exists;
- Before a barricade is removed (allowing general access), the area must be inspected by the person responsible for the work that was carried out, to ensure that the area is once again safe. If applicable, the person accepting the area back for general use shall do so on completion of his own safety inspection;
- Authorisation to remove (or modify) a barricade may only be granted by the person responsible for the erection of the barricade.

15.9 Excavations

Excavation work or activities which are required as part of the scope shall be undertaken in accordance with the requirements of this Specification as well as all applicable legislation concerning excavation work.

The contractor will be required to develop, document and implement Safe Work Procedures that are aligned with the requirements of this standard. All excavation work must be properly planned. Site-specific conditions and hazards must be considered, including traffic, overhead and buried utilities, proximity to nearby structures, soil properties, presence of surface and / or ground water, position of the water table, and weather conditions.

Excavation work may only be carried out under the personal supervision of a competent Excavation Supervisor who has been appointed in writing.

Before any excavation work is carried out, a Permit to Work authorising the activities will be issued. Similarly, no person may enter an excavation unless a Permit to Work has been issued providing authorisation for specific tasks to be carried out within the excavation.

Before issuing a Permit to Work for excavation works, the Authorised Person (i.e. Permit issuer) must verify that:

- A detailed Risk Assessment has been conducted for the work to be performed;
- A Safe Work Procedure is in place; and
- No buried services are present in the area where the excavation works are to be carried out.

As a minimum, the Risk Assessment must consider hazards and risks associated with:

- A person being trapped or buried as a result of an excavation collapsing;
- A person being struck by an object falling into an excavation;
- A person falling into an excavation;
- A person being exposed to a hazardous atmosphere within an excavation (i.e. An oxygen deficiency, explosive or flammable gases, and / or harmful concentrations of a contaminant);
- Contact with belowground services; and
- Mobile equipment and / or light vehicle movement in proximity to an excavation.

If buried services are identified (or are suspected to be present) then the safe work procedure must be altered if necessary to avoid these services. Machinery may not be used to excavate material lying within one metre of any belowground service (i.e. Cable or pipe).

Excavation work that is carried out must be limited to what is described in the Permit to Work. All controls, precautions and restrictions identified in the Permit to Work (and Risk Assessment) must be strictly observed and fully implemented. The Excavation Supervisor must discuss these controls, precautions and restrictions with all persons who will be carrying out the work. All excavation work must be carried out by persons who have been trained and are competent to perform the work.

All material removed from an excavation (spoil) must be placed no closer than three times the depth of the excavation away from the edges of the excavation. The profile of this spoil must be flattened out to prevent the material from being washed back into the excavation by rain water. Scaling must be carried out on the sides of all excavations to remove loose material.

Tools, equipment and materials may not be placed within two metres of the edges of an excavation. Alternatively, a suitable retaining device may be used to prevent tools, equipment and materials from falling, rolling or sliding into an excavation.

To prevent persons and / or mobile equipment from accidentally falling into an excavation and to prevent unauthorised entry into an excavation, rigid barricading must be erected around every excavation that is deeper than 500mm. Warning signage must be prominently displayed and, if necessary, flashing warning lights must be used at night.

The barricading must remain in place for as long as the hazard (i.e. the excavation) exists. Sections of barricading around an excavation may only be removed (and then only temporarily) to enable excavation work to continue.

If equipment is used to prevent water from entering an excavation or to prevent water accumulation within an excavation, then the equipment must be monitored by a competent person to ensure that it remains operational and effective.

A high standard of housekeeping must be maintained in and around all excavations. Tools that are not in use, and materials that are no longer required, must be removed from an excavation to

prevent these items from causing injury or being lost (buried). A register of all excavations must be compiled and maintained.

An excavation must be inspected for collapses, signs of instability, failures or signs of overloading of protective systems and equipment, hazardous atmospheres, water accumulation, and any other hazardous condition that may arise.

If a hazardous condition is identified, no person may enter the excavation until suitable corrective actions have been taken and / or suitable controls have been put in place to either eliminate the hazard or reduce the risks to acceptable levels. If a hazardous condition is identified while work is being carried out in an excavation, then all persons in the excavation must be evacuated to safety without delay.

A record of each inspection (including date, time, findings, and signature of the Excavation Supervisor who carried out the inspection) must be captured in the excavations register. Each inspection record must include a declaration as to whether the excavation is safe to work in or not. All excavations must be monitored closely throughout each work day (or shift) by the Excavation Supervisor.

Excavations must be backfilled as soon as possible, and the material used (usually the original material) must be properly compacted.

15.10 Cranes and Lifting Equipment

All applicable legislation concerning cranes and lifting equipment must be complied with at all times (Driven Machinery Regulation, Construction Regulations, Code of Practice 29, but not limited to). Each contractor carrying out lifting operations on the project site(s) must develop, document and implement Safe Work Procedures that are aligned with the requirements of this Specification.

15.10.1 Planning and Risk Assessment

For each critical lift that must be carried out on site, a documented and detailed lift plan and risk assessment must be prepared to address all associated hazards.

Only suitably qualified, competent and experienced persons (lift planners) may evaluate critical lifts and prepare lift plans.

The lifting supervisor, crane operators, riggers and spotters responsible for carrying out a critical lift must have input into the lift plan and risk assessment and must be consulted before these documents are finalised.

All lift planners, lifting supervisors, crane operators, riggers and spotters (safety observers) must be appointed in writing. No critical lift may commence until the lift plan and risk assessment have been authorised by the nominated project management representative and a Permit to Work has been issued.

Critical lifts include, but not limited to:

- All multiple (including dual) crane lifts;
- Lifts where the operational arcs of two or more cranes can overlap;
- Lifts over operating facilities where this may endanger personnel;
- Lifts over or adjacent to power lines;
- Any lift carried out in close proximity to equipment or a vessel containing a flammable or toxic substance;
- Lifts where the centre of gravity of the load could change;

- Any lift where the total weight on the hook exceeds 20 tonnes;
- Lifts near the rated capacity of the crane (i.e. Exceeding 85% of the rated capacity at the working radius);
- Any lift when the wind speed (including gusting) exceeds 30 kilometres per hour;
- Lifts involving a man basket (safety cage);
- Lifts to and from water;
- Lifts requiring specialised equipment or involving complicated lifting or rigging configurations;
- Lifts requiring non-standard rigging or slinging techniques;
- Lifts involving the simultaneous use of more than one hoist on the same crane; and
- Any other lift deemed to be critical by the nominated project management representative, or assessed as critical during a risk assessment.

The lift plan for a critical lift must include as a minimum:

- General Information – crane manufacturer, crane model, items to be lifted, and reason for lift;
- Lift Data – load weight, lifting block and hook weight, hoist rope weight, rigging weight, total weight, height of lift, radius of lift, surface area of load, and centre of gravity of load;
- Rigging Data – sling material (chain, wire rope, or synthetic), sling diameter, sling length, sling configuration, sling capacity, hook type, shackle size and capacity;
- Lift Computation – boom length, jib length, radius of lift, crane capacity as configured, size of outrigger footplates, and wind speed;
- Proximity to Power Lines and Process Areas – mobile cranes working in proximity to energised power lines must operate under a Permit to Work, which must define exclusion zones and spotter duties;
- Local Hazards and Controls – including the route for the crane, ground stability, proximity of people or equipment, and agreed communication method; and
- Diagrams (sketches) – a rigging diagram, and a crane set-up diagram illustrating the positioning of the crane(s) in relation to surrounding structures and the initial and final positions of the load (including crane boom movement).

Lifts that are not subject to detailed lift plans (i.e. Lifts that are not considered critical) must nevertheless be subject to a risk assessment, and be properly planned and executed.

The use of a crane-suspended man basket (safety cage) may only be considered when all other avenues to safely perform the work (e.g. Scaffolding, mobile elevating work platform, etc.) have been exhausted.

Cranes used to lift or suspend personnel must be approved as suitable for this purpose. If a crane must be operated in proximity to energised overhead power lines (or any other exposed electrical conductors) then minimum clearance distances (specified by the electrical power utility or the nominated project management representative) must be observed. Whenever possible, power lines must be de-energised and isolated while lifting operations are carried out.

15.10.2 Operation

At the start of every day or shift, the operator of a crane or hoist must carry out a pre-operation safety check as per Driven Machinery Regulation 18.

Documented Safe Work Procedures must be in place to ensure the following:

- Access into an area where lifting operations are being carried out must be restricted. Such an area (i.e. where there is a risk of a load falling and striking a person) must be barricaded

and only authorised persons may enter (i.e. those directly involved with the lifting operations). Warning signage must be conspicuously displayed;

- Where a load is being moved from one location to another (i.e. The lifting operations are not being carried out in a discrete area that can be barricaded), measures must be taken to ensure that all persons in the path of the suspended load are made aware of the approaching hazard and that they move, and remain, well clear of it. All persons potentially affected must be given warning before the load is lifted;
- A lift must be directed and controlled by a single person (a suitably qualified, competent and experienced rigger);
- Dedicated spotters must be in place during lifting operations to observe and provide warning (if necessary) to prevent incidents and ensure that safety protocols are adhered to;
- Before commencing with a lift, it must be verified that the load being lifted is both within the rated capacity of the crane (or hoist) and lifting equipment and within the limits set out in the lift plan and / or risk assessment. The rated load capacities of the crane, hoist, rope, chains, slings or other components may never be exceeded;
- Only certified lifting equipment (tackle) may be used to lift a load;
- No equipment (tackle) that has been used for towing may be used for lifting operations;
- Only an approved material box (skip box) may be used for lifting loose items or materials;
- Before commencing with a lift, it must be verified that no safety devices (including load limiting devices) have been bypassed, overridden or disconnected;
- To prevent the load from swinging as it is lifted, the hoist must be centred over the load (when using slings or chains) or positioned directly above the lifting point of the load;
- Hoisting ropes must be kept vertical. No side loading of a crane boom is permitted (i.e. A crane may not be used to make a side pull);
- Two full wraps of rope must remain on the hoisting drum at all times. If a lower hoist limit switch has been fitted, and it is working correctly, it should not be possible to lower the block below the point where less than two full wraps of rope are on the drum;
- Before commencing with a lift, it must be verified that all rigging connections are correct and secure. Slings, chains, or other lifting devices must be fully and securely seated in the saddle of the hook;
- Slack must be removed from the slings, chains and / or hoisting ropes before lifting the load. It must be ensured that multiple lines are not twisted around each other and that the hoist rope is not wrapped around the load;
- To ensure that the load is properly secured and balanced, it must initially only be lifted a few centimetres. Slings must be repositioned if required;
- Before moving a suspended load, it must be lifted high enough to clear all obstructions. The load must only be lifted to the height necessary to clear obstructions, and no higher;
- Directional movement must be made smoothly and deliberately (there must be no sudden acceleration or deceleration of the moving load). Abrupt, jerky movements of the load in any direction must be avoided;
- Tag lines must be used in situations where a load needs to be steadied or guided while suspended;
- When using tag lines to steady or guide a suspended load that is being moved using a mobile crane, personnel on foot must remain in sight of and in communication with the crane operator at all times, must never walk between the crane and the load, and must remain clear of the load and the crane at all times (at least 5 metres). The load must be moved at a slow walking speed;
- A suspended load must be monitored closely at all times;
- If a crane operator's view of a suspended load is unavoidably obscured (completely or partially), or if a suspended load is unavoidably obscuring (completely or partially) a crane

operator's view, then suitably positioned spotters must be in place to provide guidance to the crane operator;

- A load MAY NOT be moved over, or be suspended above, any person or any occupied building. No person may walk beneath, or position himself below, a suspended load;
- No person may pass or work beneath the boom of a crane;
- No person may be positioned between a suspended load and a solid object where there is a risk of being crushed should the load swing;
- No person may be positioned within the radius of the boom of a crane unless directly involved with the lift;
- Under no circumstances may any person ride on a crane's hook or on a load;
- No load may be left suspended unless the operator is at the controls and is monitoring the load. In such a situation, the load must be kept as close as possible to the ground or floor to minimise the possibility of injury should the load drop;
- The controls of a crane or hoist may never be left unattended while a load is suspended. If it becomes necessary to leave the controls, the operator must lower the load to the ground or floor;
- With the exception of pick-up and carry operations, no lifting may be carried out using a mobile crane unless the outriggers have been deployed and are locked in position;
- Load spreaders or packing under the outriggers must be used irrespective of the underfoot conditions;
- Before a mobile crane is moved into position to carry out a lift, the area must be inspected by a suitably qualified person who must verify that the underfoot conditions are satisfactory;
- When using a mobile crane, slewing to test the effectiveness of the outriggers must be carried out prior to commencing with a lift;
- Slew pins must be securely in place while a mobile crane is travelling;
- Unauthorised use of a crane or hoist must be prevented by removing the keys, locking the cabin, isolating the controls, etc. When lifting operations have been completed;
- When not in use, lifting equipment must be stored off the ground and must be protected from the elements (rain, harsh sunlight, etc.) And contamination (dust, solvents and other chemicals) in order to prevent damage and / or deterioration.

A crane or hoist or an item of lifting equipment may only be used for the purposes for which it was designed.

15.10.3 Inspection, Testing and Maintenance

Any crane or hoist brought onto the project premises must have a current test certificate and record of inspection as well as a suitable checklist (derived from the crane or hoist manufacturer's inspection recommendations) for use by the operator(s) when carrying out pre-operation safety checks.

An Equipment Profile (dossier) must be compiled for each crane. A register of all cranes, hoists and lifting equipment (tackle) brought onto the project premises must be compiled and maintained. Each crane, hoist and item of lifting equipment must have a unique identification code or number, which must be referenced in the register.

For each crane, hoist and item of lifting equipment, the following documentation must be kept on site and must be made available (on request) to the nominated project management representative for inspection:

- Test records and certificates;
- Inspection records;
- Maintenance records; and

- Details of any modifications or repairs made.

All cranes, hoists and lifting equipment must be inspected, tested and confirmed fit for purpose (i.e. Safe for use):

- Before being operated or put into service;
- Before being returned to service following any repair or modification; and
- Periodically as follows (unless local regulations require examination more frequently):
 - Each crane or hoist (including all ropes, chains, hooks or other attaching devices, sheaves, brakes and safety devices that form an integral part of the crane or hoist) must be thoroughly examined by a competent, experienced and appointed person every 6 months;
 - Each crane or hoist must be subjected to an annual performance test (i.e. A load test) by a competent, experienced and appointed person; and
 - All lifting equipment (tackle) must be thoroughly inspected by a competent, experienced and appointed person every 3 months.
 - The system of inspection and testing must provide verification that each crane or hoist is able to function to its design specifications, and must verify the integrity of:
- Mechanical and electrical components;
- Controls;
- Cables and all lifting attachments;
- Structural components including boom, hoist, brakes, wheels, hooks, baskets, out-riggers, hook-blocks and rails; and
- Load limiting devices, hoist limit switches, alarms or warning devices, and other safety devices and control systems (including independent fail-safe braking systems, devices to stop the crane or hoist such as a dead man's switch, and emergency shut-off switches).

A preventative maintenance system must be in place to ensure that all cranes and hoists are maintained in a safe and serviceable condition. For any crane or hoist, all inspections, testing, maintenance and repairs must, as a minimum, be carried out in compliance with the requirements and specifications of the manufacturer as well as all applicable regulatory requirements (in terms of both the frequency of inspection, testing and maintenance, and the physical condition of the crane or hoist).

Repairs to a crane or hoist may only be carried out by competent persons. After repairs have been made, the crane or hoist must be tested and recertified fit for purpose (unless the repairs did not affect the integrity of the lifting mechanism).

Any modification to a crane or hoist must be subject to the approval of the original equipment manufacturer and a rigorous change management process. Each item of lifting equipment (tackle) must be tagged following each quarterly (3-monthly) inspection. Details of these inspections must be recorded in the lifting equipment register which must be made available to the nominated project management representative on request.

The following colour coding system must be used for the tagging of all lifting equipment:

Table 27-1 colour coding system for lifting equipment

Quarter	Tag colour
January – march	Blue
April – June	Red
July – September	Green
October – December	Yellow

The tag placed on an item of lifting equipment must be traceable to an entry in the lifting equipment register where the following information concerning the inspection of that item of equipment must be recorded:

- Item description;
- Unique item identification code or number;
- Item owner;
- Item location;
- Date of inspection;
- Name and signature of competent person who carried out the inspection; and
- Any comments concerning the inspection.

Any item of lifting equipment that is found to be damaged or defective must be removed from service (and tagged, "out of service") immediately and must then either be repaired and recertified (if possible) or destroyed to prevent further use. Similarly, any lifting equipment that is known (or is suspected) to have been overloaded must be removed from service immediately and destroyed to prevent further use.

If an item of lifting equipment is removed from service or destroyed (scrapped), this must be indicated in the lifting equipment register. Any item of lifting equipment without a tag or with an out-of-date inspection may not be used.

15.10.4 Training and Competency

Only suitably trained, competent and experienced persons who have been authorised in writing by the contractor's project manager are permitted to:

- Evaluate and plan critical lifts;
- Supervise lifting operations;
- Operate cranes and hoists;
- Use lifting equipment, and rig (sling) loads;
- Provide signals for controlling lifts; and
- Inspect, maintain or test cranes, hoists and lifting equipment.

Each operator must meet the competency requirements for the particular class or type of crane or hoist to be operated. Depending on the project location and applicable legislation, operators may need to hold a certificate of competency issued by a recognised training institution.

15.11 Working at Heights

All applicable legislation concerning work performed from an elevated position must be complied with at all times. Fall prevention or fall protection measures must be in place whenever the potential exists for a person to fall.

15.11.1 Work Platforms

Wherever practical, a safe working area must be provided in the form of a work platform with fixed edge protection. This may include:

- a permanent work platform or walkway (i.e. A fixed steel structure);
- a fixed or mobile scaffold; or
- an elevating work platform such as a scissor lift, man lift, boom lift or cherry picker.

All work platforms and walkways elevated one metre or more must have complete floors, and edge protection must be in place in the form of toe boards and sturdy guard rails properly

secured (i.e. bolted, welded, clamped, etc.) to prevent accidental displacement. Safe means of access and egress must be provided.

Guard rails must be capable of withstanding a force of at least 100 kilograms applied in any direction at any point. The top rail must be positioned at a height of one metre above the working surface, and a mid-rail must be provided.

15.11.2 Floor openings, holes and edges

Any opening or hole (temporary or permanent) in a floor, platform or walkway must be protected by sturdy guard rails (removable if required) or a cover to prevent a person from stepping into or falling through the gap. Covers must be strong enough to support the loads that will be imposed on them and must be secured to prevent accidental displacement.

Ladder way floor openings and platforms must be protected by guard rails of standard construction and toe boards must be fitted along all edges, except at the entrance to an opening where a gate must be installed and so arranged that a person cannot walk directly into the opening.

When open, hatchways and floor openings must be protected by removable guard rails and toe boards of standard construction. When these openings are not in use, covers of adequate strength must be put in place and must be secured to prevent accidental displacement.

Where doors or gates open directly onto a stairway, a platform must be provided and the swing of the door or gate must not reduce the effective width of the platform to less than 500mm.

15.11.3 Wall openings

Wall openings, from which there is a drop of more than one metre, must be guarded as follows:

- When the height and position of the opening in relation to the working surface is such that standard guard rails will effectively eliminate the risk of accidentally falling through the opening, then these must be provided. The bottom edge of the opening must be fitted with a toe board. The guard rails and toe board may be removable if required;
- Alternatively, the opening may be closed using a screen. Wall opening screens must be of such construction and mounting that they are capable of withstanding a force of at least 100 kilograms applied horizontally at any point on the near side of the screen. A screen may be of solid construction, of grillwork, or of slat work.

An extension platform outside a wall opening, onto which materials can be hoisted, must have sturdy guard rails (or equivalent edge protection) on all sides. One side of the extension platform may have removable railings in order to facilitate the handling of materials.

15.11.4 Stairways

Each flight of stairs having four or more risers must be fitted with handrails. Handrails must be installed on both sides of every stairway. Riser height and tread width must be uniform throughout any flight of stairs, including any foundation structure used as one or more treads.

Stairways must be free of hazardous projections, such as protruding nails. No materials, equipment or waste may be placed on or beneath any stairway. All stairways must be well lit.

15.11.5 Fall Protection

Whenever there is a risk of falling onto dangerous equipment or machinery, or whenever work must be carried out near an opening through which (or an edge over which) a person could fall, no work may commence unless:

- A fall protection (and rescue) plan is in place (prepared by a competent person, approved by the nominated project management representative, and implemented by the contractor);
- A detailed task-specific risk assessment has been carried out;
- A safe work procedure is in place for the task to be performed;
- A permit to work has been obtained; and
- Each person has been provided with suitable fall protection equipment.

Fall protection equipment (either fall restraint or fall arrest equipment) must be used at all times whilst the work is being carried out. To prevent persons from falling, fall restraint equipment must be used whenever work must be carried out within an opening through which (or an edge over which) a person could fall.

Fall arrest equipment must be used whenever the potential exists for a person to fall. A person has been provided with suitable fall protection equipment if he is secured by means of an approved full body harness (well fitted) with two shock absorbing lanyards or an inertia reel (when fall arrest equipment is required) or two short restraining lanyards (when fall restraint equipment is required), double or triple action snap hooks (or karabiner type rings), and secure anchorage points (a person's lanyard may be attached either directly to an anchorage point or indirectly through the use of a variety of systems that incorporate a lifeline).

A dual lanyard system must be used to ensure that at least one connection point is maintained at all times.

Note: When selecting fall arrest equipment, care must be taken to ensure that the potential fall distance is greater than the height of the person plus the length of the lanyard with its shock absorber deployed (taking the height of attachment into account).

Anchorage points must, where practical, be above the head of the person, and must ensure that in the event of a fall the person will neither swing nor touch the ground. All permanent anchorage points must be designed and approved by a professional structural engineer.

All anchorage points must be periodically inspected and tested by a competent person to ensure that they are secure and can support the required load. A system must be in place to identify anchorage points as authorised for use. Temporary anchorage points (and lifeline systems) may only be used if a competent person has certified them safe to use.

If an elevating work platform is used, such equipment must be fitted with a fixed anchorage point for the attachment of fall protection equipment.

The use of fall protection (fall restraint or fall arrest) systems must be avoided wherever and whenever possible through design, the installation of physical barriers that protect persons from falling, and employing alternative methods of working. Only if physical barriers protecting against free falls cannot be installed must fall protection equipment be used.

Fall protection (fall restraint or fall arrest) systems are items of personal protective equipment and, if required, must be purchased, installed and provided to employees. Prior to commencing with any work at height, an assessment must be conducted to determine if the work requires the use of fall protection equipment, and if so, which fall protection system is the most appropriate for the work.

There must be a system for ensuring that fall protection equipment is:

- Tested and certified for use;
- Inspected by the user before use; and
- Destroyed following a fall or where inspection has shown evidence of excessive wear or mechanical malfunction.

All persons that are required to work at height (in order to carry out routine or non-routine tasks) must first be trained and certified competent to do so. Furthermore, each person must be in possession of a valid medical certificate of fitness specifically indicating that the person is fit to work at height.

All persons required to use personal fall protection equipment must be trained and certified competent in the correct selection, use, maintenance and inspection of such equipment.

All fall protection equipment must be thoroughly inspected visually prior to use and on a monthly basis thereafter by competent persons appointed in writing and each item of equipment must be tagged to show when it was last inspected. All inspections must be recorded in a register. On finding defective or damaged equipment, appropriate action must be taken by the competent person (i.e. the destruction of the equipment to prevent further use).

Persons making use of personal fall protection equipment must do so in strict accordance with the instructions or requirements specified by the manufacturer or supplier of the equipment or system. Specific pre-use inspection, maintenance and fitting protocols must be established in accordance with the manufacturer's requirements or guidelines and these protocols must be followed by all users of the fall protection equipment.

Solvents may not be used to clean fall protection equipment. Only manufacturer-approved cleaning solutions may be used.

No person required to use personal fall protection equipment may work in isolation (a minimum of two persons working together is required). Competent supervision must be in place at all times for all work carried out at height. Supervisors must be appointed in writing.

Emergency response (rescue) procedures for the rapid retrieval of suspended persons in the event of a fall from height must be prepared and tested.

Note: Even though there is no risk of free fall, fall protection equipment may be required in situations where there is a risk of falling, slipping or sliding down a slope of more than 45 degrees.

Note: The maximum service life of fall protection equipment manufactured of synthetic fibre shall be 5 years from the date of first use and / or manufacture unless otherwise specified by the manufacturer.

A person may climb or descend a ladder without fall protection provided that he is able to use both hands and legs to do so, faces the ladder, and uses one step at a time. The ladder must be tied off or supported at its base.

Prior to any roof work being performed, or prior to persons accessing a roof, a structural engineer must verify that the roof is of sound construction and that it is capable of supporting the weight of the persons as well as any equipment that may be required. Should the engineer's findings be to the contrary, alternative methods of performing the work must be found. Particular care must be taken when work is carried out on an asbestos cement roof or a fibreglass roof.

15.11.6 Risk Assessment and Permitting

The following documentation is required for any work where fall protection is required (i.e. where a risk of falling exists):

- A Fall Protection (and Rescue) Plan;
- A Risk Assessment for the task to be performed;
- A Safe Work Procedure for the task to be performed; and
- A Permit to Work.

As part of the Risk Assessment and planning processes, the following must be considered, but not limited to:

- Hazards relating to accessing the location at height;
- The nature of the work location;
- The nature of the work activities to be undertaken at height;
- Environmental and weather conditions;
- The presence of nearby persons who may be at risk due to falling objects (potentially) or who's activities may be affected by the work being performed at height;
- The selection of fall protection equipment (considering fall clearances) and / or access equipment;
- The selection of anchorage points;
- The load ratings of access platforms, work areas, anchorage points, etc.;
- The condition of supporting structures such as roofs;
- The need for the work to be carried out by multiple persons and the means of communication;
- A rescue plan that addresses retrieval or rescue contingencies;
- Working above open furnaces or molten metal;
- Exposure to heat sources;
- The use of a mobile elevating work platform, man basket, suspended scaffold or boatswain's chair; and
- Any other conditions that may affect the safe execution of the task.

15.11.7 Elevating Work Platforms

Before hiring or purchasing an elevating work platform (e.g. a scissor lift, man lift, boom lift, cherry picker or similar equipment), the certification of the equipment (with regard to suitability of design and construction) must be verified.

Before using an elevating work platform, it must be verified that the equipment is in good working order and has been serviced regularly. The service record and instruction manual must be kept on site. A system must be in place to ensure that the equipment is maintained and inspected as required by the manufacturer and / or local regulations.

Persons (operators) must be formally trained through an accredited training provider and certified competent in the operation of the equipment. Once a person has been issued with the necessary licence or qualification as required under local regulations, he must be appointed in writing to operate the equipment.

Before using an elevating work platform, the operator must inspect the equipment and a pre-use checklist must be completed. The operator of an elevating work platform must be in the “basket” unless it can be demonstrated to the satisfaction of the nominated project management representative that this is not possible or practical.

Every person in the “basket” must keep his feet on the floor at all times. Every person in the “basket” must be secured at all times by means of personal fall protection equipment attached to an approved anchorage point, and systems must be in place to prevent tools and equipment from falling.

A mobile elevating work platform must not be driven unless the “basket” has been lowered and secured in a stable position. Every elevating work platform that is used must be equipped with a dead man’s switch or foot pedal at the operator controls. An elevating work platform must only be operated on a firm surface with the outriggers extended (where fitted).

An elevating work platform must not be operated on a grade or slope beyond the capability of the machine (every mobile elevating work platform that is used must be fitted with an inclinometer which sounds an audible alarm before the maximum safe incline has been reached).

The area beneath the “basket” and the boom must be barricaded. A second competent operator of the mobile elevated work platform to be in place on the ground level – to ensure that the elevated work platform could be lowered in case of an emergency. A spotter must be used at all times when moving a mobile elevating work platform and when the “basket” is in an elevated position.

15.11.8 Man Baskets, Suspended Scaffolds and Boatswain’s Chairs

The use of a man basket, suspended scaffold or a boatswain’s chair may only be considered when all other avenues to safely perform the work (e.g. ladder, scaffolding, mobile elevating work platform, etc.) have been exhausted. Authorisation to use a man basket, suspended scaffold or a boatswain’s chair must be obtained from the nominated project management representative. If permission is granted, the use of such equipment must be in strict compliance with all applicable legislation.

Each person working from a man basket, suspended scaffold or a boatswain’s chair must be in possession of a valid medical certificate of fitness and must be trained (and assessed competent) in the Safe Work Procedures pertaining to the use of the equipment, as well as the Fall Protection Plan.

Each person working from within a man basket or suspended scaffold or from a boatswain’s chair must wear personal fall protection equipment at all times (i.e. an approved full body harness connected by means of a shock absorbing lanyard to an anchorage point or lifeline that does not form part of the basket or chair).

If suspended using a crane, the man basket, suspended scaffold or boatswain’s chair must be visible to the crane operator at all times. A suitable means of communication must be in place to ensure that the suspended person(s) are able to communicate with the crane operator and personnel on the ground.

The crane operator must remain at the controls at all times while the man basket, suspended scaffold or boatswain’s chair is occupied. Where feasible (and if it is safe to do so), tag lines must be used to stabilise the man basket, suspended scaffold or boatswain’s chair.

A man basket or suspended scaffold (including the suspension system) must be designed by a qualified engineer. Only an approved and certified man basket or suspended scaffold from a Regulatory Body can be used. Regulations require approval by an authority or certification to a national or international standard. The manufacturer's procedures and conditions for use must be strictly complied with at all times.

Each man basket or suspended scaffold must be fitted with an information plate indicating the maximum weight and number of persons that may be lifted. Copies of the welding x-rays and engineering drawings must be kept on site.

Any work involving the use of a man basket, suspended scaffold or boatswain's chair must be carried out under the supervision of a competent person who has been appointed in writing.

A man basket, suspended scaffold or boatswain's chair must be thoroughly inspected (examined for damage) by a competent person prior to use (every time the equipment is used) and the results of each inspection must be recorded in a register. The crane or hoist as well as all lifting equipment (tackle) that is used to suspend the man basket, suspended scaffold or boatswain's chair must be tested and inspected as stipulated according to applicable Legislation.

All suspended scaffold erectors, operators and inspectors must be appointed in writing and proof of competency must be provided.

Persons carrying out welding or flame cutting work from within a man basket or suspended scaffold or from a boatswain's chair must take precautions to ensure that they do not accidentally cut or burn through the cables or wire ropes that are suspending them.

15.12 Falling Objects

In the process of planning work activities, the risks associated with falling objects (i.e. materials, tools or equipment) must be assessed and appropriate control measures must be identified, implemented, and monitored taking the following hierarchy of controls into consideration:

- Preventing objects from falling – by using containment sheeting, toe boards, lanyards to secure tools (to a person or to the structure), ropes or chains to secure equipment (to the structure), lift boxes, brick cages, etc. and by properly securing loads when lifted by crane or hoist;
- Protecting people from falling objects – by establishing barricaded exclusion zones, installing catch platforms or catch nets, displaying warning signage, and posting safety watchers and / or traffic controllers. The risk of rock falls at Areas B and C will be addressed and preventative measures put into place before any construction work commences; Transnet employees working within the office block at Area A will be safeguarded from falling objects during construction and measures will be implemented before construction commences; and
- Personal Protective Equipment (particularly safety helmets and safety boots) – protective equipment is a last line of defence and must be worn.

Where overhead work is being carried out, barricading must be erected around the work area (at the level at which the work is taking place and at every level below including ground level) to

prevent persons from entering such an area and potentially being struck by falling objects. Wherever hazards related to falling objects exist, appropriate warning signage (i.e. "Overhead Work In Progress" and "No Unauthorised Access") must be prominently displayed.

No items are permitted to lie loose in elevated positions (e.g. nuts and bolts must be securely stored) and good housekeeping standards must be maintained at all times. No tools, equipment, material, debris, waste, etc. may be dropped from height. Objects must be lowered or chuted to ground level in a safe and controlled manner.

15.13 Scaffolding

15.13.1 Training, Competency and Supervision

Scaffolding may only be erected, maintained, altered or dismantled under the strict personal supervision of a competent Scaffolding Supervisor (or Scaffolding Inspector) who has been appointed in writing.

It is the Scaffolding Supervisor's responsibility to ensure that all persons carrying out such work are suitably trained and experienced. A certificate of competency issued by a reputable (i.e. accredited and approved) training provider must be produced for each Scaffolding Supervisor and each Scaffolding Erector and Inspector.

15.13.2 Erection and Dismantling of Scaffolding

Only approved scaffolding components may be used to erect a scaffold. Scaffolding must be erected, modified and used in accordance with the manufacturer's guidelines or recommendations, and in strict compliance with all applicable legislation and standards.

A free-standing scaffold must not exceed a height of three times the smallest dimension of its base. Scaffolds with a height to base width ratio of more than 3:1 must be restrained from tipping over by guying, tying, or bracing. Guy wires and ties prevent scaffolding from tipping away from the building or structure, and braces are rigid supports that prevent the scaffolding from tipping into the building or structure.

Scaffolding must be secured to the structure every 6 metres vertically and every 9 metres horizontally (as a minimum). Adequate underpinning, sills or footplates must be provided for scaffolds erected on filled or otherwise soft ground (including sand or gravel).

If the scaffolding is to be load bearing (i.e. other than normal access and workplace storage) then full calculations and a design must be prepared and authorised in writing by a structural engineer. The load limits specified by the scaffolding manufacturer may not be exceeded under any circumstances.

Scaffolds must be plumb and level at all times. All scaffolding components must be in good condition (i.e. undamaged and free of corrosion). All scaffolding components must be properly connected or secured and scaffolding must be effectively braced (diagonal bracing).

Each person erecting, maintaining, altering or dismantling scaffolding must use fall protection at all times (i.e. a full body safety harness with two shock absorbing lanyards fitted with scaffold hooks). The work must be planned to enable every Scaffolding Erector to be securely anchored at all times. A suitable lanyard length (not exceeding 2 metres) must be selected taking the potential fall distance and height of attachment (height of anchorage point) into account. If the lanyard is too long or the anchorage point is too low, the person may hit the ground, a platform, or objects below him before the lanyard is able to break his fall.

The area around the base of a scaffold must be barricaded to prevent unauthorised access into the work area. When scaffolding is erected or dismantled on a level, platform, or floor lying above ground level and the potential exists for components to fall to levels below the level on which the scaffolding is positioned, then the area directly below the scaffolding on each of those levels must also be barricaded. Appropriate warning signage (i.e. “Overhead Work In Progress” and “No Unauthorised Access”) must be prominently displayed.

Hoists, lifts and approved material baskets must be used (where available) to lift scaffolding components to elevated positions.

No scaffolding components, tools, or any other material may be dropped from height or thrown from one level to another. Components, tools and materials must be lowered or lifted in a controlled manner. Chutes may be considered for use.

Each tool must be secured to the wrist, harness or structure by means of a lanyard. A tool bag (around the waist or over the shoulder) may be used for carrying tools up and down a scaffold structure. Tools or equipment may not be carried by hand up or down a structure, as both hands must be used for climbing. If necessary, a rope must be used for lifting or lowering tools or equipment.

While a scaffold is being erected or dismantled, no scaffolding components may be stacked on the scaffold structure unless it has been designed for that purpose. Any loading of a scaffold structure must be authorised in writing by a structural engineer.

For special scaffolding, a design must be prepared by the appointed Scaffolding Supervisor and this design must be authorised in writing by a structural engineer before the scaffolding is erected. Scaffolding may not stand on steel grating unless the grating is adequately supported from below. Scaffolding must rather stand on the structure that supports the grating.

Empty drums, crates or bricks may not be used to prop up, support or anchor scaffolding. Before scaffolding is erected in close proximity to an electrical installation or live conductors, an electrical engineer (employed by Project or the client) must inspect the area and determine whether or not the scaffolding must be earthed. Should the scaffolding require earthing, this must be done as soon as possible while the scaffolding is being erected.

Scaffolding may not be erected if it is raining or in winds stronger than 32 km/h.

A green tag (displaying the words, “Scaffold Safe for Use”) or a red tag (displaying the words, “Danger: Do Not Use Scaffold”) must be prominently displayed on each scaffold at all times. The tag must be positioned close to the base of the ladder or staircase provided for safe access. The wording on the tags must be in English and any other language commonly used on site.

As a minimum, a green tag must display the Scaffolding Supervisor’s name, the date that the scaffold was erected, and the date that the scaffold was last inspected.

Only an appointed Scaffolding Supervisor may attach, change, update the information on, or remove these tags.

Scaffolding must not be:

- Left partially erected or partially dismantled except for normal work stoppages (for example, over weekends);
- Left in an unsafe condition (if scaffolding is unavoidably in an unsafe condition, barricading must be in place to prevent unauthorised access and the required red tags must be prominently displayed on the scaffold structure); or
- Moved or altered while work is in progress.

Mobile scaffolding must be equipped with brakes, which must be engaged at all times when the scaffolding is in use. A scaffold may not be moved if any person is on the structure.

15.13.3 Safe Access

Safe and convenient access must be provided to every scaffold platform by means of properly installed ladders or approved stairways, which must remain unobstructed at all times. Climbing up or down a scaffold on the braces or ledgers is forbidden.

All ladders used to access scaffolding must be securely attached to the scaffold structure. Hook-on and attachable ladders must be specifically designed for use with the type of scaffolding being used.

If a ladder is used to access a scaffold platform at a height greater than 1.5 metres above the ground, then the ladder must be secured internally (i.e. within the scaffold structure) and there must be an opening (closed with a trap-door) in the platform at the top of the ladder.

If the scaffold platform is at a height of less than 1.5 metres above the ground, then the ladder may be attached externally provided the guard rails around the platform are modified to allow access (the opening in the guard rails must be kept closed using a self-closing gate). No person may climb over or through the guard rails to gain access to a platform.

If a vertical ladder used on scaffolding is more than 5 metres in length it must be equipped with a ladder cage extending from a point 2 metres from the base of the ladder to a height of 1 metre above the platform (or the uppermost platform) that the ladder is providing access to.

The requirement for a ladder cage may be waived if platforms are provided at height intervals not exceeding 4 metres, with the vertical ladder secured on the inside of the scaffolding framework and an opening (closed with a trap-door) in each platform. Vertical ladders must be braced at three metre intervals (as a minimum) to prevent undue movement.

All vertical ladders providing access to a platform must be left in place for as long as the scaffold remains in place and must be inspected as part of the scaffold structure.

Any deviation from the requirements stipulated above must be subjected to a risk assessment and the nominated project management representative must authorise the deviation in writing.

15.13.4 Scaffolding Platforms

Safe work platforms must be provided. Every work platform must be complete (i.e. from ledger to ledger and from transom to transom without any gaps) in order to prevent personnel, materials, tools, etc. from falling through the platform.

Every work platform must be constructed from manufactured steel scaffold boards (planks) of equal thickness (height). Timber boards are not permitted under any circumstances.

Each steel scaffold board must be securely hooked (fastened) onto the ledgers or transoms that support it.

On all sides except the one facing the structure, every scaffold platform must be provided with:

- Sturdy guard rails positioned 500mm above the platform floor (the mid rail) and 1000mm above the platform floor (the top rail); and
- Steel toe boards that are at least 150mm high and securely attached such that no gap exists between the toe boards and the platform floor.

Note: Wire mesh infill panels incorporating a toe board may be used instead of a mid-rail.

Scaffold platforms must be as close to the structure as is practicable (but not closer than 75mm) except where personnel need to sit on the edge of the platform while they work in which case the distance may be increased to no more than 300mm.

Scaffold platforms must, at all times, be kept free of waste, protruding objects, and any other obstructions. Platforms must be cleaned if necessary to ensure that they are maintained in a non-slip state.

15.13.5 Inspection of Scaffolding

Every scaffold structure must be inspected by a competent Scaffolding Inspector/Supervisor who is appointed in writing:

- Prior to use after erection, and at least weekly thereafter;
- After inclement weather (heavy rain, strong winds, etc.);
- After any incident resulting in jarring, tilting or overloading;
- After any alteration is made; and
- Before being dismantled.

On completion of an inspection, the Scaffolding Inspector/Supervisor must update the information on the scaffold tag.

A record of each inspection (date and time of inspection, location of scaffolding, findings, etc.) must be captured in a register. The register(s) must be maintained by the Scaffolding Inspector/Supervisor(s) carrying out the inspections.

15.13.6 Using Scaffolding

The user of a scaffold (i.e. the responsible supervisor) must inspect the erected structure prior to acceptance and must ensure, as far as is reasonably possible, that the scaffold is safe and fit for purpose before allowing his team to make use of the scaffold.

In particular, the user must ensure that:

- The scaffold and the platforms have been constructed to meet the loading requirements of the work that is to be carried out (the Scaffolding Inspector/Supervisor must be consulted in this regard);
- The Scaffolding Inspector/Supervisor has checked that adequate ties and braces are in place;
- The work platforms are in the correct positions and are complete with toe boards and guard rails;
- Safe and convenient access has been provided (ladders and / or stairways); and

- A green ("Scaffold Safe for Use") tag has been attached to the scaffold by the Scaffolding Inspector/Supervisor.

Use of an incomplete or unsafe scaffold is prohibited. Unsteady or non-rigid scaffolds must not be used and inadequacies must be reported to, and rectified by the responsible Scaffolding Supervisor.

The user of a scaffold must ensure that every person in his team is aware that no alterations to the scaffold may be made by the team during the course of their work, and that if any alterations are required, they must be made by competent Scaffolding Erectors under the supervision of an appointed Scaffolding Supervisor.

A scaffold may not be used:

- If a red tag is displayed indicating that the scaffold is not safe to use; or
- During inclement weather, defined as wind speeds greater than 40km/h, thunderstorms, or heavy rain (in excess of 40mm/h).

Note: With due consideration of possible educational limitations, the contractor must ensure that all persons understand what green and red tags mean.

The area around the base of a scaffold must be appropriately barricaded to prevent unauthorised access into the work area. Appropriate warning signage (i.e. "Overhead Work In Progress" and "No Unauthorised Access") must be prominently displayed.

Loose tools and / or materials on scaffold platforms must be secured using lanyards, wire or fibre rope, or must be placed in secured containers. Where appropriate, "catch nets" may be installed as an additional safety measure to prevent materials or tools from falling to the ground.

The storage or placement of materials on scaffolding platforms must be kept to a minimum. Debris as well as tools and materials that are no longer required must be removed from all working platforms at least once per day.

Scaffolding platforms must be cleaned regularly. A heavy load may not be placed on a scaffolding platform unless the scaffold has been designed and constructed specifically for that purpose. Any loading of a scaffold structure must be authorised in writing by a structural engineer.

Scaffolds may not be used as hoisting towers or to support piping or equipment. Each person working from scaffolding must wear fall protection (i.e. a full body safety harness with two shock absorbing lanyards fitted with scaffold hooks) and must be securely anchored at all times.

All work must be carried out from properly constructed work platforms. Standing on railings or braces in order to perform work is forbidden. Drums, boxes and other makeshift substitutes for scaffolding may not be used under any circumstances.

Where work on an electrical system is to be undertaken from a scaffold, an electrical engineer (employed by Project or the client) must determine whether or not the scaffolding structure requires bonding and earthing. The scaffolding may not be used until this has been determined, and if required, until the structure has been bonded and earthed.

15.13.7 Identification and Inspection of Scaffolding Components

All scaffolding components belonging to a contractor must be properly marked or uniquely coloured to enable positive identification.

Prior to erecting a scaffold, all scaffolding components must be carefully inspected by a competent Scaffolding Inspector/Supervisor.

Components found to be defective during an inspection must be conspicuously marked and removed to a suitably demarcated quarantine area for destruction, repair, refurbishment or removal from site. Deformed and bent wedges must be straightened and inspected for cracks before being put back into service.

15.13.8 Storage of Scaffolding Components

All scaffolding components must be stored in a demarcated storage area in such a manner that they are not exposed to environmental extremes and will not cause injury to persons. Suitable barricading or fencing must be erected and warning signage must be posted (e.g. No Unauthorised Entry).

Within a storage area, scaffolding components must be stacked such that pathways (750mm in width) are maintained between the stacks. Each stack must be stable and components must be neatly placed to ensure that no ends protrude into any pathway. The various components must be stacked separately.

The weight of scaffolding components must be considered when stacking them in elevated positions.

Any storage area for scaffolding components must be positioned such that it will not interfere with any onsite activity (including the operation of any plant or equipment), block any access way, or obstruct access to any plant or equipment. Before establishing a storage area, the location must be agreed with the nominated project management representative.

15.14 Ladders

All ladders used on site must be of sound construction and adequate strength. Only non-conductive ladders made of wood or fibreglass may be used for electrical work or work being performed in proximity to energised electrical equipment. Metal ladders and ladders with metal reinforcing may not be used.

The use of makeshift ladders is forbidden. All ladders must be numbered, listed in a register, and inspected by a competent person on a monthly basis (the results of each inspection must be recorded in the register). Before using a ladder, the user must inspect it for damage.

Ladders with missing, broken, cracked or loose rungs, split stiles, missing or broken spreaders (stepladders) or any other form of damage or defect may not be used. A damaged ladder must be removed from service (and tagged, "Out of Service") without delay and must then either be repaired (if possible) or destroyed to prevent further use. Persons must receive instruction in the correct use and proper care of ladders.

Ladders may only be used as a means of access and egress. The use of ladders as working platforms is prohibited, except for inspection and carrying out minor tasks (i.e. light work and short duration) such as changing a light bulb.

Ladders may not be positioned horizontally and used as walkways or runways or as scaffolding. All portable ladders must be fitted with non-skid safety feet (or some other means to prevent the base of the ladder from slipping) and the feet must always be placed (stand) on a firm level surface.

The use of bricks, stones, wood or any other material to level the stiles of a ladder is prohibited. Ladders may not be placed on movable bases such as boxes, tables, trucks, etc.

The base or foot of a ladder must always be secured to prevent it from slipping. The ladder must be held by an assistant if the base cannot be secured in any other way (e.g. tied off). A straight ladder must extend at least one metre above its support (or above the working platform that it is providing access to). The top of the ladder must be tied off (or otherwise secured to its support) to prevent accidental movement.

A straight ladder must be placed at a safe angle, i.e. tilted at a ratio of approximately 4:1, meaning that the base of the ladder must be one metre away from the wall (or other vertical surface) for every four metres of height to the point of support.

A stepladder may never be used as a straight ladder. A stepladder must be opened fully and the spreaders must be locked securely. When using an extension ladder, at least four rungs must always overlap at the centre of the ladder. Ladders may not be joined together unless they have been specifically designed and manufactured for that purpose.

A suspended ladder (i.e. not standing on a base) must be attached in a secure manner to prevent undue swinging or swaying, and to ensure that it cannot be displaced.

A ladder may not be placed against a window, glass or any other material which is unlikely to withstand the force exerted on it by the top of the ladder. A ladder may not be placed in front of a door or window that opens towards the ladder unless the door or window has been locked or barricaded.

When a ladder is used near an entrance or exit, the base of the ladder must be barricaded. Materials and / or equipment may not be placed in close proximity to the base or landing of any ladder.

When ascending or descending a ladder, a person must always face the ladder and use both hands (i.e. maintain three points of contact).

Nothing may be carried up or down a ladder if it prevents the person from holding on to the ladder with both hands. Tools must always be properly secured. This can be achieved by attaching them to the wrist using lanyards or placing them in a tool belt around the waist. Tools and materials may also be carried in a bag over the shoulder or hoisted to the landing using a tool bag and rope. Only one person at a time may use (i.e. be positioned on) a ladder.

No person may stand or step above the third rung from the top of a straight ladder or above the second highest step of a stepladder.

Overreaching from a ladder is prohibited. If the target is not within comfortable reach, the person must climb down and reposition the ladder. No person may run up or down a ladder, or jump from the lower rungs or steps to the ground. All ladders must be properly maintained and cared for. Ladders must be stored under cover and should be hung in a horizontal position from several brackets.

No ladder may be left lying on the ground or be left exposed to the weather. A ladder left lying on the ground presents a tripping hazard and it may be damaged by vehicles running over it. No ladder may be left in such a position where it may fall over, be accidentally knocked over, or be blown over by the wind.

Ladders may not be painted, as the paint may conceal damage, defects, labels or other markings. Instead of paint, clear varnish or wood oil may be used to preserve wooden ladders. Ladders must be kept clean, as dirt may conceal damage or defects. Oil or grease accumulation on the rungs of a ladder may cause a person to slip.

Before making use of a ladder, each person must make an effort to remove mud, oil, grease, etc. from his boots.

15.15 Permit to Work

All personnel must comply with the Permit to Work system applicable to the project. A Permit to Work must be obtained before carrying out any work that involves:

- A hazardous energy source or system, including electricity, compressed fluids (e.g. hydraulics and pneumatics), chemical substances (e.g. toxic, corrosive, flammable or explosive gases and liquids), heat (e.g. steam), radiation, and machinery or materials with potential energy (gravitational and elastic) – isolation and lockout may be required;
- Confined space entry;
- Working at heights;
- A critical lift;
- Hot work outside of designated workshops;
- Excavation; or
- A service (e.g. water supply, fire suppression systems, etc.).

Note: A Permit to Work may only be issued by an Authorised Person, and may only be received (or accepted) by an appointed Applicant.

All costs associated with the Compliance to Permits section is for the Contractors account.

Each Permit to Work that is issued must make reference to an approved Task-Based Risk Assessment for the work that is to be carried out.

The Permit to Work system that is employed must incorporate the following basic procedures:

- Prior to meeting with the Authorised Person, the Applicant must familiarise himself with all of the hazards associated with the system, plant, equipment, structure or area on or in which the work must be performed. He must also consider the risks that may arise as a result of the tasks that will be carried out. A Task-Based Risk Assessment must be in place;
- The Applicant must then request permission to carry out the work and must meet with the Authorised Person to discuss and document the scope of the work as well as the hazards, risks and associated control measures. Isolation and lockout requirements must be identified (if applicable). The isolation and lockout process must be initiated by the Authorised Person who must contact the necessary Isolation Officers.

Note: The Applicant must ensure his own safety and that of his team, and has the right to accompany the Isolation Officers to verify that all of the necessary locks have been fitted to all of the isolation and lockout points in accordance with the applicable plant or equipment-specific Isolation and Lockout Procedure.

- Once all of the necessary isolations have been completed and the necessary Clearance Certificates have been issued by the Isolation Officer(s) (if applicable), and the Authorised Person is satisfied that the system, plant, equipment, structure or area is safe to work on or

in provided all identified precautions are observed by the Applicant, then he must issue (sign) the Permit to Work to the Applicant;

- The Applicant must accept (sign) the Permit to Work. If equipment has been isolated, the Applicant must attach his Personal Lock to the relevant Isolation Bar (or Local Isolation Point) and must ensure that every other person working on the isolated equipment also attaches his or her Personal Lock to the Isolation Bar (or Local Isolation Point) before starting any work;
- Before commencing with any work, the Applicant must discuss the hazards, risks, control measures, precautions and limitations as stated in the Permit to Work (and associated Task-Based Risk Assessment) with all personnel who will be carrying out the work. A register must be kept and all persons must sign the register once they have been briefed by the Applicant;
- The work performed must be limited to what is described in the Permit to Work;
- When a particular employee has completed his work, he must sign the personnel register to this effect and (if applicable) must remove his Personal Lock from the Isolation Bar (or Local Isolation Point);
- Once all work is complete, the Applicant must:
 - Ensure that all machine guards have been replaced;
 - Ensure that all tools and materials have been removed from the work area;
 - Ensure that the work area is clean and tidy;
 - Ensure that all Personal Locks (including his) have been removed from the Isolation Bar or Local Isolation Point (if applicable);
 - Inform the Authorised Person that the work has been completed; and
 - Sign off the Permit to Work.
- Once the work is complete and the Applicant has signed off the Permit to Work, the Authorised Person must:
 - Ensure that the relevant Isolation Officers perform all of the necessary de-isolations (if applicable);
 - On completion of the de-isolations, sign off the Permit to Work accepting the system, plant, equipment, structure or area back for service; and
 - Inform all relevant personnel that the system, plant, equipment, structure or area is ready to use.
 - Where the work must continue over more than one shift, the Permit to Work must be reviewed at every shift change by an Authorised Person. If the scope of work has changed, the permit must be cancelled and a new permit must be issued.

If any of the original conditions or precautions pertaining to the work is not being complied with, is no longer adequate or is no longer applicable, the Authorised Person must cancel the Permit to Work and must ensure that all work stops until full compliance with either the original or amended (as required) conditions and precautions is achieved and a new permit has been issued.

The Applicant must ensure that the Permit to Work (including the personnel register) is kept where the work is being carried out (i.e. posted on a portable Health and Safety Management Information Notice Board) and that the work is monitored against the permit conditions.

All Permit to Work records must be retained and must be made available for inspection when required.

The implementation of the Permit to Work system applicable to the project must be audited on a regular basis by a nominated project management representative. Furthermore, planned task observations must be carried out periodically.

15.16 Isolation and Lockout

Isolation and lockout procedures that make it impossible to inadvertently energise any system, plant or equipment so isolated, must be in place for all work where hazardous energy sources exist, including electricity, compressed fluids (e.g. hydraulics and pneumatics), chemical substances (e.g. toxic, corrosive, flammable or explosive gases and liquids), heat (e.g. steam), radiation, and machinery or materials with potential energy (gravitational and elastic). These procedures must be strictly enforced. All personnel must comply with the isolation and lockout system and procedures applicable to the project.

All Isolation and Lockout Procedures must incorporate the following basic requirements:

- The issuing of a formal Permit to Work for any work that requires the isolation of any system, plant or equipment;
- The use of defined Equipment, Discipline and Personal Locks (see Definitions), and multiple lockout systems (i.e. Isolation Bars and lockout hasps);
- Clear identification of all isolation and lockout points ensuring there is no duplication;
- Isolation of the main energy source;
- The use of slip plates or the blanking off of pipelines or ducting, in addition to the chaining and locking of valves, as determined by a risk assessment;
- Suitable methods of preventing the movement of equipment; and
- Methods to test the effectiveness or completeness of the isolation.

Note: No work may commence on a system, plant or equipment until a Permit to Work has been issued by an Authorised Person.

Note: A Permit to Work may only be issued by an Authorised Person once all required Clearance Certificates have been issued by appointed Isolation Officers.

The isolation and lockout system that is employed must incorporate the following basic procedures:

- In accordance with a system, plant or equipment-specific Isolation and Lockout Procedure, an appointed Isolation Officer(s) must isolate all points that need to be isolated in order to render the system, plant or equipment safe to work on. An Equipment Lock (and a suitable, highly visible warning tag) must be attached to each isolation point;
- On completion of an isolation (and lockout), the Isolation Officer must clear the area of all persons and must then carry out tests to ensure that the isolation is effective. This may be done by pressing a start button or by asking a control room operator to try to start the equipment. Special care must be taken to ensure that the attempted starting of the equipment has not been deactivated by another interlock forming part of the system, or by a different up-stream isolation. Alternatively, appropriate equipment may be used to test for energy (e.g. voltage verification or continuity tests).

Note: In the case of electrical isolation, a test for voltage must be carried out, after the switching device, to ensure the absence of voltage.

- The Isolation Officer must place the key to the Equipment Locks on an Isolation Bar (at a Lockout Station) and must then attach a Discipline Lock (to prevent the key from being removed) before issuing a Clearance Certificate;
The Discipline Lock must remain in place when handing over to subsequent shifts. All Discipline Locks for a particular discipline (e.g. low voltage electricity) must be keyed-alike so that any Isolation Officer appointed for that discipline (and issued with a key) can open any

of the Discipline Locks used for that discipline. This enables an Isolation Officer to de-isolate equipment that may have been isolated by another Isolation Officer during an earlier shift. Appointed Isolation Officers for a particular discipline are the only persons permitted to hold keys to the Discipline Locks used for that discipline.

Note: Local isolations do not require the use of Equipment Locks (a Discipline Lock may be attached to the Local Isolation Point by the Isolation Officer, followed by the necessary Personal Locks).

Note: For local isolations, if the Isolation Officer is the only person who will be working on the isolated equipment, then he must attach his Personal Lock to the Local Isolation Point.

- Once all required Discipline Locks are in place (i.e. attached to the Isolation Bar) and all Clearance Certificates have been issued, the Permit to Work may be issued by the Authorised Person;
- Each person who will be working on the isolated system, plant or equipment must then attach his or her Personal Lock to the Isolation Bar before starting any work (including the Isolation Officer, if he intends to work on the isolated unit);
- The attachment of a Personal Lock to the Isolation Bar prevents the removal of the key to the Equipment Locks even if the Discipline Lock is removed;
- When called (by an Authorised Person) to de-isolate the system, plant or equipment (on completion of the work under the Permit to Work), the Isolation Officer must ensure that all Personal Locks have been removed from the Isolation Bar before removing the Discipline Lock and the key to the Equipment Locks;
- Before removing the Equipment Locks and de-isolating the energy source, the Isolation Officer must inspect the system, plant or equipment that was worked on to ensure that it is safe to perform the de-isolation. This includes guard inspections, housekeeping, ensuring that all doors and covers are in place, and most importantly, ensuring that no persons are present;
- Once all Equipment Locks have been removed and the system, plant or equipment is safe for use, the Isolation Officer must cancel the Clearance Certificate and inform the Authorised Person that the unit has been de-isolated.

Where a system, plant or equipment is sequence interlocked and a hazard could be created through the inadvertent start up or shut down of a system, plant or equipment lying before or after the unit to be worked on, then that system, plant or equipment must also be isolated and locked out. Redundant or out of service equipment must, in addition to being isolated and locked out using the relevant Discipline Lock, be fitted with a tag indicating why it is out of service, who performed the lockout, and the hazards associated with that equipment.

Where it is necessary to work on live equipment for the purposes of commissioning, testing, adjusting and sampling, such work must be carried out in accordance with a written Safe Work Procedure and controls must be in place to prevent unauthorised access into the work area. The implementation of the isolation and lockout system and procedures applicable to the project must be audited on a regular basis by a nominated project management representative. Furthermore, planned task observations must be carried out periodically.

15.16.1 Personal Locks

A Personal Lock must be such that it can only be unlocked by the person to whom it belongs. Combination locks may not be used. A Personal Lock, as well as the key(s) to the lock, must be kept under the exclusive control of the person to whom the lock belongs.

A Personal Lock must be issued to each person who requires one, and the person's details must be clearly and permanently engraved directly onto his Personal Lock. Alternatively, a thick durable plastic identification tag may be used that clearly displays the company's name, the employee's name, the employee's company number, and a contact telephone number (the tag must be securely fastened to the Personal Lock). Where the above is hand written, it must be done using a permanent marker pen and it must be legible.

Each person issued with a Personal Lock must be trained and certified competent in the correct use of such a lock.

A Personal Lock may NEVER be removed by anyone other than the person to whom it belongs, except if the removal (cutting) of the lock is authorised by the nominated project management representative (in the absence of this person, authorisation can only escalate upwards). Furthermore, the removal of the lock must be done under the personal supervision of the nominated project management representative, and in accordance with a written procedure. The removal (cutting) of a Personal Lock may be required if the person who applied the lock is unable or unavailable to remove it on completion of the work (e.g. lost his key, failed to remove his lock before going home, etc.).

15.17 Electrical Safety

All electrical work must be carried out by competent personnel in accordance with all legal requirements, codes, design criteria and safety standards applicable to the project. Each contractor carrying out electrical work on the project site(s) must develop, document and implement Safe Work Procedures that are aligned with the requirements of this standard.

All persons who will be carrying out electrical work must be certified against the requirements of job and equipment-specific electrical competency standards for the project, which must address job and equipment-specific Safe Work Procedures.

15.17.1 Electrical Installations

Each electrical installation (temporary or permanent) installed or worked on by a contractor must be inspected by a nominated project management representative to ensure that the installation complies with all statutory requirements, codes, design criteria and safety standards applicable to the project.

A nominated project management representative must approve all electrical work before the installation is energised. Any installation deemed unsatisfactory by a nominated project management representative must be removed, repaired or modified by the contractor at his expense.

For every permanent or temporary electrical installation, a certificate of compliance must be issued by a competent and appropriately qualified electrician. These certificates must be available for inspection.

Work on electrical installations (new installations, and modifications or repairs to existing installations) may only be carried out by qualified and authorised personnel (i.e. electricians). Electrical safety devices (specifically, earth leakage protection and overcurrent protection) must be installed on all distribution circuits and the settings must be established by suitably qualified personnel.

To ensure the safety of the user, each distribution panel must be completely enclosed, must be of the dead-front type, and must be properly constructed and earthed.

All electrical cabling must be covered (e.g. in cable trenches) or elevated (in cable trays) to protect it from damage and to eliminate tripping hazards.

All permanent and temporary electrical installations (cabling, sockets, distribution panels, transformers, switchgear, etc.) must be inspected and tested by a competent and suitably qualified electrician on a monthly basis. The testing must include a grounding (earthing) continuity test and testing of the electrical safety devices. Details of these inspections and tests must be recorded in a register which must be made available to the nominated project management representative for inspection.

A rigorous Isolation, Lockout and Permit to Work system must be applied to all electrical work (i.e. work on electrical installations, machinery or equipment). All personnel must comply with the system and procedures applicable to the project.

Before any work on an electrical installation or equipment is carried out, the installation or equipment must be de-energised.

No electrical work may be performed live, regardless of the voltage, unless written approval is obtained from the nominated project management representative (a justification as to why it is necessary for the work to be carried out with the equipment in an energised state must be provided).

For all energised electrical work, a Safe Work Procedure must be in place and, with the exception of voltage testing and where no tools are used, a Permit to Work (specifically authorising energised electrical work) must be issued. When carrying out any energised electrical work, approved electrically insulated gloves, blankets, mats and other protective equipment must be used.

Control centres, switchgear rooms, substations, generators, transformers, capacitor banks, and other similar electrical plant and equipment must be appropriately guarded and labelled and, with the exception of emergency shut-off mechanisms, must be made inaccessible to unauthorised personnel (i.e. plant or equipment of this nature must be positioned within rooms or fenced enclosures which must be kept locked).

Appropriate warning signage must be prominently displayed within, and at all entrances to, these rooms or enclosures. The signage must indicate that unauthorised persons are prohibited from entering, that unauthorised persons are prohibited from handling or interfering with any electrical plant or equipment, the procedure to be followed in the event of a fire, and the first aid procedure to be followed should a person suffer electric shock. Suitable fire-fighting equipment must be provided in all such rooms or enclosures.

All electrical panels must be kept locked (using keyed-alike padlocks). Keys may only be issued to authorised personnel.

All un-insulated (bare) or partially insulated conductors must be enclosed and protected to prevent accidental contact therewith. Measures must be taken to prevent unauthorised access and appropriate warning signage must be conspicuously displayed.

Only authorised persons may enter rooms or enclosures housing electrical plant or equipment, and only authorised persons may access electrical panels or cabinets, and cable ducts or trenches. If

any work must be carried out in such an area or on such equipment, a Permit to Work must first be obtained from the nominated project management representative.

No connection to any electrical system may be made without prior approval and a valid Permit to Work from the nominated project management representative.

No electrical equipment or apparatus may be modified without written authorisation from the nominated project management representative.

Conductive ladders may not be used in proximity to non-insulated electrically energised lines or equipment.

All permanent and temporary electrical cables, whether energised or not, must at all times be handled as if they are energised.

Only appropriately certified intrinsically safe electrical equipment may be used in flammable or potentially explosive atmospheres such as in confined spaces. Any equipment or structure on which electric charges may accumulate (such as storage tanks) must be grounded (earthed).

Grounding (earthing) and lightning protection systems and devices must be designed, engineered, selected and installed based on site-specific requirements where required.

15.17.2 Arc Flash Safety

Depending on the scope and nature of the work, a documented arc flash protection programme must be in place. The PPE required (specific to a task and the equipment on which the task is performed) and associated procedures to mitigate the hazard must be included.

An Arc Flash Hazard Assessment must be carried out based on accurate and current data. All electrical cabinets where the potential for an arc flash hazard exists must be labelled in accordance with the hazard assessment and the potential incident energies calculated. A process must be in place for updating the Arc Flash Hazard Assessment and labelling as changes and electrical upgrades occur that might affect the available short circuit current on the system.

In order to mitigate the hazard, Safe Work Procedures must be in place and all persons potentially exposed to arc flash hazards must be trained in these Safe Work Procedures and must be supplied with appropriate arc flash PPE.

15.18 Portable Electrical Equipment

Prior to site establishment, each contractor must provide a complete inventory of all portable electrical equipment that he and his sub-contractors intend to use on the site (including plant, machines, appliances, generators, hand tools, lighting, extension cords, etc.). The nameplate data for each item of equipment must be included.

All portable electrical equipment to be used on the site must be supplied and maintained in a serviceable condition. Any electrical equipment that is in poor condition or is not in proper operating order may not be used. Any electrical equipment that a nominated project management representative deems to be unsafe or unsuitable must be removed from site.

Electrical repair work or diagnostic work on electrical equipment may only be performed by personnel who are competent and authorised to perform this work (i.e. qualified electricians). With the exception of double-insulated equipment, all electrical equipment must have an equipment grounding (earthing) conductor that connects the frame of the equipment being utilised to the grounding (earthing) conductor of the electricity supply system.

All electrical equipment and all electricity supply systems used (including generators) must be inspected and tested by a registered and competent electrician to ensure that all equipment is properly grounded (earthed).

All electrical equipment used on site must be supplied electricity through (i.e. must be protected by) an approved and tested residual current device (or earth leakage device or unit). If a socket outlet does not have a residual current device in the circuit, a portable residual current device must be used. Outlets without residual current device protection must be labelled as such.

Any electrical equipment that causes an earth leakage device to trip or deactivate the circuit may not be used again until an electrician has inspected and tested the equipment and has recorded in a register that the equipment is safe to use.

All generators must be fitted with suitable overcurrent protective devices (i.e. circuit breakers or fuses). All generators must be used in compliance with the manufacturer's requirements. Any proposed modification to a generator must be authorised in writing by the manufacturer prior to the modification being made.

Each welding machine used on site must be fitted with a Voltage Reduction Device (VRD). If this is not practical (i.e. for arc welding processes other than stick welding), a dead man's (isolation) switch in the electrode circuit (operated by a trained observer) may be used as an alternative. All welding machines must be properly grounded (earthed).

All portable electrical hand tools used on the site must be double-insulated. Electrical equipment must be disconnected or unplugged when not in use. Portable lights must be stable and each light bulb must be protected by a substantial guard.

No person may wear a watch or any jewellery, or carry any metal objects such as a lighter or keys, while working on any electrical system or equipment. No person may work on or use electrical equipment if his clothing is wet or any part of his body is in contact with water.

No person may handle electrical equipment, equipment cords or extension cords with wet hands or if the floor or ground surface is wet.

Fire extinguishers filled with carbon dioxide must be used to fight electrical equipment fires (water may never be used). If possible, the electrical equipment should be de-energised before fire-fighting activities commence (refer to the Fire Protection and Prevention Standard).

When cleaning or performing maintenance work on an item of electrical equipment, the equipment must be unplugged.

Equipment may not be unplugged while that equipment is switched on. Nor may equipment be plugged into a receptacle (socket) with the equipment's switch turned on. Electrical equipment that has a defective plug or wiring may not be used. Repair work to defective or damaged electrical equipment may only be carried out by a qualified electrician. Extension cords may be used for temporary applications only. Permanent cabling must be installed for long-term needs.

Extension cords may not be run through doors, windows, ceilings or holes in walls. An extension cord must be uncoiled completely before it is used. An extension cord must be of sufficient current-carrying capacity to power the equipment that it is supplying electricity to. Cords must not be overloaded. Extension cords must be unbroken and continuous (i.e. no joins or splices in the cord are permitted). Extension cords may not be daisy-chained (i.e. one extension cord plugged into another extension cord).

Extension cords and equipment cords may not be modified to fit a receptacle (socket). Two-conductor extension cords may not be used. A three-conductor extension cord (i.e. a grounded or earthed cord) must be used even if the equipment that it is supplying electricity to uses a two-prong plug.

Extension cords that are frayed, have insulation tears, cracks or abrasions, have exposed conductors, or have bent, broken or “spread” plug prongs may not be used. Extension cords that will be used outdoors must have heavy duty insulation and must be weather and UV resistant.

All electrical equipment cords and extension cords must be covered or elevated to protect them from damage and to eliminate tripping hazards. Each contractor is responsible for protecting his electrical equipment from the weather and from possible mechanical damage.

All portable electrical equipment (including generators) must be inspected, tested and tagged by a competent and appropriately qualified electrician on a monthly basis. Details of these inspections and tests must be recorded in a register which must be made available to the nominated project management representative for inspection.

The inspection and testing must include a continuity test of the grounding (earthing) conductor (as applicable) and a complete examination of the equipment or system to assure safe use. The following colour coding system must be used for the tagging of all electrical equipment:

Table 35-1 Colour Coding System for Electrical Equipment

Month		Tag Colour	Month	Tag Colour
January		Red	July	Red
February		Blue	August	Blue
March		Orange	September	Orange
April		Green	October	Green
May		White	November	White
June		Yellow	December	Yellow

The tag placed on a piece of equipment must be traceable to an entry in a register where the following information concerning the inspection and testing of that piece of equipment must be recorded:

- Date of inspection and testing;
- Equipment description;
- Equipment owner;
- Equipment location;
- Name, signature and licence number of the electrician who carried out the inspection and testing; and
- Comments concerning the inspection and testing, and details of any repair work carried out or required.

Any item of electrical equipment that does not pass an inspection or test must be removed from service (and tagged, "Out of Service") immediately and must then either be repaired (if possible) or removed from site. Any item of electrical equipment without a tag or with an out-of-date inspection or test may not be used.

Any item of electrical equipment found without a tag or with an out-of-date inspection or test must be removed from service until it has been inspected and tested. If it is found that more than one item of equipment being used by a contractor has not been inspected and tested as required, all work with electrical equipment must be stopped until it can be demonstrated to the satisfaction of the nominated project management representative that the contractor's systems and controls are adequate and fully implemented.

In addition to the formal monthly inspections and testing carried out by an electrician, electrical equipment (particularly extension cords, portable hand tools, welding machines, compressors and pumps) must be visually inspected by the user on a daily basis prior to use. Users must be trained to look for cracks in casings, loose casings, outer cord sheathing that is not being held firmly in position at the equipment, cuts or cracks in cord or cable insulation, exposed conductors, damaged plugs or sockets, and missing covers. Damage and / or defects must be reported immediately.

Personnel must immediately stop using and report any electrical equipment or machinery that is shocking, sparking, overheating or smoking. Corroded outlets, switches and junction boxes must also be reported.

15.19 Building works

The construction of the building shall be compliant and be constructed in accordance with CIDB act (38 of 2000). Principal contractor shall ensure compliance to all construction related regulations, and it shall be the Principal contractor's obligation to ensure enhance compliance of such compliance requirements to its contractors.

All activities relating to building or construction of the building shall be executed by the competent employees with competence certificates made available on the health and safety file documents and produced to the client or inspector up on request, building works competence requiring activities to be made available are but not limited to, Brick layers competence, painters competence, steel fixers competence, plumbers competence, roof installers or carpenters competence, electricians competence, fire and emergence device installers etc.

15.20 Arc Welding

All welding machines must be fitted with voltage reducers. The supply cable to every welding machine must be correctly rated and fitted with an approved plug to be used only with an approved

matching plug socket. The electrical circuit to every plug socket must be protected by a correctly rated circuit breaker and a supply voltage rated earth leakage unit. Welding cables must be properly insulated and correctly rated for the welding machines on which they are to be used.

Welding cable terminals must either be covered with a properly designed, constructed and installed cover so that inadvertent human contact with the terminals is impossible, whether the cables are connected or not, or the welding cables must be fitted with insulated plugs so that inadvertent human contact with any live part is impossible when the cables are plugged into the machine. Also the plug socket should be such that when the cables are not plugged in, inadvertent contact with a live part of the socket is impossible.

Earth cable clamps and electrode holders must be of an approved type. Earth clamps and electrode holders must be fixed to welding cables with eye terminals and bolts. All welding machines and safety devices must be subjected to regular planned maintenance and a monthly electrical inspection. The inspection must include a test to ensure that the voltage reducer is functioning properly, by measuring and confirming that the open circuit output voltage is reduced.

Before using a welding machine, the welder must ensure that he is wearing all the required and approved protective clothing and equipment:

- Persons assisting the welder must also wear all of the required personal protective Welding hood;
- Leather welding gloves;
- Safety boots with steel toe protection;
- Flame resistant overalls; and
- Any other clothing or equipment necessary to perform his work safely and efficiently.

When changing electrodes or moving the earth clamp, the welder or his helpers must wear gloves to avoid possible skin contact with live electrical parts and to prevent burns. When attaching welding cables to the terminals of the welding machine, the welder or his helpers must wear gloves, or preferably, the machine should be switched off to avoid possible electric shock.

Helpers who may be holding the work piece being welded must wear gloves and protective goggles. Where practicable the welder should place protective screens around the area where he is welding, to prevent injury to the eyes of passers-by.

The welder must ensure that the earth cable follows the shortest practical route between the welding machine and the work piece. The earth connection must be directly between the welding machine and the work piece and no building or other structure must form part of the earth return path.

As far as is practicable, the welder should avoid welding under wet or damp conditions. If this is unavoidable, the following precautions should be taken:

- Use only oil filled or other watertight type welding machine;
- Keep the electrode holder as dry as is practical;
- Keep as dry as possible. Stand on an elevated surface out of the water and wear watertight boots and a rain suit. Also ensure that the gloves are in good condition, free of holes.

Under conditions that result in high perspiration levels, the following measures should be implemented:

- Use an insulated electrode holder;
- Change clothing regularly (if possible);
- Use insulated material like rubber mats and/or timber tuck board to separate yourself from the work piece;
- Wear dry gloves on both hands during welding;
- Use fans and air-conditioning to reduce humidity and temperature; and
- Use an observer capable of responding in an emergency.

When working inside metal vessels or under other conditions where parts of his body may come into contact with conducting surfaces, the welder must take precautions to insulate himself from such surfaces.

When working in confined spaces, the welder must take steps to ventilate the area to prevent inhalation of fumes, which may endanger his health and the health of any assistants. Engine powered welding machines must not be used in any place that is not very well ventilated since the welder and his helpers may be overcome by carbon monoxide fumes.

The welder should take the necessary precautions when welding objects that may catch alight, explode or release poisonous fumes or gases.

15.21 Gas Welding and Burning

Welding or cutting torches and hoses shall not be connected to cylinders when stored. When work is stopped and equipment is unattended, all valves at the gas and oxygen cylinders shall be closed. The hoses shall be bled and a check shall be made later for possible pressure build-up. Torches shall be removed from the hoses prior to putting them into the toolbox. Smoking SHALL NOT be permitted during this stopping procedure.

Special care shall be taken during overhead cutting and welding operations to safeguard and prevent falling sparks from starting a fire. Warning signs shall be posted around and at each level below the area of each overhead welding or burning operation. Fire extinguishers shall be available and fire blankets shall be used for protection.

When welding or cutting, adequate ventilation must be ensured / provided. Hoses shall be kept clear from passageways, ladders and stairs. When hoses are subject to damage, they shall be properly protected. Hoses shall be inspected daily. Fire extinguishers shall be ready for instant use in locations where cutting is performed.

Flash-back arrestors must be fitted to all cutting torches at the torch and at the bottle (a total of four arrestors).

Lighting of the cutting and welding torches must only be done using a striker and not an open flame. Soap Leak tests must be performed on all flash-back arrestors.

Hoses may only be secured using approved hose clips, and not by wire, cable ties or any other means. Special care shall be taken when welding with respect to piping that has been painted, as toxic fumes may be emitted in some cases. The supervisor's advice should be sought prior to the above welding operations being carried out.

15.22 Compressed Gas Cylinders

The contractor must establish a suitable storage area for oxygen, acetylene, LPG and argon cylinders in compliance with the following requirements:

- The storage area must be located at least 10 metres away from any building, and must be well ventilated;
- The storage area must have a concrete floor;

- The storage area must be enclosed using wire mesh fencing (as this will ensure adequate ventilation). This enclosure must be kept locked. Access into the storage area must be limited and controlled;
- A protective covering or roof must be fitted to the enclosure to provide shade;
- The enclosure may not be used for the storage of any other materials / equipment, and must be kept completely free of all combustible materials at all times;
- Appropriate warning signage (i.e. "No Smoking" and "No Naked Flames") must be prominently displayed on the enclosure;
- A 9kg dry chemical powder fire extinguisher must be mounted near the entrance to the enclosure;
- If electrical lighting is required, it must be of an approved intrinsically safe type;
- Oxygen, acetylene, argon and LPG cylinders must be stored separately in the enclosure. Furthermore, full and empty cylinders must be separated. Separate storage sections must be clearly designated within the enclosure for the different gas types, and for full and empty cylinders, i.e. oxygen – full, oxygen – empty, acetylene – full, acetylene – empty, etc.;
- When a cylinder is empty, the cylinder cap must be replaced to protect the valve. Empty cylinders must be clearly marked (there must be no need to open valves to check if cylinders are full or empty);
- All cylinders must be stored in an upright position and must be secured in this position by chaining, strapping or clamping them individually to a wall, a cylinder trolley, rack or carrier, or some other rigid structure;
- Cylinders must be stored in rows (when necessary due to the number of cylinders) with aisles between the rows to facilitate easy and rapid removal in the event of a fire;
- Oxygen cylinders may never be stored near highly combustible materials, particularly oil and grease, or near fuel gas cylinders. When in storage, oxygen cylinders must be separated from fuel gas (LPG and acetylene) cylinders by a distance of 6 metres or by a 2 metre high wall made of fire-resistant material;
- The total quantity of gases stored on site must be limited to a 2 week supply.

Compressed gas cylinders must always stand upright (i.e. when being used, stored or transported) and must be properly and individually secured to prevent them from falling over. Cylinders must be protected from flame, heat and from being struck by moving equipment and falling objects.

When handling gas cylinders (whether full or empty), care must be taken to prevent sudden impacts. Whenever a cylinder is not in use, the protective cap must be in place to prevent the valve from being damaged. Gas cylinders may not be carried, dragged, rolled or slid across a floor or surface. When gas cylinders are to be moved / used, they must be placed in a proper cylinder trolley fitted with a 1.5kg dry chemical powder fire extinguisher.

Gas cylinders may not, under any circumstances, be used as rollers or work supports. If transported by crane, hoist or derrick, compressed gas cylinders must be placed in a suitable cradle, net or skip box. Cylinders may NEVER be lifted using wire rope, fibre rope, a web sling or a chain sling. Before moving / transporting a gas cylinder, the regulator must be removed and the protective valve cap must be replaced.

Gas cylinders may not be taken into a confined space. Gas hoses that are run into a confined space must be removed during breaks. Gas cylinders may not be placed on scaffolding.

Cylinder valve keys must be in place. If no suitable valve key is available then the cylinder may not be used. Nothing but the manufacturer-supplied key may be used to open the valve. A flashback arrestor and a check valve (non-return valve) must be installed between the regulator and the hose and between the hose and the torch on the oxygen line and on the fuel (acetylene) line.

Connection fittings may not be forced and safety devices associated with cylinder valves or regulators may not be altered / tampered with. Gas hoses may not be joined. Only approved hose connectors of the crimp type are permitted. Wire and jubilee clamps are prohibited. Only high quality ancillary equipment may be used. This includes flashback arrestors, hoses, clamps, spindle keys, nozzles and torches. Only trained and competent personnel may operate gas welding / cutting equipment and appliances.

When an employee opens the valve to a cylinder, he must stand to one side and open it slowly. Valves may never be left partly open – they must either be closed or be opened fully. Leaking cylinders must immediately be removed from service and the workplace (if it is safe to do so).

Suitable firefighting equipment must be at hand wherever gas cylinders containing oxygen and / or fuel gas are being used. Gas cylinders must be prevented from coming into contact with electrical circuits, e.g. welding leads. Never strike an arc on a cylinder.

Oxygen may only be used for the purpose for which it is provided. Do not use oxygen in pneumatic tools or tyres, as an explosion may occur. Empty cylinders must immediately be marked as such and must be removed to the cylinder storage area at the end of each day / shift.

15.23 Electrically Powered Tools and Equipment

All powered hand tools, such as circular saws, drills, chainsaws, percussion tools, jigsaws etc., must be equipped with a constant pressure switch that will shut off the power when the pressure is released. (Exception: this requirement does not apply to concrete vibrators, concrete breakers, powered tampers, jack hammers, rock drills, and similar hand operated power tools).

Electrical power tools must be of the approved double-insulated type. The electric cord, pneumatic or hydraulic supply line of powered tools must not be used for hoisting or lowering of the tool. Loose clothing, jewellery or gloves that could get caught in the tool must not be worn when operating powered tools. Operators of powered tools who have long hair must keep their hair tied up.

The power source must be disconnected from the tool before making any repairs, servicing, adjustments, or replacing attachments such as drill bits.

15.24 Angle Grinders

The following personal protective equipment must be worn when using angle grinders:

- Safety helmet;
- Gloves;
- Safety glasses (or safety goggles) and a full face shield (i.e. double eye protection);
- Overalls with long sleeves and long pants, avoid any form of loose clothing;
- Safety boots with steel toe protection;
- Hearing protection;
- Breathing apparatus where dust or fumes may be generated;
- Where grinding machines are used, a face shield is to be worn as extra protection to the safety glasses; and
- Certain tasks may require the use of a leather apron as determined by a risk assessment.

A 230mm angle grinder may not be used for free cutting purposes. Exceptions may be approved only if alternative methods evaluated proved more hazardous or no alternative exists. The risk assessment for the task must then specifically include mitigating measures to ensure the safest possible way of performing the task.

The use of 230mm angle grinders for grinding purposes is acceptable, however should this form of grinding be required, the 115mm or 125mm grinders would be preferable. All angle grinders must have a dead man switch incorporated, with a pressure switch in the handle. A 230mm electrical angle grinder unit must incorporate a soft start to reduce the starting strain and a braking system to reduce run on after the unit has been switched off.

All angle grinders must have a spindle lock to assist with changing the disc or grinding wheel. Anti-vibration handles are recommended to further reduce the stress if used for extended periods. Angle grinders must be equipped and operated with disc guarding at all times. Angle grinder must not be stored with fitted discs, as this will lead to damaging of the discs.

Before use and mounting of discs it is essential to check the safety codes and specifications printed on the upper side of the disc. Such specifications include the following:

- Revolutions per minute (RPM). The allowable speed of the disc must be equal to or greater than the maximum achievable speed of the grinder;
- Physical dimensions of the disc must meet grinder specification; and
- The disc must be suitable for the material type to be cut / ground as indicated on the disk. Cutting discs must never be used for grinding and vice versa.

It is critical that the correct disc mounting procedure is followed:

- Check that the machine is plugged out;
- Check the machine spindle, backup washer and thread;
- Check the condition of spindle nut - ensure spanner drive holes are not elongated;
- Ensure spindle nut spanner is the tool recommended by machine manufacturers;
- Do not use a hammer, pipe or chisel to tighten the nut, or apply additional mechanical advantage to nut torque. A firm "nip" is sufficient to retain the disc;
- Ensure the spindle diameter is suited to disc bore. Excessive clearance will cause the machine to vibrate due to eccentricity;
- Check to see that the nut and backup washer do not "bottom out". This will result in the disc not being correctly clamped on the spindle;
- Ensure the spindle speed is marked on the grinder and that it is less than the allowable disc speed; and
- Fit the disc, with the metal ring or writing to the nut side.

15.25 Pneumatically Powered Tools and Equipment

Pneumatic powered tools must only be driven by filtered compressed air with an in-line lubrication system, or be lubricated prior to use if there is no in-line lubrication system. When using pneumatic powered tools the designated tool pressure must be attained by the use of a regulator.

Pneumatic powered tools must be disconnected when not in use. They must not be disconnected from the air supply until all the residual pressure has been released or contained by a shut-off device. Hoses must not be kinked as a means of containment.

Employees operating pneumatic powered tools, and any potentially affected employee in the vicinity of use, must wear suitable personal protective equipment. All rotary compressed air tools

(e.g. drills) must have the rated revolution per minute (RPM) permanently marked on the casing. Only attachments of compatible RPM must be used with these machines.

The actual RPM of the tool must be checked every three months to ensure that the speed is as rated to manufacture specifications.

Pneumatic powered tools must be secured to the air supply hose by an approved positive means to prevent the tool from becoming accidentally disconnected. Safety clips or retainers must be securely installed and maintained on pneumatic impact (percussion) tools to prevent attachments from being accidentally expelled.

All pneumatically driven nailers, staplers, and other similar equipment provided with automatic fastener feed, which operate at more than 100 kPa pressure at the tool, must have a safety device on the muzzle to prevent the tool from ejecting fasteners unless the muzzle is in contact with the work surface.

Compressed air must not be used for cleaning purposes except where reduced to less than 30kPa, and then only with effective chip guarding and personal protective equipment in place. The 30kPa requirement does not apply to concrete form, mill scale and similar cleaning purposes.

The use of compressed air for cleaning purposes must be approved by the nominated project management representative. Compressed air must not be pointed at any part of the body or used for cleaning clothing.

Airless spray guns of the type which atomize paints and fluids at high pressures must be equipped with automatic or visible manual safety devices which will prevent pulling of the trigger to prevent release of the paint or fluid until the safety device is manually released. A diffuser nut which will prevent high pressure, high velocity release while the nozzle tip is removed, plus a nozzle tip guard which will prevent the tip from coming into contact with the operator, or other equivalent protection must be provided in lieu of the above.

Abrasive cleaning nozzles must be equipped with an operating valve, which must be held open manually to enable operation. A support must be provided on which the nozzle may be mounted when it is not in use.

15.26 Fuel Powered Tools and Equipment

Fuel powered tools must be shut down and allowed to cool before being refuelled, serviced, or maintained. Fuel must be transported, handled, and stored in approved fuel containers. Where possible, diesel driven engines must be used in preference to petrol driven engines. All fuel powered tools must be included on the contractor's Equipment Register and the register must be submitted to the nominated project management representative prior to the relevant work commencing.

When fuel powered tools are used in enclosed spaces, the space must be ventilated and the atmosphere monitored to measure toxic gas concentrations. Persons in the space must wear the necessary personal protective equipment. Confined Space Entry clearance may apply. This type of activity must only be undertaken in exceptional circumstances and requires the approval of the nominated project management representative.

15.27 Hydraulically Powered Tools and Equipment

Hydraulic powered tools must use only approved fluid that retains its operating characteristics at the most extreme temperatures to which it will be exposed. The manufacturer's stated safe operating pressures for hoses, valves, pipes, filters and fittings must not be exceeded. Only manufacturer approved hoses, valves, pipes, filters and fittings must be used.

15.28 Explosive Powered Tools

All operators shall be trained by the contractor. The contractor shall ascertain that the explosive charges to be used are of the correct strength for the purpose.

Projectiles from explosive powered tools shall NOT be driven into:

- Tile, terracotta, glazed brick, glass, marble, granite, thin slate or other brittle substances;
- High tensile steel, cast iron or steel hardened by heat treatment; or
- Concrete that contains aggregate that will not pass wholly through 25mm mesh screens.

Under no circumstances shall a tool be fired in such a manner as to cause the projectile to fly free. Suitable safety glasses and hearing protection shall be worn by operators when firing an explosive powered tool.

At all times when a tool is being used, the operator shall display clearly legible signs at or near the place where the tool is in use. Sign should read: WARNING: EXPLOSIVE POWERED TOOL IN USE – KEEP CLEAR. The operator shall warn all other employees in the vicinity of the area in which the tool is about to be used.

Tools shall never be stored in a loaded state. Cartridges and tools shall be stored separately in lockable containers. A logbook must be kept of the number of cartridges used and returned.

15.29 Hand Tools

Employees required to use hand tools must receive training relevant to the tool and have their competency assessed in the operation, inspection and maintenance of the tool. Where necessary, additional applicable personal protective equipment must be worn when using hand tools.

Wrenches, including adjustable, pipe, end, and socket wrenches, must not be used when the jaws are sprung to a point where slippage occurs. Impact tools such as drift pins, wedges and chisels, must be kept free of mushroomed heads. The wooden handles of tools must be kept free of splinters or cracks.

Adjustable wrenches must not be used in lieu of ring or open-end type spanners, unless a risk assessment has been conducted and the use of the adjustable wrench is approved by the nominated project management representative. Wherever possible, ring spanners must be used in preference to open end spanners.

Correct hand tools for the job must be used, e.g. screwdrivers must not be used as chisels, and pliers must not be used as hammers. All wedges and drifts that may spring, fly or fall to lower levels upon impact must be fitted with an attachment which attaches a safety "lanyard" to a solid structure to restrain the impact tool from becoming a projectile.

All hand tools used in elevated areas, that may be dropped or fall to lower levels must be fitted with safety lanyards and attached to solid structures or in the case of podges, scaffold keys etc., attached by wrist lanyard to the user.

A utility knife must be used as a last resort, when it is the safest tool to use. Always consider alternatives that pose less of a risk to the operator.

Whenever a utility knife is used, ensure that a complete risk assessment is done and that all possible hazards have been addressed. Only utility knives with retractable blades are to be used. The blade is to be retracted at all times when the knife is not in use or is being stored.

Before using the utility knife, ensure that the tool is in a good condition and the blade is secure in the holder (seated correctly and that there is no play). Ensure that the blade is always sharp and in good condition. This will prevent the use of excessive force.

Always wear cut resistant gloves and safety glasses when using a utility knife. There is always a risk of the blade breaking under tension and becoming a projectile. Always ensure that you cut away from your body, and that no part of your body is in the firing line. Always ensure cleanliness of all equipment in use during the cutting operations.

15.30 Inspection of Equipment and Tools

All tools must be inspected by the user before, during and after use. If any faults are identified, the tool must be taken out of service and not used until repaired. Faulty tools that are not able to be repaired must be tagged "out of service" and removed from site.

15.31 Manual Handling and Vibration

Any handling or lifting task that can only be done manually must be planned and rehearsed before the task is done. If more than one person is involved in a task a communication procedure must be agreed in advance. Lowering the load must be done in a controlled manner. Dropping a load is dangerous and must be avoided.

As a guideline 25 kg is considered to be the limit of what a person can safely handle. Where there are loads exceeding 25 kg the risk of handling the load must be mitigated to assure minimal potential for any injury. When mechanical lifting aids are provided, they should be used.

Extra care should be taken when lifting awkwardly shaped objects. Correct lifting techniques must be used at all times when lifting a load manually.

The following, but not limited to, should be considered with conducting the Risk Assessment with regards Manual Handling and also take into consideration the task factors, physical demands and tools involved in the task:

- Load weight/frequency;
- Hand distance from lower back;
- Asymmetrical trunk/load;
- Postural constraints;
- Grip on the load;
- Floor surface;
- Environmental factors;
- Carry distance; and
- Obstacles and route.

Team Manual Handling:

- Load weight;
- Hand distance from lower back;
- Vertical lift region;
- Trunk twisting/sideways bending;
- Postural constraints;
- Grip on the load;
- Floor surface;
- Environmental factors; and
- Communication, co-ordination and control.

As far as possible, exposure to vibration must be eliminated. However, if this is not possible, short-term solutions to decrease exposure include:

- Reducing the vibration levels;
- Removing the person from the vibrating equipment / tools;
- Reducing the period of time that the person works with the vibrating equipment / tools (at least 40 minutes break after 20 minutes working with a machine that vibrates excessively).

In order to reduce exposure to vibration:

- Consider buying equipment that operates effectively at lower speeds;
- Buy equipment with built-in damping materials;
- Buy lighter tools if they are available - they require less of a grip;
- Maintain the equipment;
- Make sure equipment is balanced and there are no worn parts;
- Use remote controls when they are available;
- Reduce your grip on the equipment when it is safe. The less time you actually have your hands on the equipment the better. Relax your hands during these brief breaks;
- Take scheduled breaks; and
- Do other tasks that allow you to move away from vibrating tools and equipment.

The workplace must be assessed by a competent person for compliance with good design, layout and practice, to avoid or minimise adverse health consequences due to manual handling and vibration issues.

Quantitative evaluations of vibration produced by specific equipment must include the following measurement parameters: direction of movement, frequency, intensity, and variation with time and duration, as per documented methods.

Employees and contractors must be informed of the results of assessments and instructed in appropriate manual handling techniques, where the risk assessment indicates a need. Workplace vibration sources that could contribute to the exceedance of an Occupational Exposure Limit (hence potential for impact on worker musculo-skeletal fitness) must be identified and adequately characterised.

Manual handling tasks assessed as having the potential to cause a Lost Time Injury (i.e. with potential for impact on worker musculo-skeletal fitness) must be identified and adequately characterised. Workplace manual / materials handling tasks risk rated as "significant" must be assessed and recorded to include biomechanical factors (e.g. posture, bending, twisting, repetitive motions, working overhead, and exerting force away from the body).

15.32 Demolition Work

Demolition work must be carried out as per the requirements of Construction Regulations, 2014, Regulations 14.

The contractor must appoint a competent person in writing to supervise and control all demolition work on a project site.

Legislation and legal requirements, Asbestos Regulations and all relevant requirements to be adhered to where material containing asbestos has to be demolished and worked with.

15.33 Temporary Works

The contractor must appoint a temporary works designer in writing to design, inspect and approve the erected temporary works on site before use.

The contractor must ensure that all temporary works operations are carried out under the supervision of a competent person who has been appointed in writing for that purpose. The contractor must ensure that, all temporary works structures are adequately erected, supported, braced and maintained by a competent person so that they are capable of supporting all anticipated vertical and lateral loads that may be applied to them, and that no loads are imposed onto the structure that the structure is not designed to withstand.

All temporary works structures are done with close reference to the structural design drawings, and where any uncertainty exists the structural designer should be consulted. Detailed activity specific drawings pertaining to the design of temporary works structures are kept on the site and are available on request to an inspector, other contractors, the client, the client's agent or any employee.

All persons required to erect, move or dismantle temporary works structures are provided with adequate training and instruction to perform those operations safely. All equipment used in temporary works structure are carefully examined and checked for suitability by a competent person, before being used.

All temporary works structures are inspected by a competent person immediately before, during and after the placement of concrete, after inclement weather or any other imposed load and at least on a daily basis until the temporary works structure has been removed and the results have been recorded in a register and made available on site;

No person may cast concrete, until authorization in writing has been given by the competent person; if, after erection, any temporary works structure is found to be damaged or weakened to such a degree that its integrity is affected, it is safely removed or reinforced immediately. Adequate precautionary measures must be taken in order to:

- Secure any deck panels against displacement; and
- Prevent any person from slipping on temporary works due to the application of release agents;
- As far as is reasonably practicable, the health of any person is not affected through the use of solvents or oils or any other similar substances;
- Upon casting concrete, the temporary works structure is left in place until the concrete has acquired sufficient strength to safely support its own weight and any imposed load, and is not removed until authorization in writing has been given by the competent person contemplated in paragraph (a);
- The foundation conditions are suitable to withstand the loads caused by the temporary works structure and any imposed load in accordance with the temporary works design.
- Provision is made for safe access by means of secured ladders or staircases for
- A temporary works drawing or any other relevant document includes construction sequences and methods statements;
- The temporary works designer has been issued with the latest revision of any relevant structural design drawing;
- A temporary works design and drawing is used only for its intended purpose and for a specific portion of a construction site; and
- The temporary works drawings are approved by the temporary works designer before the erection of any temporary works.

No contractor may use a temporary works design and drawing for any work other than its intended purpose.

15.34 Structure

The contractor must ensure that:

- All reasonably practicable steps are taken to prevent the uncontrolled collapse of any new or existing structure or any part thereof, which may become unstable or is in a temporary state of weakness or instability due to the carrying out of construction work;
- No structure or part of a structure is loaded in a manner which would render it unsafe; and
- All drawings pertaining to the design of the relevant structure are kept on site and are available on request to an inspector, other contractors, the client and the client's agent or employee.

An owner of a structure must ensure that;

- Inspections of that structure are carried out periodically by competent persons in order to render the structure safe for continued use;
- The structure is maintained in such a manner that it remains safe for continued use;
- The records of inspections and maintenance are kept and made available on request to an inspector.

15.35 Personal Protective Equipment

Applicable legislation, standards, procedures and safe work procedures (such as but not limited to Construction Regulations, General Safety Regulations, Client HS Specification) concerning Personal Protective Equipment (PPE) must be complied with at all times. As a minimum, the following PPE must be worn by all persons (including visitors) at all times whilst on the project site:

- Safety footwear with steel toe protection;
- Safety glasses (individuals who wear prescription spectacles must be provided with either over-spec safety glasses or prescription safety glasses);
- Safety helmet (hard hat); and
- High visibility protective clothing with reflective taping (long trousers and long-sleeved shirts with collars and cuffs).
- Additional PPE requirements must be determined through hazard identification and risk assessment. This hazard-specific PPE (such as hand protection, hearing protection and respiratory protection) must be worn as required (e.g. when in a certain area, when performing a certain task, or when working with a certain substance);
- The correct PPE must always be worn:
 - In accordance with site requirements (as indicated at the entrances to a project site and at the entrances to buildings and / or designated areas on the premises);
 - In zoned areas (e.g. noise zones and respirator zones); or
 - As required by a Safe Work Procedure, a risk assessment, safety information boards or a Safety data sheet (SDS).

Each contractor must provide each of his employees with all required PPE (at no cost to the employee). The specific PPE that is provided to a particular employee must be based on the nature of that employee's work and the location in which the work is performed (i.e. must be based on the hazards to which the employee is exposed). PPE requirements for a particular job or for a particular area must be determined through a risk assessment for that job or area.

Any employee who does not have all of the PPE that is required for him to perform his duties safely will not be permitted to work. Each employee must care for his PPE, maintain it in good condition, and inspect it on a daily basis. If an item of PPE has worn out, has become damaged, or is found to be defective in any way, it must be replaced by the contractor.

PPE must be stored in accordance with the manufacturer's requirements and / or recommendations.

Each employee must receive training in the use, maintenance and limitations of the PPE that is provided to him, and must be made aware of why the PPE is necessary as well as the consequences of not wearing it as instructed (i.e. the potential for injury and / or disciplinary action). Training records must be retained.

Any person who refuses to wear PPE as required must be removed from the site. Symbolic signs indicating mandatory PPE requirements must be prominently displayed at the entrances to a project site and at the entrances to buildings and / or designated areas on the premises where additional PPE is required. These signs must comply with the applicable national standard (if one exists).

Contractors must appoint an employee to:

- Control the issuing and replacement of PPE;
- Keep an up-to-date register as proof that items of PPE have been issued to individuals (an employee must sign for the items that he receives);
- Ensure that there is an adequate supply of all required PPE (i.e. maintain PPE stock levels on site); and
- Carry out regular inspections to ensure that PPE is being used correctly, is being maintained in a good, serviceable and hygienic state, and is not being shared between employees.

15.35.1 Head Protection

A safety helmet (or hard hat) worn correctly will help protect the head in the event of:

- An employee being struck on the head by a falling or flying object;
- An employee striking his head against a fixed or protruding object; or
- Accidental head contact being made with an electrical hazard.

A safety helmet must be worn at all times on a project site, with the following exceptions:

- Vehicle and equipment operators inside enclosed cabs;
- In offices and in office or administration buildings; and
- At designated lunch and break areas (provided that no work is in progress in the immediate break area).

A safety helmet must be worn in accordance with the manufacturer's requirements. A safety helmet must be worn directly on the head. The wearing of a cap or other headgear beneath a safety helmet is prohibited unless the items have been specifically designed to be used in combination (i.e. the arrangement is approved by the safety helmet manufacturer).

The suspension system inside a safety helmet (that acts as a shock absorber) may not be removed. The painting of safety helmets is prohibited. Safety helmets may only be cleaned using a mild detergent and water. No solvents may be used.

15.35.2 Eye Protection

If an employee is carrying out, assisting with, or working adjacent to any activity where sparks or projectile particles are being generated, where chemical mists or fumes are being generated, where

liquids may splash or spray, where harmful electromagnetic radiation (heat or light) is being generated, or where there is a risk of wind-blown particles entering the eyes, then suitable protective eyewear must be worn at all times (i.e. safety glasses, safety goggles, a face shield, a welding helmet, or a combination of these).

Such activities include:

- Working with rotating equipment (e.g. grinders, drills, mills, lathes, and saws);
- Welding and cutting;
- Chipping, chiselling or caulking;
- Using explosive powered tools;
- Abrasive blasting;
- Sanding; and
- Working with chemical substances (e.g. drilling fluids, acids, solvents, paints, pesticides, etc.).

For certain activities, special eye protection is required (e.g. a heat-resistant face shield is required when working near molten metal). Double eye protection is required for activities such as:

- Grinding, cutting, chipping, chasing and reaming (employees must wear both a full face shield and safety glasses or goggles); and
- Arc welding (welders must wear both safety glasses and a welding helmet).

Screens must be erected to protect passers-by, where practical.

Safety glasses must be worn at all times on a project site, with the following exceptions:

- Vehicle and equipment operators inside enclosed cabs with the windows fully closed;
- In offices and in office or administration buildings;
- At designated lunch and break areas (provided that no work is in progress in the immediate break area); and
- When another form of eye protection is required (e.g. safety goggles).

All safety glasses used on site must have suitable permanent side protection.

In strong sunlight, dark safety glasses should be worn to reduce eyestrain and fatigue. However, caution must be exercised when employees are required to frequently move between outdoor and indoor environments. Dark safety glasses may not be worn indoors or in poor daylight conditions. Prescription spectacles with tinted lenses are prohibited inside buildings or other structures with limited illumination unless the lenses are light-sensing and adjust to changing illumination levels.

Employees who wear prescription spectacles (i.e. require corrective lenses) must make use of either:

- Prescription safety glasses (with permanent fixed side shields) that conform to the requirements of a recognised national or international standard (e.g. CSA, ANSI, or equivalent); or
- Over-spec safety glasses or goggles.

The use of contact lenses in certain areas may not be suitable because of increased risk to the eye due to dust or heat.

15.35.3 Hearing Protection

Local regulations concerning occupational exposure to noise and the use of hearing protection must be complied with as a minimum. "Low noise" tools and machinery must be used wherever possible

to reduce noise levels. Where noise cannot be reduced to an acceptable level through engineering and work practice controls, measures must be put in place to minimise the exposure of employees to the noise (i.e. administrative controls and personal hearing protection).

Areas where it is likely that the 95% upper confidence limit of an eight hour L_{eq} mean exceeds 85dB(A), or areas where impulse noise exceeds 140dB(C), must be designated as noise zones. These noise zones must be clearly demarcated and mapped, signs must be posted, and all employees must be made aware of the requirements for working in such an area.

Suitable hearing protection must be worn in all designated noise zones and when carrying out (or working in the vicinity of) any activity where the noise level exceeds 85dB(A).

Where hearing protection is required, a hearing conservation programme (applicable to all personnel and visitors) must be implemented. The programme must include training in the correct use and proper storage of hearing protection devices as well as replacement requirements. Training must be provided when hearing protection is first issued to an employee and refresher training must be carried out at least annually thereafter. Training records must be retained.

At least two types of personal hearing protection must be made available to employees. The hearing protection devices provided must have adequate noise reduction ratings (i.e. must be able to attenuate the noise level to below 85dB(A)).

Personal hearing protection must be issued on an individual basis and must not be shared. In addition to personally issued hearing protection, suitable disposable hearing protection must be made available at the entrances to all noise zones. All Hearing Protection Devices (except for disposable hearing protection) must be properly inspected and cleaned on a regular basis.

15.35.4 Respiratory Protection

Designated areas (respirator zones) must be established where:

- It is likely that the 95% upper confidence limit of a Similar Exposure Group's mean exposure concentration exceeds the relevant Occupational Exposure Limit (OEL) for agents resulting in chronic effects, such as total inhalable dust, respirable dust, respirable crystalline silica, PAH, fluorides, lead, mercury, asbestos or non-asbestos fibrous materials; or
- The concentration of an agent (particulate, vapour or gas) with an acute effect exceeds 50% of the relevant OEL.

Note: For a particular hazardous agent, the OEL to be adopted must be either the client's OEL or the OEL specified in local legislation, whichever is the most stringent.

Respirator zones identified must be clearly demarcated and mapped, signs must be posted, and all employees must be made aware of the requirements for working in such an area.

Suitable Respiratory Protection Devices (RPDs) must be worn in all designated respirator zones and when carrying out (or working in the vicinity of) any activity where the risk assessment has identified the need for respiratory protection.

RPD's must be selected based on:

- The type(s) of airborne contaminants that are present (gases, vapours, and particulates and aerosols including dusts, fumes, sprays, mists, and smoke);
- The potential particulate size distribution;
- Substance toxicity; and

- The likely concentrations.

Compatibility with the work tasks and other PPE, comfort (as it affects wear-time), and the ability to communicate adequately, must also be considered.

The risk assessment and method statement for the work to be performed, the information contained in the relevant Safety data sheets (SDSs), and the results of any air monitoring associated with the substances to be worked with or activities to be carried out, must be used to ensure that the most suitable RPD is selected.

Only RPDs certified to a recognised standard and approved by the nominated project management representative may be used.

Where respiratory protection is required, a respiratory protection programme (applicable to all personnel and visitors) must be implemented.

The respiratory protection programme must include:

- Periodic inspection of RPDs, including before each use;
- Periodic evaluation (by competent persons) of cleaning, sanitising, maintenance and storage practices;
- Performance of positive pressure and negative pressure fit checks by RPD wearers before each use to ensure that the respirator is functioning properly; and
- Training at first issue of a RPD and regular refresher training thereafter in accordance with regulatory requirements or at least once every two years (the training must cover fit testing, use, cleaning, maintenance, filter cartridge replacement, and storage). Training records must be retained.

RPDs must be used, maintained, and stored in compliance with the manufacturer's requirements as well as the respiratory protection programme. Suitable facilities must be provided for the cleaning and sanitary storage of RPD's.

As a minimum, qualitative and documented fit testing must be carried out (although quantitative fit testing is preferred) to ensure that the use of negative pressure RPDs (including disposable RPDs) is effective. Fit testing must be performed by a competent person when an RPD is first issued and must be repeated periodically in accordance with legal requirements or every two years as a minimum. A policy must be in place requiring a clean shaven face when using a negative or neutral pressure RPD for routine tasks (otherwise a positive pressure RPD must be used). A medical evaluation including a pulmonary function test may be required to determine whether or not an individual is medically fit to wear a respirator.

For air-supplied RPDs, breathing air must be effectively filtered and / or isolated from plant and instrument air, and isolated from sources of potential contaminants. The supplied air must be tested to determine if the air quality complies with the requirements of applicable standards for breathing air.

For nuisance dust, dust masks with a protection level of at least FFP2 must be worn.

15.35.5 Hand and Arm Protection

Gloves must be worn when handling or working with equipment, materials or substances with the potential to cause injury or illness. Suitable gloves must be selected based on the task to be performed and the specific hazard against which the employee requires protection, such as:

- Sharp edges;
- Sharp points and splinters;
- Abrasive surfaces;
- Hazardous chemical substances (toxic, corrosive, sensitising, etc.);
- Extreme temperatures; and
- Viruses, bacteria and parasites.

15.35.6 Foot Protection

Safety boots must be worn at all times whilst on a project site, with the exception of offices and office or administration buildings in which closed athletic, business or similar shoes may be worn. Sandals, slaps, slippers, open-toed and high-heeled shoes are not permitted on any project premises.

Safety boots must provide the following protection:

- Steel toe cap to protect against crushing (impact and compression forces);
- Leather uppers that provide resistance against water penetration and water absorption;
- Slip resistant soles;

And where a risk assessment identifies the need:

- Puncture resistant soles (i.e. steel midsoles) for protection against sharp objects;
- Chemical resistant soles for protection against spilt chemical substances (such as solvents, hydrocarbons, acids, and alkalis);
- Heat resistant soles for protection against hot surfaces or molten metal; or
- Electrical shock resistant soles for protection (insulation) against live electrical conductors.
- Gumboots with steel toe caps must be worn when working in water or very wet conditions.

15.35.7 Clothing

All employees working on a project site must wear high visibility protective clothing with reflective taping. Trousers must be long and shirts must be long-sleeved. Shirts must be buttoned at the neck and wrists.

Protective clothing must preferably be made of natural fibres. Short pants, short-sleeved shirts, sleeveless shirts, and vests are prohibited as outer garments (with the exception of a high visibility vest worn over a long-sleeved shirt).

Loose clothing may not be worn where it may become caught in moving machinery or equipment. For hot work (e.g. welding, cutting, etc.), work in the vicinity of molten metal, and any work carried out in the vicinity of an open flame, the protective clothing worn (shirt and trousers) must be made of a suitable fire retardant fabric. Underwear and socks must be made of natural fibres (preferably wool) or fire retardant fabric.

15.35.8 Body Protection

Suitable body protection must be provided as required to protect employees against specific hazards. A range of work activities require body protection in one form or another, including but not limited to:

- Working in extremes of temperature, such as fire-fighting, attending to a heating furnace, working with molten metal, working in refrigerated environments, etc.;
- Hot work (e.g. welding, burning, cutting and grinding);

- Working with hazardous chemical substances (e.g. acids, solvents, pesticides, etc.); and
- Clean up and disposal of hazardous materials and wastes (e.g. asbestos, hydrocarbons, etc.).

A wide variety of protective garments are available, such as fire-fighting suits, furnace suits, freezer jackets, leather aprons, leather spats, laboratory coats, chemical resistant aprons, chemical resistant (or hazmat) suits, and disposable coveralls. Suitable items must be selected to provide protection against the specific hazard(s) to which an employee is exposed. Hazards must be carefully identified and characterised to ensure that the correct protection is used.

Body protection must be sized properly to prevent tearing, the parting of seams, tripping, or restriction of movement.

15.35.9 Electrical Protective Equipment

To reduce the risk of electric shock, electrical insulating equipment appropriate for the voltage that may be encountered must be worn when working on energised electrical installations and when working within two metres of exposed energised conductors.

All rubber electrical insulating equipment (including gloves, sleeves, matting, covers, blankets, and line hoses) must be inspected for damage prior to and after each use, and immediately following any incident that can reasonably be suspected of having caused damage.

Rubber insulating equipment with any of the following defects and / or damage may not be used:

- A cut, rip, tear, hole, or puncture;
- Ozone cutting or ozone checking (i.e. the cutting action of ozone on rubber under mechanical stress causing a series of interlacing cracks);
- An embedded foreign object;
- Chemical deterioration (texture changes) such as swelling, softening, hardening, or becoming sticky or inelastic; or
- Any other defect that damages the insulating properties.

Rubber insulating gloves must be electrically tested before first issue and every 12 months thereafter as a minimum. Insulating gloves must also be given an air test along with the daily inspection. Essentially, this involves filling a glove with air and checking for any holes or leakage.

Insulating equipment that fails an inspection or electrical test may be repaired only as follows:

- Rubber insulating line hose may be used in shorter lengths with the defective portion(s) cut off;
- A rubber insulating blanket may be repaired using a compatible patch that results in the patched area having electrical and physical properties equal to those of the blanket;
- A rubber insulating blanket may be salvaged by cutting the defective area off the undamaged portion of the blanket;
- Rubber insulating gloves and sleeves with minor physical defects, such as small cuts, tears, or punctures, may be repaired by applying compatible patches. The patched areas must have electrical and physical properties equal to those of the surrounding material.

Repairs to gloves are permitted only in the area between the wrist and the reinforced edge of the opening.

Repaired insulating equipment must be retested before it is put back into use. Insulating equipment must be cleaned as required to remove foreign substances (using a mild detergent).

Insulating equipment must be stored in such a location and in such a manner so as to protect it from light, temperature extremes, excessive humidity, ozone, and other damaging substances and conditions.

Leather protective gloves must be worn over rubber insulating gloves to provide mechanical protection against cuts, abrasions, and punctures.

Suitable arc flash PPE (e.g. voltage rated gloves, fire retardant clothing, arc rated face shield, arc flash hood, arc flash suit, etc.) must be worn whenever an employee is potentially exposed to an arc flash hazard. The appropriate level of PPE must be worn depending on the task and the potential energy exposure. These PPE requirements must be clearly specified as part of a project-specific arc flash protection programme.

15.35.10 Jewellery

Necklaces, dangling earrings, and bracelets may not be worn on a project site. No ring or watch may be worn where there is a risk that it may become caught in machinery or equipment. No jewellery or other conductive apparel (such as a key chain or watch) may be worn when carrying out energised electrical work.

15.35.11 Hair

Scalp hair that is longer than the top of the shoulders must be tied up and restrained within the person's safety helmet or within the collar of his or her overalls, shirt or jacket.

For negative or neutral pressure Respiratory Protection Devices, facial hair must not cause the seal between the respirator and facial skin to be broken (or prevent a seal from being formed in the first place).

15.35.12 Task-Specific PPE

In addition to the standard PPE required for a project site (including a safety helmet, safety glasses, safety boots, and high visibility protective clothing), the following task-specific PPE must be used as a minimum by any person carrying out or assisting with such a task:

- Arc Welding – safety glasses and welding helmet (i.e. double eye protection), respiratory protection against the specific airborne contaminants being generated (fumes, gases, dusts, etc.), leather welding gloves, leather apron, leather spats, leather yoke (for work above shoulder height), and knee pads for welders in kneeling positions;
- Gas Welding, Cutting or Brazing – gas cutting or welding goggles with shade 4 filter lenses and full face shield (i.e. double eye protection), respiratory protection against the specific airborne contaminants being generated (fumes, gases, dusts, etc.), leather gloves (long cuff for welding and cutting, short cuff may be used for brazing), leather apron, leather spats, and leather yoke (for work above shoulder height);
- Grinding – safety glasses or goggles and full face shield (i.e. double eye protection), hearing protection, respiratory protection where dust or fumes may be generated, leather gloves, leather apron, and leather spats;
- Abrasive Blasting – respiratory protection (air-supplied hood), hearing protection, leather gloves, and leather apron;
- Spray Painting – respiratory protection (air-supplied hood for confined spaces), safety goggles (if the respirator design does not provide this protection), hearing protection where air compressors are used), chemical resistant gloves, and chemical resistant disposable coveralls.

15.35.13 Sun Protection

The contractor must ensure that all personnel are protected in sunlight through the use of long sleeve shirts, long trousers, brims to safety helmets and UV factored sunscreen. Shade structures must also be made available to all employees.

The contractor must conduct training and awareness sessions with his employees, advising on the risks associated with working in the heat (including dehydration) and the precautions to be taken (e.g. ensuring adequate fluid intake).

15.36 Fuel / Flammable Liquid Storage and Refuelling

No fuel (diesel, petrol, paraffin, etc.) or any other flammable liquid (paints, solvents, etc.) may be stored on site unless approved in writing by the nominated project management representative.

If the on-site storage of a fuel or a flammable liquid is approved, the contractor must ensure the following:

- The quantity of fuel / flammable liquid to be stored on site must be kept to the minimum that is required;
- The storage area must be located in a well-ventilated area at least 10 metres away from any building, drain, boundary or any combustible material;
- If more than 200 litres of fuel / flammable liquid is to be stored, the tank must be installed / the containers must be positioned within a bund;
- If the fuel / flammable liquid are to be stored in bulk tanks / vessels, then the minimum capacity of the bund must be 110% of the volume of the largest tank / vessel. If many small containers (e.g. 210 litre drums) are to be stored, the bund must be able to contain 25% of the total volume of the stored products;
- The bund must be impermeable. It must have a solid concrete floor and the walls must be constructed out of brick and must be plastered on the inside;
- The bund must be fitted with a lockable drain valve (for draining away rainwater), which must remain locked in the closed position. The valve may only be opened under supervision and in accordance with a written procedure;
- The fuel / flammable liquid storage area may not be used for the storage of any other materials / equipment, and must be kept completely free of all combustible materials (including rubbish, brush and long grass) at all times;
- Access to the storage area must be controlled (wire mesh fencing and gate);
- Appropriate warning signage (i.e. "Flammable Liquid", "No Smoking" and "No Naked Flames") must be prominently displayed at the storage area. The contents and volume of each tank must be indicated;
- In order to contain spillages, the offloading / refuelling bay at the fuel / flammable liquid storage area must have a solid concrete base surrounded by bund walls, ramps or humps and / or spill trenches (covered with steel grating) that lead into a sump;
- Fuel dispensing pumps must be protected against impact damage;
- All fuel / flammable liquid storage tanks and dispensing equipment must be electrically bonded and properly earthed;
- All electrical installations and fittings must be of an approved intrinsically safe type;
- Two 9kg dry chemical powder fire extinguishers must be mounted in an easily accessible position near the entrance gate to the fuel / flammable liquid storage area. Depending on the size of the storage area, additional fire extinguishers may be required to ensure that an extinguisher is no further than 15 metres away from any point on the perimeter of the storage area;
- A fire extinguisher must be at hand wherever refuelling is carried out;
- Smoking or open flames within 10 metres of a fuel / flammable liquid storage / refuelling area is strictly prohibited;
- No petrol or diesel powered vehicle or equipment may be refuelled while the engine / motor is running;

- Cellular phones must be switched off in fuel / flammable liquid storage / refuelling areas;
- Spill clean-up kits (containing a suitable absorbent fibre product) must be provided;
- Any spillages must be cleaned up immediately and all contaminated cleaning materials must be disposed of in accordance with the applicable legislation;
- If a flammable liquid is spilt or is leaking from a container / vessel, the area must be cordoned off and appropriate warning signage must be displayed to keep unauthorised personnel away from the affected area. Every effort must be made to contain the spillage. All hot work in the vicinity must be stopped immediately. If the spilt product is volatile and the possibility exists that a vapour cloud may form, or if the leak or spillage cannot be contained or stopped, then appropriate emergency response procedures must be activated, including the evacuation of all persons in the vicinity. Suitable fire fighting equipment must be positioned ready for use should the spilt product ignite;
- The manual decanting of fuel or a flammable liquid from a large container should only be done using a stirrup pump (or similar) or a purpose-made frame which allows the container / drum to tilt for decanting and then return to the upright position;
- Drip trays must be used wherever required;
- All tanks, drums, cans, etc. containing flammable liquids must be tightly closed and properly sealed except for when a container is being filled or when a product is being decanted;
- The transport or storage of corrosive or flammable liquids in open containers is strictly prohibited;
- Daily-use quantities of fuel (up to a maximum of 20 litres) must be handled in an approved safety can with a flash arresting screen, spring closing lid and spout cover that will safely relieve internal pressure if the can is exposed to fire;
- Where safety cans may be impracticable, only approved metal containers with screw caps may be used. Each container must be clearly labelled to indicate its contents;
- Only small quantities of flammable liquids (paints, solvents, etc.) may be stored within a building. Each product must be kept either in its original container or in an approved container which must be properly sealed. Each container must be clearly labelled to indicate its contents. When not in use, all such containers must be stored in a well-ventilated steel cabinet which must be kept locked to prevent unauthorised access;
- Not even small quantities of flammable liquids may be stored or dispensed in buildings or places of public assembly, in general warehouses, or in buildings containing sources of ignition such as space heaters, cooking devices, open electric motors, motor vehicles, or where welding, cutting, or grinding activities are being carried out;
- Safe Work Procedures must be compiled for the transportation (including delivery), offloading, storage, handling and use of any fuel / flammable liquid on site;
- All personnel that will be required to work with or may come into contact with a flammable liquid must be made aware of the hazards associated with the product and must be thoroughly trained in the safe transportation, use, handling and storage thereof.

15.37 Fire Protection and Prevention

The contractor must compile a Fire Protection and Prevention Plan for the work that will be carried out on site.

The contractor must assess / survey his area of responsibility and identify locations where the risk of fire is high. Cognisance must be taken of the fact that certain locations may need to be designated as high risk due to the presence of large quantities of flammable or combustible materials / substances. For all high risk areas, the contractor must ensure that additional precautions are taken to prevent fires and strict control is exercised over any hot work (i.e. welding, cutting, grinding, etc.) that is carried out.

The contractor must supply and maintain all required fire-fighting equipment. The type, capacity,

positioning, and number of fire-fighting appliances must be to the satisfaction of the nominated project management representative and must meet the requirements of the applicable legislation. Fire mains, hydrants and hose reels will rarely be available on site, so use must primarily be made of portable fire extinguishers.

Fire-fighting equipment, fixed and portable, must be strategically located with a view to being able to rapidly deploy the equipment in order to bring potentially dangerous and destructive fires under control while still in their infancy.

All fire extinguishers (and any other fire-fighting equipment) placed on site must be:

- Conspicuously numbered;
- Recorded in a register;
- Visually inspected by a competent person on a monthly basis (the results of each inspection must be recorded in the register and the competent person must sign off on the entries made); and
- Inspected and serviced by an accredited service provider every six months (the nominated project management representative may require that this frequency be increased depending on the environmental conditions (e.g. high dust levels, water, heat, etc.) to which the fire extinguishers are exposed).

Any fire extinguisher that has a broken seal, has depressurised, or shows any sign of damage must be sent to an accredited service provider for repair and / or recharging. Details must be recorded in the register.

Fire-fighting equipment may not be used for any purpose other than fighting fires. Disciplinary action must be taken against any person who misuses or wilfully damages any fire-fighting equipment.

Access to fire-fighting equipment, fixed or portable, must be kept unobstructed at all times. Approved signage must be in place to clearly indicate the location of each permanently mounted fire extinguisher, fire hose reel, etc.

The contractor must ensure that all persons working in / entering his area of responsibility are made aware of where all fire-fighting appliances and alarm points are located. The contractor must ensure that his employees (and those of any appointed sub-contractors) are trained in fire-fighting procedures and the use of fire-fighting equipment.

The contractor must compile an emergency response procedure detailing the actions that must be taken in the event of a fire or a fire / evacuation alarm. All personnel working within the contractor's area of responsibility must be trained, and all visitors must be instructed, on this procedure. Copies of the procedure must be prominently displayed in the workplace in all languages commonly used on the site.

Used fire extinguishers must be replaced by the contractor without delay.

No hot work (i.e. welding, cutting, grinding, etc.) or any other activity that could give rise to a fire may be performed outside of a designated workshop without a Permit to Work having been issued.

Wherever hot work is being carried out, a fire extinguisher must be at hand. Where the risk assessment determines that it is necessary, a fire watch must be stationed. Supervisors must carry out workplace inspections regularly to ensure adherence to fire prevention measures and procedures.

At the end of every working period (i.e. before each tea / lunch break and at the end of every shift / day), the workplace must be thoroughly inspected to ensure that no material is left smouldering and no condition / situation exists that could give rise to a fire.

The contractor must ensure that all supervisors and all employees carrying out or assisting with any hot work or any other activity that could give rise to a fire have been trained in fire-fighting procedures and the use of fire-fighting equipment. The training must be conducted by an accredited training provider.

When using electrical equipment, all cables must be in good condition and the nearest convenient socket must be used. No power socket may be loaded beyond its rated capacity through the use of adaptors, etc. Makeshift electrical connections are not permitted under any circumstances. Water-based fire-fighting equipment must not be used on electrical equipment or burning liquids.

Each vehicle used on site for work purposes and each item of mobile equipment with a diesel or petrol engine must be fitted with a permanently mounted fire extinguisher. Smoking is only permitted in designated smoking areas. Cigarette ends / butts must be properly stubbed out in the ashtrays provided and never thrown into waste bins.

The contractor must ensure that good housekeeping practices are enforced, as this is crucial to the prevention of fires.

All combustible waste materials must be removed from the workplace on a daily basis (at the end of each shift) and placed in waste receptacles located at least 5 metres away from any structure. The accumulation of waste materials in out-of-the-way places is prohibited. Offices, desks, cabinets, etc. must always be kept tidy and uncluttered. Waste paper bins must be emptied regularly.

The storage of combustible materials under stairways or in attics is prohibited. The storage of any materials against the exterior of a building or any other structure is prohibited. All walkways, passages and stairways must be kept clear (i.e. must be unobstructed) at all times, as they may need to be used as a means of escape.

The areas around and the routes to all exits, fire escape doors, fire hydrants, fire hose reels and fire extinguishers must be kept clear (i.e. must be unobstructed) at all times. "No Smoking" signs must be conspicuously displayed in and around all storage areas / rooms. Waste may not be burned under any circumstances.

No flammable liquid (such as petrol, acetone, alcohol, benzene, etc.) may be used for starting fires or as a solvent for cleaning clothes, tools, equipment, etc. Only solvents approved by the nominated project management representative may be used for cleaning purposes.

Whenever any work is carried out involving the use of a flammable substance / material, the area must be cordoned off and appropriate warning signage (i.e. "No Unauthorised Entry", "No Smoking" and "No Naked Flames") must be displayed.

15.38 Smoking

The contractor must not permit smoking on site except within designated smoking areas selected in accordance with the applicable legislation. Such an area must be clearly demarcated and the required signage must be displayed.

Any person found smoking or discarding a cigarette butt outside of a designated smoking area may be removed (temporarily or permanently) from site. In all designated smoking areas, adequate non-combustible commercial ashtrays and / or cigarette butt receptacles (butt cans) must be provided.

Ashtrays and other receptacles provided for the disposal of smoking materials must not be emptied into rubbish bins or any other container holding combustible materials. "No Smoking" signs must be strictly observed.

15.39 Housekeeping

The contractor must maintain all work areas in a tidy state, free of debris and rubbish. Unless directed otherwise, the contractor must dispose of all debris, rubbish, spoil and hazardous waste off site in a designated and authorised area or facility. The contractor must familiarise himself with the waste management plan for the site including collection and disposal arrangements, and must align his waste management activities accordingly.

In cases where an inadequate standard of housekeeping has developed and compromised safety and cleanliness, a nominated project management representative may instruct the contractor to cease work until the area has been tidied up and made safe. Neither additional costs nor contract deadline extensions will be allowed as a result of such a stoppage. Failure to comply will result in a clean-up being arranged through another service provider at the cost of the non-complying contractor.

The contractor must carry out housekeeping inspections on a weekly basis to ensure maintenance of satisfactory standards. The contractor must document the results of each inspection. These records must be maintained and must be made available to the nominated project management representative on request.

The contractor must implement a housekeeping plan for the duration of the contract ensuring that the site housekeeping is maintained. Furthermore, at the end of every shift, the contractor must ensure that all work areas are cleaned, all tools and equipment are properly stored, and construction rubble is removed.

Where the contractor fails to maintain housekeeping standards, the nominated project management representative may instruct the contractor to appoint a dedicated housekeeping team for the duration of the project at the contractor's expense. Littering is prohibited.

15.40 Waste Management

Waste may not be disposed of unless the disposal of that waste is authorised by law. The contractor must therefore ensure that all waste that is generated is handled, stored, transported and disposed of in accordance with the requirements of the applicable legislation / local authority.

15.41 Stacking and Storage

All irregular shaped items will be stacked at floor / ground level in designated stacking areas on a level, firm base capable of withstanding the weight of the commodities being stacked and stacked in such a manner that the items do not topple over or change position due to subsidence or weight

transfer when being moved.

Where these commodities are stacked on shelves or racks, the shelves or racks must be designed to carry the weight of the commodity being stacked. All racks or shelves where heavy material or commodities are stacked will have a weight carrying limitation clearly marked on the structure and have a safety factor of at least +10% of maximum total carrying capacity.

All materials, commodities or articles, which could be damaged due to inclement weather, must be stored under cover. Waste material that is combustible must not be allowed to accumulate in sufficient quantities to create a hazard.

No commodities or equipment may be stacked or stored within 500mm of rolling stock tracks or where mobile equipment travels. The storage of material, small equipment, tools, files and general items in cupboards and on shelves must be neat and controlled at all times. Incompatible substances must not be stored in or on the same cupboard or shelf.

No equipment, tools, files or documents may be stored or stacked on top of cupboards which are higher than 1.5 metres in height.

15.42 Facilities

Sanitary conveniences must be provided and maintained at a rate of at least one shower facility for every 20 workers, at least one toilet facility for every 10 workers, separate male and female changing facilities and sheltered eating areas.

Where chemical toilets are provided, one toilet for every 10 employees must be allocated. All toilets must be cleaned daily, disinfected and provided with toilet paper. All employees making use of these facilities have the responsibility to help keep the facilities neat, clean and hygienic.

Washing facilities, including soap and towels, must be made available for use by the contractor's employees.

Drainage from all washing / toilet facilities must be properly designed and constructed to prevent employee exposure to waste water (and the associated biological hazards). Waste water may not accumulate or stand in pools at any location on the project site.

Change rooms must be provided and must be kept clean and free from odours at all times. No chemicals, except those normally used for domestic cleaning of these facilities, may be stored in the facilities.

No equipment or items (other than those normally associated with hygiene facilities) may be stored in the facilities. All entrances must be constructed in a way to afford privacy to users.

Drinking water must be provided from an approved source. A sheltered (covered) area must be set aside on site to be used as a dining facility (eating area). Adequate seating must be provided for the maximum number of employees. The facility must be kept clean and tidy.

A suitably sized, impervious receptacle (bin) must be provided for the disposal of waste food and other refuse generated at the dining facility. This bin must be emptied and cleaned regularly (i.e. promptly after meal times).

Food may only be consumed in authorised sheltered areas. Adequate refrigerated storage must be provided to the contractor's employees for the storage of food and drinks. Fridges must not be overstocked and must maintain sufficiently low temperatures.

16. Occupational Health and Hygiene

The contractor must ensure that the exposure or potential exposure of his employees to any of the following stressors is assessed and measured:

- Noise;
- Thermal stress (heat and cold);
- Particulates (dust);
- Silica (free crystalline silica);
- Asbestos;
- Gases or vapours;
- Lead;
- Chemicals;
- Ionising radiation;
- Non-ionising radiation;
- Vibration (hand / arm vibration and whole body vibration);
- Ergonomics; and
- Illumination.

If it is determined that exposure levels for a particular stressor are unacceptable, then a monitoring and control plan must be implemented to manage any risk of overexposure.

Note: Where chemical substances are to be used as part of the refurbishment process, the contractor must ensure that the chemical composition of each substance is known.

Carcinogenic (cancer-causing) ingredients must be specifically identified with due understanding that no chemical known to cause cancer will be permitted for use on site (an alternative will need to be sourced).

TRANSNET Health and Hygiene Department is required to provide the following monitoring services where relevant and required:

- Chemical agents =Gases, vapours, solids, fibres, liquids, dusts, mists, fumes, etc.
- Physical agents =Noise, Vibration, Heat, Cold, Electromagnetic fields, lighting etc.
- Biological agents =Bacteria, fungi, etc.
- Ergonomic factors =Lifting, stretching, and repetitive motion.
- Psychosocial factors =Stress, workload and work organisation

TRANSNET Health and Hygiene must provide the contractor with a project specific health risk assessment in respect of existing Occupational Health Risk on Sites.

The contractor must conduct an Occupational Health Risk Assessment in respect of their project activities. The contractor will be required to appoint an Approved Inspection Authority (AIA) for Occupational Hygiene to conduct Occupational hygiene Surveys should such a need arise.

16.1 Lighting

For all work areas and access ways, if the natural lighting available is inadequate it must be supplemented by artificial lighting to meet the minimum levels required.

A lighting survey to determine luminance must be conducted for all work areas, at least once prior to work commencing for the first time in any area.

Emergency lighting must be provided in all indoor workplaces that do not have adequate natural lighting or in which persons work at night. The emergency sources of lighting that are provided must be such that, when activated, an illuminance of not less than 0.3 lux is obtained at floor level, to enable employees to evacuate safely.

Where it is necessary to stop machinery or shut down plant or processes before evacuating the workplace, or where dangerous materials are present or dangerous processes are carried out, the illuminance must not be less than 20 lux.

Windows and translucent sheeting must be kept adequately clean and clear of obstructions as far as reasonably practicable. Light fittings, i.e. lenses and reflectors must be kept clean. If a light intensity meter is used, a valid calibration certificate must be available.

Neon lights must not be installed in areas where moving parts of machinery or equipment cannot be fully guarded, i.e. lathes, bench grinders, etc. in order to eliminate the stroboscopic effect. No person may use a portable electrical light where the operating voltage exceeds 50 volts, unless:

- It is fitted with a non-hygroscopic, non-conducting handle;
- All metal parts which may become live are protected against accidental contact;
- The lamp is protected by means of a guard firmly attached to the handle; and
- The cable can withstand rough use.

No person may use a portable electric light in damp or wet conditions or in closely confined spaces, inside metal vessels or when in contact with large masses of metal, unless:

- The lamp is connected to a source incorporating an earth leakage; and
- The operating voltage of the lamp does not exceed 50 volts.

All lighting on site must comply with the requirements of the Environmental Regulations for Work Places GNR2281 of 16 October, 1987.

16.2 Noise

A hearing conservation program must be implemented and protection against the effects of noise exposure must be provided when the noise exposures equal or exceed an 8-hour time-weighted average sound level of 85 decibels measured on the A-weighted scale of a standard sound level meter at slow response.

For the hearing conservation program to be effective it must include as a minimum:

- Monitoring of the workplace to determine the representative exposure of employees to excessive noise levels;
- An audiometric testing program for employees, which must include:
 - A baseline audiogram for all employees exposed to noise levels equal to or in excess of the standard;
 - Audiograms for each overexposed employee at a frequency determined by the OMP;
 - Analysis of audiogram results with retesting and/or referral to an otolaryngologist or qualified physician when a significant threshold shift (STS) occurs; and
 - Written employee notification of the STS.
- A training program for all employees exposed to noise;
- Provision of personal protective equipment to all affected employees when administrative or engineering controls fail to reduce sound levels to within the levels of the standards.

Monitoring of employee exposures to noise shall be conducted by an Approved inspection Authority (AIA).

The monitoring requirement may be met by either area monitoring or personal monitoring that is representative of employee exposures. Personal monitoring is preferred, and may be required based on the type(s) of noise sources.

For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with local legislation. A person-task specification shall be available for every job category and shall be submitted with an employee for audiometric testing.

Audiometric test results obtained from the pre-employment medical examination for a new employee shall be used as the baseline audiogram. Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise.

Hearing protectors shall not be used as a substitute for the requirement that baseline audiograms be preceded by 14 hours without exposure to workplace noise. Employees shall be notified of the need to avoid high levels of non-occupational noise exposure during this 14-hour period.

Record-keeping for the audiogram shall include, as a minimum:

- Name and job classification of the employee;
- Date of the audiogram;
- The examiner's name;
- Date of the last acoustic or exhaustive calibration of the audiometer;
- Employee's most recent noise exposure assessment.

Audiometric test results shall be maintained in the employee's medical file. To control noise exposure, its three basic elements shall be examined, i.e. source of the sound, travel path, and effect on receiver or listener. Solution of a given noise problem might require alteration or modification of any or all of these three basic elements.

Controlling noise at the noise source can be achieved by the following:

- Select quiet equipment initially. In selecting quiet equipment the following features shall be considered:
 - Low-noise certification;
 - Advertisement of "quiet" operation, evidence of noise control design;
 - Evidence of "lower" and "slower" operating characteristics;
 - Side-by-side noise testing of equipment; and
 - "On-site" or "in operation" inspection of mechanical equipment before purchase.
- Reduce operating noise by considering the following control measures:
 - Reduce impact or impulse noise by reducing weight, size, or height of fall of impacting mass;
 - Reduce speed in machines and flow velocities and pressure in fluid systems;
 - Balance rotating parts – to control machinery noise and vibration of fans, fly wheels, pulleys, cams, etc.
 - Reduce frictional resistance between rotating, sliding or moving parts in mechanical systems: frequent lubrication, proper alignment of moving parts; static and dynamic balancing of rotating parts; correction of eccentricity or "out-of-roundness" of wheels, gears, rollers, pulley, etc.;

- Reduce resistance in air or fluid systems: use of low flow velocities, smooth boundary surfaces of duct or pipe systems, and long-radius turns and flared actions in pipes, etc., to reduce turbulence noise;
- Isolate vibration elements in machinery; install motors, pumps, etc. on most massive part of machine; use belt or roller drives in place of gear trains; use flexible hoses and wiring instead of rigid piping and stiff wiring, etc.
- Apply vibration damping materials such as liquid mastic; pads of rubber, felt, foam or fibrous blankets; or sheet metal visco-elastic laminates or composites to vibrating machine surfaces; and;
- Reduce noise leakage from the interior of machines such as compressors by sealing or covering all openings or applying acoustical materials to machine interiors.

Controlling noise in the transmission path can be achieved by the following:

- Separate the noise source and receiver as much as possible;
- Use sound-absorbing materials on ceiling, floor or wall surfaces as close to the machine as possible;
- Use sound barriers and deflectors in the noise path;
- Use acoustical lining on inside surfaces of such passageways as ducts, pipe chases, or electrical channels;
- Use mufflers, silencers or snubbers on all gasoline or diesel engines, regardless of size; and particularly on equipment when large quantities of high-pressure, high-velocity gases, liquids, steam or air are discharged into the open air; and
- Use vibration isolators and flexible couplers where the noise transmission path is structure borne in character.

Protection for the receiver – when engineering controls fail to reduce the levels to within the levels specified in local legislation, the following measures shall be implemented:

- Personal protective equipment shall be provided and replaced as necessary at no cost to employees;
- Supervisors shall ensure that hearing protective devices are worn by all employees who are exposed to a time-weighted average of 85 decibels or greater and who have experienced a significant threshold shift;
- Employees shall be given the opportunity to select their hearing protectors from a variety of suitable protectors.

Noise zones shall be indicated by means of signs at every entrance to such zones. When noise levels exceed 100 dB(A), a combination of earplugs and earmuffs may be required to achieve protection of the worker. It is important to note that using double protection will add only 5 to 10 dB of extra attenuation above that of a single Hearing Protection Device. Where an earmuff and earplugs are used together, OSHA recommends using this simple calculation: Take the higher rating of the two devices, and add five. Hearing Protection Devices should be worn for the full noise exposure period.

Where an audiometry programme is required, it must meet the following standards:

- All testing must be by pure tone audiometry in an approved audiometry booth or quiet room, with measured noise levels less than 40 dB(A);
- The initial audiogram must be taken prior (minimum of 24 hours) to exposure to significant noise. Further audiograms must be taken periodically; annually where exposures are over 85 dB(A) Leq or where continued deterioration to hearing is occurring;
- Testing must be performed by trained and competent personnel;

- Audiometers must be calibrated according to the manufacturer's guidelines. As a minimum these will be a weekly biological calibration using an employee unexposed to noise, or a bio-acoustic simulator, and an annual quantitative check. All results must be documented; and
- Audiograms must be read by trained persons who will identify any increasing hearing loss and then determine if this is noise induced. Any employee with a significant downward shift in one or both ears (measured as an average non age-adjusted loss from baseline of 10 dB at 2, 3 or 4 kHz) must be retested following removal from noise for a minimum of 24 hours, usually after a days-off period. If the downward shift persists the employee must be reviewed by a physician and improved hearing protection considered.

16.3 Particulate and Gas / Vapour Exposure

Designated areas must be created where:

- It is likely that the 95 per cent upper confidence limit of a Specific Exposure Group's (SEG) mean exposure concentration for agents resulting in chronic effects (such as total inhalable dust, respirable dust, respirable crystalline silica, PAH, fluorides, lead, mercury, asbestos or non-asbestos fibrous materials) exceeds the relevant OEL; and
- Agents with an acute effect, such as particulate hazards, or gases (e.g. CO, SO₂, NH₃, HF, etc.), or vapours exceed 50 per cent of the relevant OEL.

Designated areas must:

- Be identified and mapped, signposted or otherwise clearly communicated to employees working in the area. Signposting, where necessary, must use appropriate wording or symbols on signs to identify the hazard;
- Have a documented respiratory protection programme based on suitable risk assessment and standards, which is applied to employees, contractors and visitors;
- Have regular monitoring of SEGs working in the area; and
- Have a formal review of the practicality of engineering controls at least every two years, or less where it is a critical control for a significant risk.

Particulate and gas / vapour monitoring must be appropriate to the exposure conditions and toxicants, and based on the use of equipment approved by local regulatory authorities, as per documented methods.

Where risk assessment indicates the possible presence of levels of gas or vapour sufficient to cause health effects in less than one shift (e.g. confined space entry), continuous monitoring is required as long as the potential for harm exists.

Employees and contractors must be covered by a medical surveillance programme when:

- Their Specific Exposure Group TWA mean exposure to respirable crystalline silica, total inhalable dust, respirable dust, lead or asbestos is greater than 50 per cent of the relevant OEL;
- The medical adviser considers that it is advisable; or
- There is a legal requirement for medical monitoring.

Where risk assessment indicates a risk of a respiratory condition, assessment programmes must include chest x-rays and / or lung function tests. The test or tests chosen must enable the earliest detection of adverse effects from the exposure of concern. Where indicated, they must meet the following standards:

- High quality chest x-rays will be taken every five years, unless local legislation requires these to be more frequent;
- All chest x-rays for pneumoconiosis surveillance will be read to International Labour Organisation (ILO) standards by an ILO B reader, wherever possible, and if not, by a competent radiologist using verifiable quality criteria;
- Any progression of more than one step on the ILO extended scheme to a reading above 1/0 will be reviewed by a physician;
- Any reading suggesting active lung disease will be reviewed by a physician; and
- All spirometry will be performed by trained staff following the American Thoracic Society guidelines or equivalent and be offered at a frequency determined by the likely rate of detectable change in lung function.

Controls must be of an adequate standard such that surfaces are adequately cleaned to avoid:

- Dust generation due to material dislodgment (e.g. windblown), where practicable; or
- Fume generation from accumulated dust during welding / heating or cutting operations.

Where risk assessment indicates the need to reduce exposures to toxic substances for employees or their families, good personal hygiene must be enforced. The programme must include:

- No smoking, eating or drinking in designated hazard areas;
- Washing of hands and face prior to drinking, eating or smoking;
- Showering at work post shift or after exposure to 'dirty' conditions; and
- Laundering of contaminated clothing by the contractor.

Abrasive blast cleaning must be conducted so as to protect worker health and minimise dust emissions. Substitutes must be used whenever practicable for abrasives containing crystalline silica. However, if such abrasives are used, workers must be aware of the hazards and exposure monitoring conducted. The hazardous properties of alternative materials must be considered before use.

Where required, training in the recognition of signs and symptoms of hazardous particulate and gas / vapour exposure, emergency procedures and preventative measures must be provided.

16.4 Respiratory Protection Devices

The selection of Respiratory Protection Devices (RPD's) must be based on:

- The potential particulate size distribution, gas / vapour types, substance toxicity and likely concentrations;
- Compatibility with the work tasks and other PPE; and
- Comfort (as it affects wear-time) and allowance for adequate communication.

Only RPD's approved by the nominated project management representative may be used. Suitable facilities must be available for cleaning and sanitary storage of RPD's.

Half-mask and full-face air-purifying respirators must NOT be used where:

- The atmosphere is oxygen deficient (< 19.5 per cent);
- The atmosphere is immediately dangerous to life or health (e.g. in areas where CO concentrations are > 1500 ppm, HF > 30 ppm or NH₄ > 300 ppm);
- Gases and vapours are more than ten times their OEL or greater than 1000 ppm for half-mask respirators, or more than 100 times their OEL for full-face respirators; or
- Particulates are more than five times their OEL for half-mask respirators, or more than 50 times their OEL for full-face respirators.

For atmospheres that are oxygen deficient, or contain unknown hazards, or have concentrations of gases and vapours that are unknown, or could potentially exceed levels that are immediately dangerous to life or health, an air-supplied type respirator must be worn.

For effective use of negative pressure RPD's (including disposable RPD's), fit testing must be qualitative and documented as a minimum, although quantitative fit testing is preferred. Fit testing must be performed by a competent person when RPD's are first issued and must be repeated periodically according to legal requirements or two-yearly as a minimum frequency. There must be a policy requiring a clean shaven face when using a negative or neutral pressure RPD for routine tasks, or the use of a positive pressure RPD will be required. A pulmonary function test and medical evaluation may be required to determine whether or not an individual is medically fit to wear a respirator.

For air-supplied RPD's, breathing air must be effectively filtered and / or isolated from plant and instrument air, and isolated from sources of potential contaminants. The quality of the breathing air must be checked for conformance with applicable standards.

The respiratory protection programme must include:

- Periodic inspection of RPD's, including before each use;
- Periodic evaluation of cleaning, sanitising, maintenance and storage practices by competent persons;
- Performance of positive and negative fit checks before each use by RPD wearers to ensure that the respirator is functioning properly; and
- Training at first issue of a RPD and regular refresher training thereafter in accordance with regulatory requirements or at least once every two years.

16.5 Hazardous Chemical Substances

No chemical substance may be brought onto site unless it has been approved for use by the nominated project management representative. The contractor must develop and maintain a hazardous chemical substance register specifying as a minimum the type and volumes of substances on site.

If the contractor wishes to make use of a chemical substance that does not appear on the register, then the contractor must provide the following minimum information to the nominated project management representative for review PRIOR to bringing the substance onto site:

- A detailed 16-point Safety data sheet (SDS) issued by the manufacturer / supplier of the substance;
- The reason for wanting to bring the substance onto site (i.e. the intended use of the substance);
- The proposed method of transportation;
- The proposed arrangements for the safe storage of the substance;
- The quantity to be stored on site;
- The proposed methods for handling / using the substance (including PPE);
- The proposed method of disposal of the waste;
- Proof that the contractor is able to readily provide the necessary first aid measures as specified in the SDS; and
- A risk assessment covering the transportation, use, handling, storage and disposal of the substance with specific reference to the substance's compatibility with other chemicals.

This information must be provided at least five (5) working days prior to the date on which the contractor intends to bring the substance onto site for use. Any chemical substance brought onto site without adherence to the requirements stipulated above shall be removed from site immediately.

If the nominated project management representative approves the substance for use, the contractor must ensure that all necessary precautions are taken concerning the transportation, use, handling, storage and disposal of the substance, and that all required PPE and first aid materials / equipment (as stipulated in the SDS) are readily available on site.

The contractor must ensure that a Safety data sheet (SDS) is obtained for each chemical substance brought onto site. A file, or files, containing all of the SDS's must be maintained and must be readily available to all personnel on site (particularly first aiders) as well as other potentially affected parties (e.g. emergency services personnel, persons from the local community, etc.). The SDS's must be in the language(s) commonly used on site.

The contractor must appoint a trained and competent Hazardous Chemical Substances Coordinator who understands and is able to evaluate the risks associated with a wide variety of substances. This person shall be responsible for:

- Assessing the hazardous properties and risks associated with all chemical substances brought onto site by the contractor and appointed sub-contractors (using the SDS's);
- Determining precautions and safe practices for transportation, use, handling, storage and disposal (including PPE requirements) (using the SDS's);
- Determining first aid and emergency response requirements / procedures (using the SDS's);
- Maintaining the SDS file;
- Managing and monitoring the consumption of inventory; and
- Providing an "as needed" service to site personnel and suppliers.

The risks associated with the transportation, use, handling, storage and disposal of all hazardous chemical substances brought onto site must be assessed and managed by the contractor through a process that incorporates risk reduction using the hierarchy of controls as described as described by this Specification. Whenever a task-based risk assessment is carried out, consideration must be given to the use of chemical substances (e.g. greases, solvents, etc.).

The contractor must provide Safe Work Procedures for the transportation, use, handling, storage and disposal of all hazardous chemical substances to be used on site.

The contractor must provide his employees with all of the Personal Protective Equipment that is necessary to prevent exposure / injury while handling / using the hazardous chemical substances that they will be required to work with. Appropriate PPE must be selected with consideration given to the potential hazards, permeability, penetration, resistance to damage and compatibility with the work tasks.

The contractor's employees must be trained in the safe transportation, use, handling, storage and disposal of the hazardous chemical substances that they will be required to work with or may come into contact with. The training must specifically address PPE requirements (including the correct selection, fitment and use thereof).

All personnel must be trained to understand the potential health effects associated with exposure to hazardous chemical substances and therefore the importance of Safe Work Procedures and PPE. All personnel must be trained on emergency response procedures and first aid measures.

Behaviour-based observations and coaching must include the use / handling of hazardous chemical substances.

An appropriate occupational exposure monitoring and medical surveillance programme must be in place for all personnel potentially exposed to hazardous chemical substances which have the potential to cause immediate or long-term harm.

Emergency showers and eyewash stations must be provided where required by law, or where a risk assessment indicates a need. The emergency showers and eyewash stations must be appropriately located, signposted, and regularly tested and maintained. Employees must receive training on the location and use of the showers / eyewash stations.

An emergency response plan for incidents involving hazardous chemical substances must be in place. Regular and appropriately staged emergency drills (possibly involving external spill response and ambulance support services) must be held and lessons learnt must be incorporated into the emergency response plan.

The contractor must provide appropriate storage facilities for all hazardous chemical substances to be used on site. The storage facilities must be secure and protected from damage. They must also be designed for easy access for firefighting purposes. Where applicable, the storage facility must protect chemical containers from physical damage due to temperature extremes, moisture, corrosive mists or vapours, and vehicles.

The inventory of hazardous chemical substances stored on site must be kept to a minimum. The quantity of each chemical stored must be justifiable.

Storage and segregation requirements for all hazardous chemical substances to be used on site must be based on:

- The quantities of the substances stored;
- The physical state of the substances (solid, liquid or gas);
- The degree of incompatibility; and
- The known behaviour of the substances.

Access to areas where hazardous chemical substances are stored and handled must be limited and controlled.

Every chemical substance container must be adequately and clearly labelled to identify its contents, to indicate precautionary requirements for the substance, and to indicate the date of expiry (if applicable). Pipes used to transfer / convey / distribute chemical substances must be clearly identified (e.g. colour coding). Directional flow must be indicated where practical.

Before any item, equipment or empty container containing a chemical residue is disposed of as general waste, it must be properly decontaminated (where applicable). Before being disposed of, empty chemical containers must also be rendered unusable for carrying water (by puncturing, cutting or crushing them).

Hazardous chemical substance waste (i.e. redundant / expired hazardous chemical substances, containers containing residues, contaminated items / materials, etc.) must be disposed of in accordance with the applicable legislation.

Maintenance, inspection and testing schedules and procedures must be in place for critical equipment associated with hazardous chemical substances. A system must be in place to ensure that the risks are assessed before any changes are made to equipment and / or processes for the transportation, storage, handling, use or disposal of a hazardous chemical substance.

A programme must be in place to continually investigate possibilities / opportunities for replacing hazardous substances with safer alternatives.

16.6 Thermal Stress

Hot areas or activities where employees have experienced or could experience excessive fatigue, muscle cramp, dehydration, dizziness and other symptoms of heat stress must be identified and described.

Where a risk of thermal stress is determined, a competent person must conduct monitoring surveys on site, in consultation with workers.

For defined extreme thermal conditions and job activities, medical examinations must include information about the operator's physiological and biomedical aspects, and an assessment of fitness for the working conditions.

Cold areas or activities where employees have experienced or could experience pain or loss of feeling in extremities, frostbite, severe shivering, excessive fatigue and other symptoms of cold stress must be identified and described.

Workplace thermal stress levels (temperature, air movement, humidity, etc.), activities (work level, etc.) and conditions (clothing, health, etc.) that have the potential to exacerbate thermal stress effects must be adequately characterised and described. Workplace exposure assessment must be repeated according to regulatory requirements or whenever there is a change in production, work organisation, process or equipment which may impact thermal stress levels.

Detailed heat stress assessment of identified tasks or jobs must be tiered to:

- Commence with the use of a simple heat stress index as a screening tool; then, if necessary;
- Use rational heat stress indices in an iterative manner to determine the 'best' control methods for alleviating potential heat stress; and
- Undertake physiological monitoring when exposure times are calculated to be less than 30 minutes, or where high level PPE that limits heat loss must be worn.

Detailed cold stress assessment of identified tasks or jobs must be conducted according to current appropriate guidelines that incorporate a cold stress index, to determine the 'best' control methods for alleviating potential cold stress.

When a risk of thermal stress is identified, the following exposure controls must be implemented:

- An acclimatisation period for new workers and those returning from extended leave or sickness;
- Training in the recognition of signs and symptoms of heat or cold stress, emergency procedures and preventative measures;
- Protective observation (buddy system or supervision); and
- A requirement for self-paced working.

The following exposure controls must be considered by a competent person:

- Work / rest regimes and job rotation based on measurements conducted;
- Suitable rest areas with a provision of cool drinking water and cool conditions for high temperatures, or provision of warm drinks and warm conditions for cold temperatures;
- Selection of appropriate clothing or other PPE for extreme temperature conditions;
- The use of engineering controls; and
- Undertake hot / cold tasks during a cooler / warmer time of the day.

Where thermal stress is assessed to be a risk, the operation must develop a suitable emergency response plan.

16.7 Fitness for Work

The contractor must develop and implement a programme to manage employee fitness for work. All employees working on site for whom the contractor is responsible (i.e. direct employees of the contractor as well as the employees of any appointed sub-contractors) must be subject to this programme.

All safety critical jobs (i.e. roles where fatigue or other causes of reduced fitness for work could lead to serious injury, illness or death to employees, significant equipment / plant damage, or significant environmental impact) must be identified and the risks associated with reduced fitness for work in these roles must be assessed.

A programme to manage these risks must be implemented, and it must include:

- Mechanisms for managing fatigue, stress and lack of fitness;
- An alcohol and other (including prescription, pharmaceutical or illicit) drugs policy that includes testing;
- An Employee Assistance Programme providing confidential access to resources and counsellors; and
- Training and awareness programmes.

Each employee has an obligation to present himself fit for work at the start of the day / shift, and to remain fit for work throughout the work period. Reporting for work under the influence of alcohol or any other intoxicating substance will not be tolerated. Any transgression concerning the alcohol and other drugs policy applicable to the project may result in the offending employee's access to the project premises being temporarily or permanently withdrawn.

Alcohol and drug testing on the project premises will be carried out randomly (as employees report for duty and during the course of the day / shift), following any incidents (all persons involved), and whenever there is reasonable suspicion. Alcohol and drug testing must also be carried out as part of a Pre-Employment Medical Examination.

Sleep deprivation during shift work or from excessive working hours is a known cause of fatigue. Fatigued employees are at increased risk of accidents. Shift system design must consider:

- The effect on worker fatigue;
- The effects of activities carried out during scheduled and overtime hours;
- The impact on sleep cycles of activities such as commuting to and from site; and
- The monitoring and control of working hours.

The contractor is responsible for the administration of the working hours of his employees as well as the employees of any appointed sub-contractors. The maximum working hours per day and the minimum rest times between shifts must be specified in the contractor's Health and Safety Management Plan and must comply with all applicable legislation.

All employees are required to undergo fitness assessments (medical examinations) which must be carried out prior to the commencement of employment on the project, prior to a change in role, periodically based on an employee's individual risk profile, and on termination of employment on the project:

- Pre-Employment Medical Examination – to assess the physical suitability of the person for the role and environment in which he will work (carried out prior to the commencement of employment on the project and prior to induction). The contractor must take note that employee medicals for this project must include a drug test;
- Periodic (Surveillance) Medical Examination – to assess the on-going physical condition of an employee to determine if his role is impacting on his health and whether the employee's fitness level is still adequate for the role he holds (these medical examinations are "risk driven" – the specific protocol followed and the frequency of the examinations will depend on the applicable legal requirements and the employee's individual risk profile as determined by his personal fitness, the nature of his role / duties, and the environment in which he works / occupational health hazards to which he is exposed).
- The periodic medical assessment programme must include:
 - ◆ The identification of modifiable risk factors that may impact fitness for work;
 - ◆ Education and support to maintain health or address identified risk factors; and
 - ◆ Education and support to help employees regain their fitness for work.
- Role Change Medical Examination – to assess an employee's physical suitability for a different role and work environment (carried out prior to a change in role / duties);
- Exit (Post-Employment) Medical Examination – to determine the total physical impact of the work the employee performed (carried out on termination of employment on the project).

Note: The results of an Exit Medical Examination from previous employment will not be accepted as a Pre-Employment Medical Examination.

Note: The medical examinations described above may only be carried out by an Occupational Medical Practitioner (i.e. a medical doctor who holds a qualification in occupational medicine).

A detailed job (role) description and an exposure profile (noise, dust, heat, fumes, vapours, etc.) must be provided for each employee or group of employees. The medical examinations that an employee undergoes must be based on (i.e. the employee's fitness must be assessed against) the information contained in these documents as well as the baseline risk assessment for the work. This information must be made available to the occupational medical practitioner performing the medical examination.

For each role, the medical criteria for fitness must be documented and these must be based on an evaluation of the physical and medical requirements for the role. Depending on the circumstances, certain vaccinations may need to be provided to employees.

The medical examinations carried out for all drivers and operators must include testing / assessment for medical conditions that could affect the safe operation of vehicles or equipment.

Specific testing / questioning must be carried out to determine if an individual:

- Suffers from epilepsy or any other medical condition deemed to be a risk by the occupational medical practitioner;

- Makes use of chronic medication that could affect performance;
- Is colour-blind; or
- Has poor day or night vision.

The medical examinations carried out for employees that are required to work at height must include testing / questioning to determine if an individual suffers from epilepsy, hypertension (high blood pressure) or any other medical condition deemed to be a risk (with regard to working at height) by the occupational medical practitioner. Electricians must be tested for colour-blindness.

With regard to the placement of new employees:

- Prospective employees must be referred to a suitable occupational medical practitioner (doctor) for a "Pre-Employment Medical Examination";
- If an individual is found to be medically "unfit for placement", the doctor will indicate which work activities cannot be performed by the person;
- The individual may still be employed on the project if his medical restrictions can be accommodated and provided that no legislation is transgressed.

A process must be established to manage medical restrictions that may be placed on an employee. For every employee with a medical restriction, regular follow up visits with the occupational medical practitioner must be arranged to ensure that each case is proactively managed.

An employee in a safety critical job must report (to his supervisor) any condition that might impair his ability to safely perform the duties associated with his role. A mechanism must be in place for such reports to be referred to an occupational medical practitioner to determine if the employee is fit to continue with his work.

Proof of all medical examinations (i.e. certificates of fitness signed by an occupational medical practitioner) must be kept on site and these records must be readily available for inspection by the nominated project management representative.

An employee's certificates of fitness must be included in his Personal Profile (dossier). If an Employee Personal Profile (dossier) hasn't already been compiled for a particular employee, then this must be done without delay following the employee's Pre-Employment Medical Examination. No employee may commence work on site without proof that he has undergone a Pre-Employment Medical Examination.

Occupational medical examinations and data interpretation may only be carried out by medical practitioners that are appropriately qualified and certified to do so. Occupational medical data contained in reports to management must be grouped and summarised to ensure that the confidentiality rights of each individual employee are maintained. All occupational medical data and records must be retained for at least 40 years.

16.8 HIV / Aids

The contractor must assess the risks posed by HIV. Appropriate mitigation strategies must be implemented as required. Discrimination towards employees on the basis of actual or perceived HIV status is forbidden. All information on the HIV status and condition of employees including that relating to counselling, care and treatment and receipt of benefits, must be maintained in medical confidence.

HIV / AIDS screening may not be a requirement for recruitment or a condition of employment.

16.9 Contagious diseases i.e. Covid 19

The Principal Contractor must ensure that covid 19 and all other transmittable diseases are handled appropriately in compliance with regulations of hazardous biological agent.

16.10 Measuring and Monitoring

The workplace exposure (or potential exposure) of persons to hazardous substances or agents must be measured and monitored to determine the effectiveness of control measures as well as compliance with legal and other requirements, particularly Occupational Exposure Limits. All such measuring and monitoring must be carried out by an Approved Inspection Authority (i.e. a specialist service provider that is appropriately registered with a governing authority).

A plan for measuring and monitoring occupational exposure must be developed and it must include, as a minimum:

- Detail of what must be measured and monitored, based on a risk assessment and / or identified legal or other requirements;
- The frequency of measurement and monitoring;
- A description of the necessary equipment;
- Data quality requirements and controls (including details on the sample size for statistical validation and any rejection criteria);
- The sampling and analysis method(s) including any laboratory certification requirements; and
- The competency requirements for persons carrying out workplace monitoring.

Each instrument and item of equipment used for occupational exposure measurement and / or monitoring must be:

- Properly maintained to ensure compliance with legislative requirements;
- Controlled and safeguarded from unintentional adjustments;
- Suitably stored and protected from damage; and
- Calibrated or verified against a traceable standard at specific intervals (calibration records must be retained).

Each analytical laboratory service that is used must have implemented a credible quality assurance or quality control programme.

All monitoring results obtained must be analysed on a regular basis to:

- Identify trends and potential exceedances of legal or other requirements (such as Occupational Exposure Limits);
- Identify inconsistent or unusual results;
- Evaluate the effectiveness of existing control measures;
- Measure performance against stated objectives; and
- Identify continual improvement opportunities.

Each exceedance of a specified requirement or limit must be recorded, investigated and reported. Appropriate corrective actions must be identified and implemented.

17. Emergency Preparedness and Response

The contractor must develop, implement, test and maintain an Emergency Response Plan (incorporating emergency evacuation procedures) that focuses specifically on the contractor's team and work activities. The plan must be risk-based and must detail the procedures that must be followed when responding to all potential emergency scenarios such as a medical emergency (including first aid response), a fire, an explosion, a hazardous substance spill, flooding, rescue from height, rescue from a confined space, etc.

Potential off-site emergency scenarios must be included (e.g. emergency scenarios related to the transport of personnel, the transport of hazardous materials, and personnel performing work in remote locations).

Consideration must be given to surrounding Port users and tenants, and to the availability and capability of local emergency services. Details of any arrangements with external emergency response service providers must be included.

The Emergency Response Plan must satisfy and comply with all applicable legal requirements. The plan must be adequately resourced to ensure effective implementation. These resources must include appropriate personnel, external emergency response service providers, emergency response equipment, and warning devices. All equipment and warning devices must be identified, maintained and tested to ensure availability at all times.

Accountability for the Emergency Response Plan must be clearly defined. An Emergency Response Team (ERT) responsible for the implementation, management and execution of the Emergency Response Plan must be established. The roles and responsibilities of each team member must be clearly defined in the plan. Each team member must receive appropriate training to ensure that each role is performed competently.

The process for managing incident communication, notification, and reporting must be incorporated into the Emergency Response Plan. The responsible person(s) must be clearly identified, and the protocols for communicating with internal and external stakeholders must be defined.

Emergency evacuation procedures must be developed and included in the Emergency Response Plan. A copy of the plan must be provided to the nominated project management representative for approval prior to site establishment. The Emergency Response Plan must be formally reviewed (and amended if necessary) when project needs require, and following any emergency situation, to ensure that it remains appropriate and effective.

At each project work site, as a minimum:

- A suitable evacuation alarm (siren) must be provided. All persons working in an area where an evacuation alarm is sounded must respond to it immediately.
- Suitable fire-fighting equipment must be provided and maintained, and personnel must be trained in fire-fighting procedures and the use of fire-fighting equipment.
- Suitable first aid equipment and supplies must be provided and maintained, and an adequate number of appropriately trained First Aiders must be in place.
- Emergency assembly points positioned in safe locations away from buildings, plant and equipment must be designated (and conspicuously signposted). In the event of an evacuation, all persons (i.e. personnel and visitors) must assemble and be accounted for at these emergency assembly points.
- All personnel must receive awareness training on the applicable emergency response procedures, and all visitors entering the site must be properly instructed in these procedures.
- The emergency response procedures must be displayed on each notice board.
- A diagram (site plan) indicating evacuation routes, emergency assembly point locations, and the positioning of emergency equipment (fire extinguishers, first aid boxes, etc.) must be prominently displayed in all buildings and plants, in all offices, on all notice boards, and in other locations on the site as may be required.

- An up-to-date list of emergency telephone numbers must be compiled and maintained. A copy of this list must be posted at each site entrance, in each office, near each telephone, and on every notice board.
- Emergency response drills must be conducted to test the effectiveness of the emergency procedures and equipment, as well as the knowledge and proficiency of the response personnel. Where appropriate, drills must include liaison with and the involvement of external emergency response service providers. A variety of emergency scenarios must be tested including, but not limited to, medical emergencies, fires, rescues, and hazardous substance spills. A drill must be carried out one month after site establishment and then again six months thereafter.

Each drill must be monitored and the outcomes (highlights and shortcomings) must be documented. Corrective actions must be identified and implemented to address the shortcomings, and the Emergency Response Plan and associated procedures must be amended as required.

Refer to the Transnet Health and Safety Management Site Emergency Managements HAS-P-0001.

17.1 Fire Fighting

The contractor must ensure that Fire Fighting requirements are complied with.

17.2 First Aid and First Aid Kits

The contractor must ensure that First Aiders are trained and appointed as described in this Specification and in accordance with relevant legislative requirements.

A suitable first aid kit (i.e. appropriate to the level of training) must be readily available to each First Aider. All kits must be provided and maintained by the contractor.

Taking into account the type of injuries that are likely to occur in the workplace, each first aid kit must contain suitable equipment and supplies. First aid equipment and supplies required by applicable legislation must be provided as a minimum.

The contents of each first aid kit must be kept clean and dry. Each kit must be contained in either a portable weather-proof case / bag or a steel box mounted to a fixed structure. Access to first aid equipment / supplies must be limited to train First Aiders only. Access to portable kit bags must be controlled and steel first aid boxes mounted in the workplace must be kept locked. Approved signage must be in place to indicate the locations of the first aid boxes / bags. A record of each treatment administered must be kept in a suitable register.

No tablets or medication are to be stored in the first aid box.

No tablets or medication to be administered by first aiders or other personnel to employees who are not feeling well or have been injured.

Additional items / supplies may need to be provided depending on the nature of the workplace (specific hazards) and the level of training of the first aider in position of the kit.

18. Management Review

A review of the contractor's Health and Safety Management System must be undertaken as required within the project timeframe to ensure that the system continues to be effective in managing health and safety performance and meeting project requirements.

The review must evaluate if there is any need for change and must identify actions to improve the system.

The review must be led by senior management and the following must be considered:

- The suitability of the policy adopted for the project;
- The impact of changing legislation;
- The management of risk;
- Health and safety objectives and performance indicators;
- Changing expectations and requirements of relevant stakeholders;
- Changes to the contractor's scope, schedule, designs, etc.;
- Changes to the contractor's organisational structure;
- Communication and feedback (particularly from employees, Project representatives, and client representatives);
- The effectiveness of the management of change process;
- Workplace exposure monitoring and medical surveillance;
- The status of corrective actions;
- Performance statistics, including an annual summary of safety statistics, and occupational hygiene monitoring and medical surveillance results;
- Non-conformances (findings) from completed audits;
- Follow up on actions from previous management reviews; and
- Recommendations and opportunities for improving the effectiveness of the management system.

A record of each completed management review must be retained and it must include all decisions and identified actions concerning alterations, modifications or improvements to the management system that demonstrate a commitment to continual improvement.

19. Management of Change

To ensure that proposed changes do not give rise to unacceptable health or safety risk, the contractor must develop and implement a process for identifying and managing change in the workplace (e.g. changes to scope, schedule, procedures, work methods, site conditions, designs, plans, plant and equipment, materials, processes, etc.) that may impact on health or safety performance.

The management of change process must take into consideration that changes may be planned or unplanned, sudden or gradual, temporary or permanent.

The process must aim to ensure that:

- Changes are identified and assessed before they are implemented;
- Careful consideration is given to managing the risks associated with any change;
- Due diligence can be shown to have taken place;
- The number of unsatisfactory or unnecessary changes is minimised;
- The right people are involved in the change process; and
- All statutory requirements are met.

All risks associated with a proposed change must be evaluated and ranked. The risks that are ranked as moderate or higher must be managed to prevent serious injury or illness.

It must not simply be assumed that a change will not result in significant risks. All proposed changes must be formally evaluated. The evaluation or review must include:

- An appropriate level of technical expertise;

- The involvement of the workforce potentially affected by the proposed change; and
- Approval of the change by a person with at least the same level of authority as those who control the existing process or item being changed.

20. Contractor / Sub-contractor Alignment

Processes must be in place to ensure that the health and safety risks associated with the procurement of materials, equipment, services and labour are identified, evaluated and effectively managed.

A process for evaluating a sub-contractor's (or supplier's) ability to provide materials, equipment, services and labour that meet defined specifications must be in place. A prospective sub-contractor's health and safety management expertise, experience and capability (including previous health and safety performance) must be formally assessed prior to any contract or purchase order being awarded.

Each appointed sub-contractor must develop and implement a detailed Health and Safety Management Plan based on the requirements of the contractor's Health and Safety Management Plan and the Health and Safety Specification for the project. This plan must be reviewed and approved by the contractor prior to the commencement of any work.

The properties of all materials provided to the project must be adequately understood, documented and integrated into operating procedures where exposure to these materials presents a significant health or safety risk.

Procedures, commensurate with the evaluated risk, must be in place for the receiving, storing, dispatching and transporting of all equipment and materials.

Before work commences on any contract, all sub-contractor personnel must receive comprehensive orientation and induction training as required by this Specification. All work carried out by a sub-contractor must be managed (activity supervised) throughout the contract period and performance must be reviewed (audited) on a regular basis.

21. Incident (Occurrence) Management

The contractor must establish a procedure for the management of all health and safety incidents. This procedure must define the responsibilities, methodologies and processes that must be followed for:

- Reporting an incident;
- Investigating an incident;
- Analysing an incident to determine the root cause;
- Identifying and implementing corrective actions to prevent a recurrence; and
- Communicating information concerning an incident to relevant persons and / or groups.

Please Note: Arrangements must be in place to ensure that proper medical care is provided to any contractor (or sub-contractor) employee that suffers an occupational injury or illness. These arrangements must be described briefly in the contractor's Health and Safety Management Plan and in detail in the Incident Management Procedure.

An incident may have multiple impacts. For each impact, the Actual Consequence and the Maximum Reasonable Outcome must be evaluated. Each impact must be evaluated independently, with the most significant classification forming the primary rating of the incident.

A near-miss is an incident. All near-miss incidents must be reported.

An incident must be reported on the same work day or shift on which it occurs and preliminary details must be recorded and a TRANSNET Incident Flash Report must be completed and submitted within 24 hours to the relevant TRANSNET representative. Depending on the Actual Consequence, the relevant internal and external parties must be notified in accordance with specified protocols and timeframes, and legislative requirements.

In the event of a significant incident (i.e. an incident with an Actual Consequence of Moderate, Major or Catastrophic), work must cease and must only resume once the necessary actions (including the re-evaluation of any relevant risk assessments) have been taken to eliminate or reduce the risk of recurrence. Work must only be permitted to recommence once formal authorisation has been granted by the Project Construction Manager. In the case of incidents with an Actual Consequence of Major or Catastrophic, work must not be permitted to recommence until authorisation has been granted by the relevant government authorities (i.e. the South African Police, the Department of Labour or the Department of Mineral Resources).

The Project Construction Manager must ensure that an investigation is completed for each incident that occurs, and that appropriately senior personnel participate in, and authorise the outcomes of, each investigation. Incident investigations must be facilitated by competent and experienced persons who have been trained in the appropriate methodology. (e.g IRCAT). .

All significant incidents must be investigated using the approved Transnet investigation methodology. Such an investigation must be facilitated by a trained project representative within 7 calendar days.

For all other incidents other methodologies approved by the Project Health and Safety Manager may be used.

Each incident (including near-miss incidents) must be investigated.

Each incident must be analysed to determine the root cause, and corrective actions must be identified and prioritised for implementation to eliminate or reduce the risk(s) in order to prevent recurrence of the incident.

For each corrective action, a responsible person must be designated and an appropriate timeframe (target date) for completion of the corrective action must be specified. Progress on implementing corrective actions (i.e. closing incidents) must be monitored and reported on. The implementation of corrective actions must be verified during monthly audits by the TRANSNET Project Health and Safety Practitioners but also no later than 30 calendar days after the conclusion of the incident investigation. The contractor must document the results of each investigation and a report must be submitted to the nominated project management representative within a stipulated time frame as determined by the nominated project management representative.

As a minimum, each incident report must include:

- The date, time and location of the incident;
- A detailed description of the incident, including photographs;
- The names of any injured persons;
- Injury details (if applicable);
- A summary of the first aid and / or medical treatment provided (if applicable);

- The current status of any injured persons;
- The root causes of the incident; and
- Detailed corrective actions, including responsible persons and target dates for implementation.

Each significant incident must be summarised for its lessons learnt following the investigation. This information must be reviewed by the contractor's Project Manager to assure completeness, accuracy and relevance before it is shared with (communicated to) all project personnel.

22. Non-conformance

Non-conformance Reports (NCR) will be issued to Contractors upon the identification of non-compliances to this specification. NCR's will be issued to Contractors for their response and implementation of corrective actions. NCR's must be closed out within a 48hour period depending on the severity of the non-conformance.

The contractor must establish a process for identifying and recording corrective actions arising from:

- Non-compliances;
- Incident investigations;
- Hazard identification and risk assessment;
- Measurement and monitoring;
- Improvement plans and suggestions;
- Managing change;
- Audits and inspections; and
- Safety observations and coaching (safety interactions).

The contractor must establish a procedure for managing actions that addresses:

- Identification, categorisation and prioritisation of actions;
- Formal evaluation and approval of actions (management of change process);
- Assignment of responsibilities, resources and schedules for implementation;
- Implementation of actions;
- Tracking and reporting on implementation status; and
- Monitoring and verifying the effectiveness of the actions.

23. Performance Assessment and Auditing

The contractor must establish and maintain programmes for measuring and monitoring health and safety performance on a regular basis. Metrics must include leading and lagging indicators, and be based on qualitative and quantitative data.

23.1 Reporting on Performance

Reports summarising the contractor's health and safety performance on the project must be compiled on a weekly and a monthly basis.

The contractor must be prepared to discuss the content of these reports at scheduled health and safety meetings.

The reports must contain the following minimum information:

- Number of contractor and sub-contractor employees on site;
- Total hours worked on site by contractor and sub-contractor employees (by company);
- Number of incidents by category (i.e. Near-miss, FAI, MTI and LTI);
- Lost Time Injury Frequency Rate (LTIFR) (project to date and 12-month rolling);

- Details of all new incidents for the reporting period and the corrective actions taken or to be taken;
- Feedback (progress updates) on all open incidents and outstanding corrective actions;
- Status and feedback on any employee that may have been injured and has not yet returned to work;
- Details of all health and safety training carried out during the reporting period;
- Number of SOC (Safety Observations and Coaching) carried out during the reporting period;
- SOC trends identified and proposed action for the coming week or month to maintain positive trends and / or address negative trends;
- Details of all audits, inspections and site visits carried out during the reporting period, and the corrective actions taken (or to be taken) to address all non-conformances;
- Feedback (progress updates) on all open non-conformances and outstanding corrective actions;
- Number of Toolbox Talks conducted during the reporting period (monthly);
- Number of Planned Task Observations (PTOs) carried out during the reporting period (monthly);
- Details of all active risk assessments and Safe Work Procedures highlighting those that are due for review in the coming month (monthly);
- A look ahead (to the coming week, month or quarter) to ensure that appropriate health and safety planning and preparation is done for upcoming work;
- Challenges faced with regard to health and safety; and
- Any other health and safety related information specific to the project that may be required.

Leading indicators (e.g. audit findings, observations, etc.) must be analysed, and any negative trends identified with regard to unsafe behaviour or conditions must be appropriately addressed to prevent incidents.

Lagging indicators (e.g. injuries, illnesses, near-miss, etc.) must be investigated in detail to determine the root causes. Corrective actions must be identified, implemented and integrated into Safe Work Procedures to prevent recurrences.

23.2 Audits and Inspections

On a monthly basis, the health and safety management system and workplace activities of the contractor will be audited by a Project Health and Safety Practitioner as well as the project PrCHSA to assess compliance with the project health and safety requirements. Any deviation from these requirements (i.e. non-conformance) that places the health or safety of any person in immediate danger will result in the specific activity being stopped until the non-conformance is corrected.

For each non-conformance determined during any audit, the contractor must identify and implement appropriate corrective actions.

For each corrective action, a responsible person must be designated and an appropriate timeframe (target date) for completion of the corrective action must be specified. Progress on implementing corrective actions (i.e. closing non-conformances) must be monitored and reported on. The implementation of corrective actions will be verified during the monthly audits.

Should it be determined that the contractor's level of compliance is unsatisfactory, all work being performed by the contractor on the project site may be stopped (at the contractor's expense) until an investigation into the reasons for the poor performance has been carried out, a corrective action plan has been developed, and corrective actions have been implemented.

In addition to the audit carried out by the Project Health and Safety Manager/Practitioner and the Agent, the contractor must carry out an internal audit on a monthly basis to assess compliance with the project health and safety requirements (including the requirements of this specification and the contractor's Health and Safety Management Plan). Furthermore, the contractor must ensure that each appointed sub-contractor is audited and measured to the same standard. Copies of these audit reports must be submitted to the Project Health and Safety Practitioner on a monthly basis.

The contractor must carry out internal health and safety inspections as follows:

- General site health and safety inspections on a daily basis; and
- Inspections of plant, tools and equipment prior to establishment or use on site, and at least monthly thereafter.

All audits and inspections must be carried out by competent persons who have been appointed in writing.

A schedule of planned audits and inspections must be compiled and maintained ensuring that:

- All work areas and all activities are covered at regular intervals;
- All applicable legal requirements are complied with; and
- Areas or activities with significant associated hazards or risks receive greater attention.

24. Reference Documents

1. Occupational Health and Safety act, No 85 of 1993 and all relevant Regulations
2. Compensation for Occupational Injuries and Diseases Act, No 130 of 1993
3. TIMS – Contractor Management Procedure 014

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure Q: Health and Safety Baseline Risk Assessment



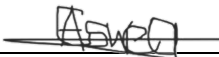
NATIONAL FIRE INFRASTRUCTURE AND EQUIPMENT UPGRADE

PORT OF PORT ELIZABETH FIRE INFRASTRUCTURE PROJECT

Baseline Risk Assessment

Prepared by:  25/04/2025
Nathi Madondo
Health and Safety Practitioner
Date

Reviewed by: *S. Ahmed* 28/04/2025
Sharifa Ahmed
Health and Safety Manager
Date

Approved by:  29 April 2025
Carlin van Aswegen
Project Manager
Date

01	04/2025	For signature
00	05/2024	For review
Rev No.	Date	Revision Details



Baseline Risk Assessment

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2. PROJECT SCOPE.....	4
3. RISK ASSESSMENT.....	4
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1. Definitions and Abbreviations

ABBREVIATION	DESCRIPTION
DSTI	Daily Safe Task Instruction
HME	Heavy Mobile Equipment
SDS	Safety Data Sheet
PPE	Personal Protective Equipment
SWP	Safe Work Procedure
RA	Risk Assessment
H&S Spec	Health and Safety Specification
HCS	Hazardous Chemical Substances

1.1 Project Background

The strategic initiator of the TNPA National Fire Services Infrastructure and Equipment Upgrade Project originated from a study of the existing capabilities of the Fire and Emergency Services of TNPA conducted at the Ports of Cape Town, Saldanha, Richards Bay, East London, Ngqura and Port Elizabeth. The study was conducted by the Fire Protection Association of Southern Africa (FPASA). To date the audit findings are still relevant and sufficient because they emphasize the space limitation and response time posed by the current location of the Fire station within the Port of Port Elizabeth.

The need to upgrade the infrastructure of the Fire Services Department at Port of Port Elizabeth arises mainly from the current inadequate operational space, because:

The current infrastructure does not meet the requirements for proper firefighting, as the current building is too small, and it is shared with other service providers in the port.

The infrastructure does not cater for the new fire services equipment.

The current infrastructure does not have training facilities.

The current Fire Services buildings does not have, Proper change room facilities, Parking garages for equipment, Controls rooms, Lecture rooms and adequate staff kitchen.

The building is not centrally located and does not meet the response time throughout the Port.



Baseline Risk Assessment

2. Project Scope

The scope of this project entails internal architectural, structural, civils, electrical etc. The building will be constructed from the ground and there will be some demolishing works done on an existing building to create more space for the new fire infrastructure building. There will be some camera installation in and around the building to enhance security measures.

3. Risk Assessment



Baseline Risk Assessment

Risk Assessment Title	Baseline Risk Assessment for the fire infrastructure project for the Port of Port Elizabeth

Risk Assessment Team				
	Name	Designation	Contact Number	E-mail
Facilitator	Nathi Madondo	Health and Safety Practitioner	081 853 5321	@transnet.net
Team Member 1	Sharifa Ahmed	Health and Safety Manager	083 400 6108	@transnet.net
Team Member 2	Carlin van Aswegen	Project Manager	083 391 4422	@transnet.net
Team Member 3	Yandisa Siralarala	Snr Construction Manager	060 569 4491	@transnet.net

Activities Covered
This baseline risk assessment focusses on the high-level health and safety hazards and risks anticipated during construction taking into consideration all construction methods.
Geographical location: Gqeberha, Port of Port Elizabeth, Eastern Cape

Risk Controls
Legal requirements pertaining to the specific task step's control measures are assumed to be implemented and will not be repeated in the baseline risk assessment. Proposed Risk Controls focus on unique risks anticipated, and/or specific client requirements.
Scope of Risk Assessment
The risks identified are those that will have a direct effect on the contractors during construction but also those that could have a detrimental effect on the project directly or indirectly from a time delay and / or cost point of view.



Baseline Risk Assessment

	Hazards, Associated Risks, and Ratings						
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
	Occupational Health & Hygiene						
1.	Demolishing of existing building using mechanical machines and or hand breaker machines	Noise exposure due to operation or working in close proximity of where the demolishing is executed, emission of dust and sparks. Release and exposure to material containing asbestos fibres.	Noise induced hearing loss Lung and eyes infection. Asbestosis from exposure to asbestos fibre.	○ Pre employment and exit medical surveillance. ○ PPE needs analyses ○ Compliance to Project H&S Spec. ○ Inductions.	Possible	Major	High
2.	Working in extreme temperatures/ adverse weather conditions	Exposure to extreme ambient temperatures during winter and summer days, UV exposure, windy conditions	○ Adverse health conditions such as heat exhaustion or hypothermia. ○ Lung/chest/eye infections from particles being blown into eyes and inhaled	○ Medical surveillance. ○ PPE needs analyses. ○ Compliance to Project H&S Spec ○ Risk assessments	Possible	Minor	Medium
3.	Manual handling of material	Ergonomic hazards such as awkward work positions, improper lifting	Musculoskeletal injuries, muscle strains; Fatigue	○ Compliance to Project H&S Spec	Rare	Moderate	Low

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
		method, improper tools, and machinery. Heavy load manual handling; repetitive work		(i.e. lifting techniques), - Task based RA, DSTI and Toolbox Talks, - Ergonomic assessment awareness.			
4.	Drilling and cutting of the reinforcement and concrete	Exposure to solid dust. Airborne particles from drilling and noise.	Dust inhalation resulting in respiratory infection (potentially permanent health impact). Lung Irritation / damage to eyes/ red eyes.	- PPE needs analyses, face shield, gloves, dust masks etc. - Compliance to Project H&S Spec, - Medical surveillance - Dust monitoring.	Possible	Major	High
		Exposure to vibration and fumes emitting from drilling and demolition using hand breakers and drillers. Fumes inhalation.	Carpal tunnel syndrome. Effect on employee's kidneys. Respiratory infection i.e. Lung infection.	- Compliance to Project H&S Spec - Risk assessment i.e. health related risks - Medical surveillance - PPE needs analyses i.e. masks	Possible	Major	High

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
5.	Employees interacting and working in limited space	Contact with an infected person or area; Sneezing or coughing without closing the mouth; Unhygienic practices; providing first aid to bleeding employees without proper PPE	Contracting Covid-19, HIV and other contagious illnesses. Spread of diseases and Fatalities.	○ Awareness on infectious diseases ○ PPE needs analyses, i.e. Use of surgical gloves ○ Training and competences	Possible	Major	High
Site Establishment							
6.	Transportation of personnel to site	Un-roadworthy vehicles. Intoxicated driver. Incompetent/unlicensed drivers. Driver disobeying road safety signs and rules. Speeding. Vehicle overloaded. Employees loaded with tools. Vehicle not fitted with seat belts. Vehicles parking in the parking of school workers	Motor vehicle accidents, Injuries and fatalities; property damage.	○ Compliance to National Road Traffic Act (No. 93 of 1996), ○ Compliance to Project H&S Spec, ○ Traffic management plan ○ Service history of vehicles. ○ Adherence to Port rules	Possible	Critical	High

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
		i.e. teacher's reserved parking					
7.	Use of equipment and tools	Improper use of tools and equipment. Incompetent/untrained operators/users. Substandard tools and equipment. No safeguards where required. Homemade tools. No SWP and SOP.	Pinch points, cuts, laceration incidents (caught by, in between) resulting in LTI's, medical treatment cases or First Aid Injuries; damage to property.	- Compliance to Project H&S Spec, - Correct tools for the job and correct use of the tools, - Tool inspection - Machine inspection	Likely	Major	High
8.	Employees facilities	Failure to provide employees facilities on site (i.e. eating and ablution facilities) Poor hygiene exercise	Health risk Environmental impact.	- Compliance to Project H&S Spec - Awareness Training on health and hygiene requirements, - Comply to Facilities Regulations.	Unlikely	Moderate	Medium
9.	Electrical Installations	Incompetent Installers, Unsafe installations due to faulty wiring,	Fatality and Injuries resulting in permanent disabilities (electrocution,	Compliance to electrical regulations	Possible	Critical	High

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
		Lack of insulation & openings, Substandard electrical tools (e.g. portable electrical grinders, drills) being used, Contact with live electrical conductors, Failure to adhere to isolation and lockout procedures,	burns etc.) and property damage	○ Compliance to Project H&S Spec, ○ Training needs analyses, i.e. electrician ○ Certificate of compliance ○ Lockout procedures, ○ Demarcation of exposed wires ○ Risk assessment			
10.	Stacking and Storage	Employees may be exposed to dust from handling of stockpiled material, i.e. sands and cement bags. Incorrect control of stockpile, high stockpile may cause injury to Employees.	Medical Treatment Injury Lost time injury Damage to property.	○ Compliance to Project H&S Spec, ○ PPE compliance, i.e. gloves, ○ Stacking and storage supervision.	Rare	Moderate	Low

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
11.	Site Access Control	Failure to obtain site access certificate. Failure to provide security or prevent unauthorised person entering site. Failure to test for intoxication.	Injuries, property damage/loss and theft incidents	- Security Management procedure, i.e. site access control Plan - Compliance to Project H&S Spec, - Mandatory alcohol testing	Possible	Minor	Medium
Project Construction Activities							
12.	Trucks delivering material to site. TLB and other small plant assisting with construction works.	Defective trucks. Incompetent operator. Intoxicated operator. Medically unfit operator. Lack of plant inspection and service history. Man/machine interface. Congested areas. Speeding of operators. Excessive noise	Multiple injuries/fatalities, property damage Disturbance of school proceedings Property damage caused by operators.	- Compliance to Project H&S Spec, - Inductions - Traffic management plan - Inspection, - Plant service history. - Competence certificates - Medical reports, - Supervision, - Intoxication testing,	Possible	Major	High



Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
13.	Excavation/ Trenching and back filling (i.e. for foundation and sewer system, using hand and machines	Inclement weather (poor visibility conditions i.e. rain, blind spots). Mechanical failure of machines (brakes, steering, park brake, leaks, etc). Machines not in safe and serviceable condition. Unprotected excavations. Noise and Dust. Damage to underground services. Unstable excavation walls (after inclement weather). Underground services being struck/damaged, uneven surfaces. Use of hand tools	Collisions resulting in fatality, Injuries resulting in permanent disabilities, property damage, collapsing of excavation resulting in injuries. Slips, trips and falls. Hand and body injuries. Use of homemade hand tools. Noise induced hearing loss. Lung infection	○ Training competence ○ Supervision ○ Machine service history ○ Project H&S Spec ○ Excavation protection ○ Warning signs. ○ Inspections by appointed personnel. ○ Appointments ○ Risk assessments. ○ Use of latest layout drawings. ○ PPE needs analyses i.e. dust masks and ear protection.	Possible	Major	High



Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
14.	Brick laying	Use of hand tools. Motion repetition Dust Cement contact Working on elevated positions	Injuries/fatalities, property damage, Lung infections.	- Tool inspection. - Risk assessments. - PPE needs analyses, i.e. dust masks, long sleeve overall. - Training and competence. - Training needs analyses, working at height certificate.	Possible	Minor	Medium
15.	Concrete Work (Pouring)	Improper handling of concrete can lead to eyes or skin contact. Holding of concrete weighted equipment. Incompetent concrete mix operator. Slipping and tripping. Concrete spill. Nip points from chutes. Defective concrete plant	Skin and or eye irritation. Back sprain. Incidents (collision) resulting fatality injuries. Environmental impact, (fauna and flora) Injury to employees and property damage.	- SDS - Risk assessment. - Compliance to project H&S Spec, - Medical Surveillance - Competencies - HCS Procedure. - PPE needs analyses i.e. long sleeve overall, footwear, eyes, hand gloves etc.	Rare	Minor	Low

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
				Plant service history.			
16.	Erecting and working on Scaffolding	Incompetence of erectors, Poor inspection, Falling, Inclement weather, Uneven surface, Ground vibration due to trains passing by. Slippery surfaces. Employee under influence	Injuries and fatalities, Property damage.	- Training competence. - Fall protection plan. - Inspections. - Risk assessment. - Medical surveillance. - PPE needs analyses i.e. safety harnesses. - Supervision. - Appointments - Control of substance abuse.	Possible	Critical	High
17	Access and work at height using a ladder	Use of and falling from the ladder. No ladder assistant used to hold the ladder. Defective ladder used. Homemade ladder.	Injury requiring medical treatment. Lost Time Injuries.	- Risk assessment. - Ladder inspection. - Safe working procedure. - Inspections. - Training needs analyses. - Training competence	Possible	Major	High

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
		Improper method used when climbing the ladder.					
18	Install floor and wall tiles	Cutting tiles with grinder Defective grinder Cracked or improper cutting disk Noise Dust Incompetent grinder operator Electrical extension cable with joints Absence of fire extinguisher	Injury to employees Property damage Noise induced hearing loss Eye irritation and chest infection Multiply injuries. Uncontrolled fire	- Tool inspections - Training competence - Safe working procedure. - PPE needs analyses, - Supervision. - Emergence response plan.	Possible	Major	High
19.	Plumbing works	Defective/homemade tools and equipment. Incompetent plumber. Sewer waste spillage and contact.	Cuts, lacerations, bruises. Hand injuries. Poor connection resulting into pipes explosion. dislocation or connected to wrong channel. Health impact.	- Tool inspection - PPE needs analyses. - Risk assessment. - Training competence - Referral to a layout plan.	Rare	Moderate	Low

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
20.	Plastering	Repetitive movements Hand mixing cement with plastering sand Cement spillage to vegetation. Cement contact with eyes and skin. Incompetent person doing the work. Manmade hand tools.	Back sprain. Environmental impact Skin and eye infection. Employee injury	○ Training competence ○ Environmental protection. ○ Compliance to SDS. ○ PPE needs analyses, i.e. long sleeve overalls etc. ○ Supervision	Rare	Moderate	Low
21.	Painting	Repetitive movements Paint splashes in the eye. Exposure to paint fumes. Paint skin contact Incompetent painter Paint spillages.	Back sprain. Eye infection. Inhalation/pulmonary problems. Dermatitis. Environmental Pollution.	○ Training competence. ○ PPE needs analyses, i.e. respirators ○ HCS handling procedure. ○ Compliance to SDS. ○ Spillage handling procedure. ○ Building ventilation	Likely	Minor	Medium

Baseline Risk Assessment

Hazards, Associated Risks, and Ratings							
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
22.	Local community strikes	Community riots.	Injuries. Project delays. Property damage. Theft (Looting).	- Local Economic Development personnel. - Other stakeholder engagement, i.e. local government. - Business continuity plan. - Security Management Plan. - Emergency Preparedness Plan.	Possible	Major	High
23.	Public and Port users during the day and at night	Port users after hours. Construction site intruders. Non reflective demarcation.	Injuries to people. Insurance claims. Damage to properties	- Security measures. - Compliance to project H&S Spec. - Proper demarcation of site. - Emergence response plan.	Possible	Minor	Medium
24.	Close out of construction activities	Poor housekeeping	Injuries to public and port users. Property damages.	- Adherence to project H&S Spec. - Closeout inspection and audit.	Possible	Minor	Medium



Baseline Risk Assessment

	Hazards, Associated Risks, and Ratings						
	Task Steps / Short risk name	Hazards	Associated risk event	Risk controls	Risk rating with controls		
					L	C	R
				○ Rehabilitation			

Monitor and Review the Risk Controls

It is important to monitor risk controls and review risk assessments regularly. Review is required when there is a change in the process, relevant legal changes, and where a cause for concern has arisen. Reviews could be scheduled on an annual basis. If the risk assessment has substantially changed a new risk assessment is warranted.

Baseline Risk Assessment

4. Risk Matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Critical
Almost Certain	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Medium	High	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Low	Medium

Assessed Risk Level	Description of Risk Level	Action Required
Low	If an incident were to occur, there would be little likelihood that an injury would result	Undertake the activity with the existing controls in place
Medium	If an incident were to occur, there would be some chance that an injury requiring First Aid would result	Additional controls may be needed

Baseline Risk Assessment

High	If an incident were to occur, it will be likely that an injury requiring medical treatment would result	Controls will need to be in place before the activity is undertaken
Extreme	If an incident were to occur it, it would be likely that a permanent or death would result	Consider alternatives to doing the activity. Significant control measures will need to be implemented to ensure safety

Likelihood	Description of Likelihood		Consequence	Description of Consequence
1. Rare	Will only occur in exceptional circumstances		1. Insignificant	No treatment required
2. Unlikely	Not likely to occur within the foreseeable future, or within the project lifecycle		2. Minor	Minor injury requiring First Aid treatment (e.g. minor cuts, bruises, bumps)
3. Possible	May occur within the foreseeable future, or within the project lifecycle		3. Moderate	Injury requiring medical treatment or lost time
4. Likely	Likely to occur within the foreseeable future, or within the project lifecycle		4. Major	Serious injury (injuries) requiring specialist medical treatment or hospitalisation
5. Almost Certain	Almost certain to occur within the foreseeable future or within the project lifecycle		5. Critical	Loss of life, permanent disability or multiple serious injuries

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure R: Health and Safety Cost Breakdown Sheet

Tender Health and Safety Cost Breakdown

Tenderer (Company)		Responsible Person	Designation	Date
Project/Tender Title		Project/Tender No.	Project Location / Description	
#	Cost element	Unit Cost (R)	# of Units	Total Cost (R)
1.	Human Resources			
2.	Systems Documentation			
3.	Meetings & Administration			
4.	H&S Training			
5.	PPE & Safety Equipment			
6.	Signage & Barricading			
7.	Workplace Facilities			
8.	Emergency & Rescue Measures			
9.	Hygiene Surveys & Monitoring			
10.	Medical Surveillance			
11.	Safe Transport of Workers			
12.	HazMat Management (e.g. asbestos /silica)			
13.	Substance Abuse Testing			
14.	H&S Reward & Recognition			
15.	Incident Management			

Total Health and Safety Cost (R)	
Total Tender Value (R)	
H&S Cost as % of Tender value	%

Signature:

Designation:

Date:

SCOPE OF WORKS SUPPORTING ANNEXURES:

**Annexure S: Transnet Integrated Management Systems (TIMS)
Commitment Statement – IMS-GRP-GDL-002-1**

Transnet Integrated Management System (TIMS) POLICY COMMITMENT STATEMENT

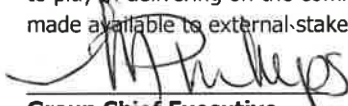
Transnet is a State-Owned Company that operates as an integrated freight transport company. It is structured around six core Operating Divisions, namely Transnet Freight Rail (TFR), Transnet Engineering (TE), Transnet National Ports Authority (TNPA), Transnet Port Terminals (TPT), Transnet Pipelines (TPL) and Transnet Property (TP) as well as the Transnet Academy, a specialised unit, a skills development provider in the transportation, freight, maritime, logistics and associated industries.

Transnet has developed and implemented a Transnet Integrated Management System (TIMS) programme, which sets out Systems, Policies, Procedures and Processes, providing a foundation and framework for conducting its core business. We are committed to **transporting freight, passengers and providing excellent customer service** to our customers along the key transport corridors. Our aim is to **competitively grow our business, enhance customer satisfaction** and ensure **sustainable business development** for the benefit of the South African economy.

TIMS is established, implemented, and maintained in accordance with recognised best practices that will enable us to:

- Incorporate and comply with applicable **legislation, regulations, codes, standards, protocols, best practices and customer requirements** to which we subscribe, in order to achieve our business objectives.
 - Set and achieve **objectives and targets** that address significant enterprise-wide **strategic, tactical, and operational risks, opportunities and mitigate the consequences** thereof.
 - Proactively implement **strategies** to prevent **environmental degradation, protect ecosystems and drive climate change mitigation and adaptation**.
 - Continually promote the prudent and **sustainable** use of **energy and natural resources**.
 - Provide **quality products and services** to meet our customers' requirements.
 - Create a **safe and secure environment** for our employees and stakeholders.
 - Carry out our business in a manner which **protects our assets and information** and **prevents injuries and ill health** to our employees and stakeholders.
 - Promote **safe operational principles** during operations to minimise occurrences.
 - Strategically **source our contractors** through fair, equitable and transparent processes.
 - Provide **socio-economic development** as a good corporate citizen.
 - Uphold **food safety practices** in our food preparation and handling environments.
 - Ensure **proficiency and preparedness** to deal with and **effectively recover** from any **emergency situations**.
 - **Develop, train and manage our employees** through inspirational leadership, providing the necessary **organisational information, knowledge and resources** to achieve the intention of this policy statement.
 - Build relationships based on care, openness, mutual trust and involvement while protecting **personal and confidential information** of internal and external stakeholders. **Communicate, engage, support** and promote TIMS risk awareness culture.
 - Allocate **responsibilities and accountabilities** to meet the requirements of the TIMS Policy Statement.
- Drive an **integrated assurance management programme** to ensure **continual improvement** of TIMS.

The TIMS Policy Commitment Statement shall be **reviewed every three (3) years** or **as circumstances dictate** to ensure that it remains **current and relevant**. Our progress on the achievement of the policy statement commitments shall be reported to the respective Governance Structures. Transnet Leadership, employees and stakeholders have a role to play in delivering on the commitment set out in this policy statement. The TIMS Policy Commitment Statement can be made available to external stakeholders on request.


Group Chief Executive

Date: 10/05/24

Next Review Date: 31 May 2027

SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure T: Contractor's environmental and sustainable specifications Guideline (CESSG) (TRN-IMS-GRPGDL-014.4)

CONTRACTOR ENVIRONMENTAL AND SUSTAINABILITY SPECIFICATION GUIDELINES

Document number	TRN-IMS-GRP-GDL-014.4
Version number	3.0
Classification	Unclassified
Effective date	01 October 2023
Review date	30 September 2028

SUMMARY VERSION CONTROL

VERSION NO.	NATURE OF AMENDMENT	PAGE NO.	DATE REVISED
3.0	• Addition of reference documents (section 3) • Inclusion of additional definitions • Removal of DEA and replacing it with DFFE • Removal of Transnet EO and replacing with Transnet Environmental Resource (PER) • Inclusion of additional abbreviations • Inclusion of minimum environmental requirements for construction (section 5) • Inclusion of details of site inspections/audits (table 1) • Inclusion of Records Management	6-7 7-10 11 12 12-23 23 45	June 2023

Note: Only latest amendments and/or additions are reflected in italics in the body of the document.

DOCUMENTATION SIGN-OFF SHEET

I, the undersigned hereby approve this procedure.

ROLE	CAPACITY/ FUNCTION	SIGNATURE	DATE
Process Owner:	Senior Specialist: Environmental Risk and Compliance		01/10/2023
Accepts document for adequacy and practicability. Comments:			
Approval Committee:	GM: Corporate Sustainability		01/10/2023
Approves document for use. Comments:			

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1. PURPOSE

This document describes the minimum requirements for environmental management to which Contractors must comply. This document must be read in conjunction with the Transnet Construction Environmental Management Standard Operating Procedure (CEM SOP).

In this document, unless the context clearly indicates otherwise:

- Words importing any one gender shall include the other gender;
- The singular shall include the plural and vice versa; and
- Any reference in this document to legislation or subordinate legislation is to such legislation or subordinate legislation at the date of promulgation thereof and as amended and/or re-enacted from time to time.

2. APPLICABILITY

This standard applies to Contractors that work on site under the authority of Transnet SOC Ltd.

3. REFERENCE DOCUMENTS

Name	Applicable Section
Constitution of South Africa, Act 108 of 1996	Section 24
National Environmental Management Act, 107 of 1998	Section 2 National Environmental Management Principles
National Water Act, 36 of 1998	Section 164, Permissible Water Use
National Environmental Management: Waste Act, 58 of 2008	Part 1 15 (1) (i) and (2) Part 6 26 (10) (a) and (b) Schedule 3, Defined Wastes Category A: Hazardous Wastes Part 8: Contaminated Land
Environment Conservation Act, 73 of 1989	Section 20
Occupational Health and Safety Act, 85 of 1993	Asbestos Regulations, 2001

Name	Applicable Section
	Government Notice R155 in Government Gazette 23108 of February 2002 General Safety Regulations-Reg. 2 (2) PPE
GNR 326, 7 April 2017 as amended, EIA Regulations	Chapter 15, Appendix 4
Transnet Environmental Risk Management strategy and Framework	2015:42
Environmental Management Systems ISO 14001: 2015	Clause 5, 6, 7, 8, 9 and 10

4. DEFINITIONS AND ABBREVIATIONS

4.1 Definitions

Compliance	Meeting of all the organization's regulatory requirements
Conformance	The action or fact of conforming to this standard and other internal Transnet policies, procedures, guidelines and best practice.
Construction Environmental Management Standard Operating Procedure	Is a document which is used to define how environmental management will be practiced on any construction site under the management of Transnet to ensure that the environment is considered, negative impacts avoided or minimized, and positive impacts are enhanced.
Contractor	The Principal Contractor as engaged by Transnet for infrastructure construction operations, including all sub-contractors appointed by the main contractor of his own volition for the execution of parts of the construction operations; and any other contractor from time to time engaged by Transnet directly in connection with any part of the construction operations which is not a nominated sub-contractor to the Principal Contractor.

Contractor Environmental and Sustainability Specification Guidelines	A set of minimum environmental standards for all Transnet SOC Ltd-managed construction sites.
Environmental Aspect	Element of an organization's activities or products or services that interacts or can interact with the environment.
Environmental Impact	Change to the environment whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects.
Environmental Risk	The product of the likelihood and severity of an unforeseen occurrence/incident/aspect and the impact it would have, if realised, on the environment.
Fauna	A group of animals specific to a certain region or time period.
Flora	A group of plants specific to a certain region or time period.
General waste	Waste that does not pose an immediate hazard or threat to health or to the environment; and includes:- (a) domestic waste; (b) building and demolition waste; (c) business waste; (d) inert waste;
Indigenous vegetation	Plants that naturally occur in an area.
Liquid waste	Waste that appear in liquid form such as used oil, grease and/or contaminated water or waste water.

Method statement	A document that describes how the Contractor will apply environmental management measures associated with a particular activity during construction.
Monitoring	Determining the status of a system, a process or an activity
Natural Vegetation	All existing species, indigenous or otherwise, of trees, shrubs, groundcover, grasses and all other plants found growing on the site.
Responsible Authority	A Responsible Authority, according to the National Water Act 36 of 1998, relates to specific power or authority in respect of water uses that is assigned by the Minister to a Catchment Management Agency or to a Regional Office.
Rehabilitation	Refers to measures that must be put in place to restore the site to its pre-construction or enhanced state, subsequent to construction taking place.
Scope of Work	The construction work for which the Contractor has been appointed in terms of the Contract with Transnet.
Sensitive area	Any area that is denoted as sensitive by this Specification due to its particular attributes, which could include the presence of rare or endangered vegetation, the presence of heritage resources (e.g. archaeological artefact or graves), the presence of a unique natural feature, the presence of a watercourse or water body, the presence of sensitive social receptors etc. As a minimum, habitats that fall under this definition include: mountain catchments, Ramsar wetland sites, coastal shores, estuaries and endangered ecosystems.
Solid waste	All solid waste, including construction debris, chemical waste, excess cement/ concrete, wrapping materials, timber, tins and cans, drums, wire, nails, food and domestic waste (e.g. plastic packets and wrappers).

Spoil	Excavated material which is unsuitable for re-use as material in the Works or any other use; or is material which is surplus to the requirements of the Works.
Sub -Contractor	is a person or organisation who has a contract with the contractor to: Construct or install part of the contractor's work. Provide a service necessary to provide the works; or Supply plant and materials which the person or organisation has wholly or partly designed specifically for the works.
Temporary Storage	A once-off storage of waste for a period not exceeding 90 days.
Topsoil	Means a varying depth (up to 300 mm) of the soil profile irrespective of the fertility appearance, structure, agricultural potential, fertility and composition of the soil.
Waste	Any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes. Waste or a portion of waste ceases to be a waste only once the waste is, or has been re-used, recycled or recovered.
Wastewater	means water containing waste, or water that has been in contact with waste material
Watercourse	Refers to - a river or spring; a natural channel in which water flows regularly or intermittently;

a wetland, lake or dam into which, or from which, water flows;
and

any collection of water gazetted by the National Water Act, 36 of 1998 as a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Wetland

Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

4.2 Abbreviations

Acronym	Meaning In Full
CEM SOP	Construction Environmental Management Standard Operating Procedure
CM	Construction Manager
CV	Curriculum Vitae
DEFF	Department of Environment, Forestry and Fisheries
EA	Environmental Authorisation
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
CESSG	Contractor Environmental and Sustainability Specification Guidelines
EO	Environmental Officer

Acronym	Meaning In Full
EMP	Environmental Management Plan
EMPr	Environmental Management Programme
EGF	Environmental Governance Framework
NEMA	National Environmental Management Act 107 of 1998
NEM:BA	National Environmental Management: Biodiversity Act 10 of 2004
NWA	National Water Act 36 of 1998
PER	Project Environmental Resource
PES	Project Environmental Specification
PM	Project Manager
SAHRA	South African Heritage Resource Agency
SDS	Safety Data Sheet
SHEQ	Safety, Health, Environment and Quality
TRANSNET	Transnet SOC Ltd

5. MINIMUM ENVIRONMENTAL REQUIREMENTS FOR CONSTRUCTION

5.1 Tender Documents

Any construction-related tender issued to the market must include:

- Transnet Integrated Management System Policy Statement;
- The Transnet Construction Environmental Management Standard Operating Procedure (CEM SOP);
- The Contractor Environmental & Sustainability Specification Guideline; and
- The Project Environmental Specification (PES).

Any construction-related tender must be recommended for issue by the Transnet Project Environmental Resource/s before it is released to the market.

5.2 Project Environmental Specification (PES)

Must incorporate all relevant recommendations of the Environmental Impact Assessment (EIA) and other environmental studies for the project and the relevant conditions of the EA and/or other applicable environmental permit(s) and licence(s), and the Transnet Operating Division's Environmental Management requirements (where applicable) into an environmental performance specification for implementation during the construction phase of the project.

The PES need not be a separate document; however it can be in a format of an appendix/addendum making reference to environmental authorisation(s), permit(s) or licence(s) applicable to the project. In cases where the project does not trigger any of the NEMA listed activities or any permit(s)/licence(s); the PES may be compiled to prescribe additional environmental management measures over and above the measures stipulated in the MERC.

5.3 Contractor's Environmental Policy

The Contractor's Environmental Policy must be signed and dated by Top Management.

The content of the Contractor's Environmental Policy must:

- be appropriate to the purpose and context of the Contractor's organization, including the nature, scale and environmental impacts of its activities, products and services;
- provide a framework for setting environmental objectives;
- include a commitment to the protection of the environment, including prevention of pollution and other specific commitment(s) relevant to the context of the Contractor's organization;
- include a commitment to fulfil compliance obligations; and
- include a commitment to continual improvement of the Contractor's environmental management system to enhance environmental performance

5.4 Contractor's Environmental Management Plan (EMP)

The Contractor's EMP must include:

- the name of the person who compiled the EMP;
- the expertise of the person who compiled the EMP, including a CV;
- a description of the Contractor's scope of work;
- a detailed description of the environmental aspects related to the Contractor's scope of work;
- a map at an appropriate scale which depicts all construction activities including associated structures, and infrastructure and environmental sensitivities affected by the construction footprint , as well as no go-areas and associated buffers;
 - The map must include the following:
 - an accurate indication of the project site position as well as the positions of the alternative sites, if any;
 - road names or numbers of all the major roads as well as the roads that provide access to the site(s)
 - a north arrow;
 - a legend;
 - the prevailing wind direction;
 - site sensitivities, including but not limited to vegetation, wetlands, watercourses, heritage sites, critical biodiversity area/s, World Heritage Site, etc. and it must be overlaid by the study area; and

- GPS co-ordinates (Indicate the position of the proposed activity with the latitude and longitude at the centre point for each alternative site. The co-ordinates should be in degrees and decimal minutes. The minutes should be to at least three decimal places. The projection that must be used in all cases is the WGS-84 spheroid in a national or local projection).
- a description of the impacts and risks that need to be avoided, managed and mitigated during the execution of the Contractor's scope of work including (as relevant);
 - planning and design;
 - pre-construction activities;
 - construction activities;
 - rehabilitation; and
 - operation of Transnet assets.
- a description and identification of impact management outcomes required for the identified aspects;
- a description of proposed impact management actions, identifying the manner in which the impact management objectives and outcomes contemplated above will be achieved, and must, where applicable, include actions to:
 - avoid, modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation;
 - comply with any prescribed environmental management standards or practices; and
 - comply with any applicable local, provincial and national legislation.
- the method of monitoring the implementation of the impact management actions contemplated above;
- the frequency of monitoring the implementation of the impact management actions contemplated above;
- an indication of the persons who will be responsible for the implementation of the impact management actions;
- the timeframe within which the impact management actions contemplated above must be implemented;
- the mechanism for monitoring compliance with the impact management actions contemplated above;

- a program for reporting on compliance, taking into account the requirements of this document;
- an environmental awareness plan describing the manner in which:
 - the Contractor intends to inform his employees of any environmental risk which may result from his scope of work; and
 - risks must be dealt with in order to avoid pollution or the degradation of the environment.
- any specific information that may be required by Transnet.

5.5 Contractor's Environmental Officer (EO)

The Contractor's EO should have relevant environmental qualifications and experience required for the project. The level of qualifications and experience must be in line with the complexity of the Contractor's scope of work coupled with the sensitivity of the site. The level of competency will be determined by Transnet during tender.

5.6 Management of Sub-Contractors

The Contractor must ensure that all his sub-contractors comply with this document in so far as it relates to their specific scope of work or services.

5.7 Pre-Site Access Environmental Governance

The Contractor must appoint the EO recommended in his tender proposal. Should the EO no longer be available, the Contractor must submit a CV of an alternative EO with similar or better qualifications and experience for approval by the Transnet PM and PER. The same principle will apply if the Contractor's EO is replaced for whatever reason at any stage. No construction may take place without a duly appointed Contractor's EO.

The Contractor must provide his EO with all environmental documents provided by Transnet during tender and submitted as a part of the Contractor's proposal.

The Contractor must obtain the contact details of the responsible Transnet PER and Transnet PER and provide these details to his EO.

The Contractor's EO must develop an appropriate environmental file for approval by the Transnet PER, including but not necessarily limited to (the environmental file must always be available and up to date on the construction site):

- Documents from the tender as described above.
- His CV.
- An organogram indicating reporting lines of all Contractor's staff (with names included).
- Contact Information for: the overall responsible person acting on behalf of the Contractor to execute the construction works; Contractor's Construction Manager (CM); Contractor's EO; and all relevant emergency personnel.
- A list of the Contractor's plant and equipment indicating a description of the plant/equipment, its fuel capacity, any hazardous components (oils, greases etc.), individual service/maintenance cycles and noise levels.
- A list of hazardous substances to be used during construction indicating: official substance name from Material Safety Data Sheets (MSDS)/ Safety Data Sheet (SDS); quantity on site; storage method; transport method to site; and period to be used on site. All substances listed must have MSDS/ SDS on site in the environmental file.

The MSDS/ SDS should contain the following minimum requirements:

- Section 1: Product and company name
- Section 2: Hazard identification
- Section 3: Composition/information on ingredients
- Section 4: First aid measures
- Section 5: Fire fighting measures
- Section 6: Accidental release measure
- Section 7: Handling storage
- Section 8: Exposure controls/personal protection
- Section 9: Physical and chemical properties
- Section 10: Stability and reactivity
- Section 11: Toxicological Information
- Section 12: Ecological Information
- Section 13: Disposal Consideration

- Section 14: Transportation
- Section 15: Regulatory Information
- Section 16: Other Information
- Photographic pre-construction report that details the site before any activities commence.
- Site Layout Plan indicating but not necessarily limited to,: access roads, site offices, material laydown areas, stockpile areas and parking areas, waste and effluent storage and handling facilities, entire construction footprint, no-go-areas, sewage and sanitary facilities. The plan must be appropriately drawn on a computer and must be clearly visible and properly scaled.
- A site establishment method statement (minimum requirements for method statements are described below in this document).
- Environmental Induction Material to be used to educate site staff and visitors (minimum requirements for environmental induction are described below in this document).
- An activity-based environmental risk assessment.

The Contractor's EO must submit the environmental file for acceptance to the Transnet PER.

The Contractor must obtain a Site Access Certificate from the Transnet PM before accessing the site.

5.8 Safety Data Sheets

Each hazardous substance used on site must have a valid SDS. The SDS must comply with the requirements of the Occupational Health and Safety Act, 85 of 1993.

5.9 Environmental Induction

The Contractor will ensure that all management, foremen and the general workforce, as well as all sub-contractors, suppliers and visitors to site have attended the Transnet Environmental Induction Programme prior to commencing any work on site. Where new personnel commence work on site during the construction period, the Contractor will ensure that these personnel also undergo the Transnet Environmental Induction Programme and are made aware of the environmental specifications on site.

The Contractor must ensure that all of his personnel understand the requirements of the CEM SOP; MERC; EA, EMPr, relevant permits and licences and PES as relevant to their scope of work.

5.10 Environmental Method Statements

- Environmental Method Statements as identified by the Transnet PER based on the Contractor's activity-based environmental risk assessment will be written submissions by the Contractor to the Transnet CM and PER describing:
- The proposed activity, setting out the plant, equipment, materials, labour and method the Contractor proposes using to carry out an activity;
- The environmental management of site conditions – waste management, housekeeping, site establishment etc;
- Transportation of the equipment to and from site;
- How the equipment/ material will be moved while on site;
- How and where material will be stored;
- The containment (or action to be taken if containment is not possible) of leaks or spills of any liquid or material that may occur;
- Timing and location of activities;
- Description of potential positive and negative environmental impacts and how they will be managed;
- Conformance/ non-conformance with this document and any other statutory and best practice standards;
- Monitoring and reporting requirements;
- Records Management; and
- Any other information deemed necessary by the Transnet CM and Transnet PER as well as ECO where applicable.

The Environmental Method Statements will enable the potential positive and negative environmental impacts associated with the proposed construction activity to be identified and mitigation measures put in place. All method statements must be signed by the Contractor, Transnet CM and PER, with the addition of the ECO on authorized projects, thereby indicating that the works will be carried out according to the methodology described therein.

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. This will be highlighted in the Project Environmental Specification, where applicable.

All changes to the original Environmental Method Statements must be approved by the Transnet PER and Transnet CM prior to implementation.

To enable timely approvals, the environmental method statements will be submitted to the Transnet CM and Transnet PER for review two (2) weeks prior to the intended date of commencement of the activity, or as directed by the Transnet Project Manager/CM.

Emergency construction activity Environmental Method Statements may also be required. The activities requiring Environmental Method Statements cannot commence if they have not been approved by the CM and PER or ECO.

NOTE: No advice, approval of method statements or any other form of communication from Transnet will be construed as an acceptance by Transnet of any obligation that indemnifies the Contractor from achieving any required level of performance. Further, there is no acceptance of liability by Transnet which may result from the Contractor failing to comply with the specifications, i.e. the Contractor remains responsible for achieving the required performance levels.

5.11 Environmental Occurrences (Incidents)

The Transnet PER shall provide the Contractor with the procedure to follow in managing environmental occurrences during pre-site access governance.

The Contractor shall follow the procedure provided to him by the Transnet PER and maintain required records thereof.

In the event of an environmental occurrence, the Contractor must, as soon as is reasonably practicable:

- classify an environmental occurrence in line with the Transnet Environmental Management Occurrence process flow;

- take all reasonable measures to contain and minimise the effects of the occurrence, including its effects on the environment and any risks posed by the occurrence to the health, safety and property of persons;
- undertake cleanup procedures;
- remedy the effects of the occurrence; and
- assess the immediate and long-term effects of the occurrence on the environment and public health

5.12 Environmental Non-Conformances (Defects)

Environmental Non-Conformances shall be handled as per the terms and conditions of the Contract.

The Transnet PER shall provide the Contractor with the procedure to follow in managing environmental non-conformances during pre-site access governance.

The Contractor shall follow the procedure provided to him by the Transnet PER and maintain required records thereof.

The Transnet Project Manager shall ensure that all Non-conformances are appropriately closed out within the timeframe specified in the Non-Conformance Report.

Any environmental non-conformance will be dealt with similarly to a Defect as defined in the Contract. A defect is due to non-compliance with the Works Information and it is the responsibility of the Contractor to correct the defect in order to ensure that the work takes place in accordance with the Works Information. Similarly, non-conformance/non-compliance with any other permit or licence will be regarded as a non-conformance with the Works Information. The Contractor is responsible for rectifying any defect (non-conformance) as defined above promptly.

The Contractor's EO shall be responsible to search for and identify non-conformances with the environmental specifications at inspection intervals agreed to with the Transnet PER. The Transnet PER shall also undertake such inspections on a monthly basis. If such monthly inspections indicate that any part of the Contractor's work is non-conformant with the environmental requirements, the Transnet PER shall advise the Transnet PM to issue a Defects Notification to the Contractor accordingly. The Contractor shall correct the non-

conformance (defect) within the timeframes specified in the report and notification and submit proof of such correction to the Transnet PER.

The Transnet PER shall not recommend that a Site Closure Certificate be issued to the Contractor if any non-conformances have not been properly closed out. In such an event, the Transnet Project Manager may also make use of any reasonable contractual means to rectify the non-conformance(s) as allowed by the Contract (retention moneys etc.).

5.13 Community Grievances (Public Complaints)

The Transnet PER shall provide the Contractor with the procedure to follow in managing community grievances during pre-site access governance.

The Contractor shall follow the procedure provided to him by the Transnet PER and maintain required records thereof.

5.14 Environmental Inspections and Audits

Environmental inspections and audits may be conducted using five basic techniques:

- Interviews with Contractor's staff including Sub-contractors and suppliers;
- Document review;
- Observations;
- Monitoring; and
- Measurement and verification.

Table 1 sets out the areas and aspects of the construction site that will be inspected or audited, the frequency of such inspections/audits, the inspector/auditor and the inspected party/auditee. It should be noted that the list is not exhaustive and that each site will have specific issues that will need to be inspected/audited.

Table 1: Details on Environmental Inspections/Audits (where Transnet is the Inspected Party/Auditee, respective Contractors must give full cooperation).

Place	Inspector/Auditor	Inspected Party/Auditee	Inspection/audit frequency
Construction Site	Contractor's Environmental Officer	Contractor	Daily/Weekly Inspection
Project (including all construction sites).	Transnet Project Environmental Resource/Project Environmental Manager	Contractor	Monthly Inspection
Project (including all construction sites)	Transnet Environmental Specialist: Assurance	Transnet Project Environmental Resource	As stipulated on the annual audit plan
Project (as defined in Environmental Authorisation)	Environmental Control Officer	Transnet (represented by Transnet Environmental Resource)	As stipulated in the Environmental Authorisation
Project (as defined in Water Use Authorisation)	Independent Auditor	Transnet (represented by Transnet Environmental Resource)	As stipulated in the Water Use Authorisation

The Contractor's EO will be required to conduct inspections of all work areas for which the Contractor is responsible, at intervals agreed to with the Transnet PER. Monitoring shall

be conducted as per the Contractor's approved EMP and all required records shall be maintained by the Contractor.

The Transnet PER will be required to conduct inspections of all work areas for which the Contractor is responsible on a monthly basis or at intervals agreed to with the Transnet Project Environmental Manager. Monitoring shall be conducted as per the Project Environmental Specification. The Inspection Checklist to be used shall be approved by the Transnet PER prior to each inspection.

5.15 Contractor's Environmental Performance

The Transnet PER will explain how the Contractor's performance will be scored during pre-site access governance to the Contractor's EO. The standard/minimum requirement for all environmental inspections will be 90%.

5.16 Site Planning and Establishment

The Contractor shall establish his construction camps, offices, workshops, eating areas and any other facilities on the site in a manner that does not adversely affect the environment. These facilities must not be sited in close proximity to sensitive areas; the buffer to be determined by the ecological requirements of the fauna/flora found on-site.

The site offices should not be sited in close proximity to steep areas. It is recommended that the offices, and in particular the ablution facilities, aggregate stockpiles, spoil areas and hazardous material stockpiles be located as far away as possible from any watercourse.

5.16.1 Site Layout Plan

The Site Layout Plan must as a minimum include but not limited to:

- Detailed layout of the construction works areas including access roads, site offices, material laydown areas, temporary stockpile areas and parking areas;
- Detailed locality and layout of all waste storage and handling facilities for litter, kitchen refuse and workshop-derived effluent;
- Proposed areas for the stockpiling of topsoil and excavated spoil material;
- Demarcation of the construction footprint including areas not to be disturbed by the development;

- Location of sewage and sanitary facilities at the site offices and staff accommodation at all localities where there will be a concentration of labour.

Any changes to the location of the facilities and site activities as per the approved site layout plan shall be re-submitted to the Transnet CM and Transnet PER for approval prior to implementation.

The Contractor may be required to submit a separate layout plan dealing only with his site camp. If so this will be specified in the PES.

5.16.2 Identification and Establishment of Suitable Access Routes/Roads

Existing access routes to the construction/works areas must be used as far as possible. The building of access roads must be restricted to prevent unnecessary disturbance of the surrounding environment. Access tracks must be maintained in a good condition at all times during construction to minimize erosion and dust generation.

5.16.3 Demarcation of Site Limits

Prior to the commencement of construction, the site must be clearly demarcated by means of visible barriers. Vegetation within the demarcated zone may be cleared only upon obtaining approval from the Transnet PER. No activities are allowed outside of the approved footprint on the Site Layout Plan.

5.16.4 Eating Areas

The Contractor is responsible for providing adequate eating facilities within the works area to ensure that workers do not leave the site to eat during working hours. Refuse bags/bins must be provided at all established eating areas and when full it should be disposed of appropriately.

5.16.5 Liquid Waste Management

Liquid waste water from site shall be stored on-site in a properly designed and constructed system, situated so as not to adversely affect water courses. Only domestic type wastewater, i.e. toilet, shower, basin, kitchen water shall be allowed to enter the designated system.

5.17 Sewage and Sanitation

The Contractor is responsible for providing adequate sanitary facilities including toilets, toilet paper, wash basins etc. to all workers on site and for enforcing the proper use of these facilities.

Toilet facilities shall be serviced regularly and the waste material generated from these facilities shall be disposed of at a registered waste water treatment works/macerator and relevant permits for transportation of waste and proof of servicing and disposal shall be maintained.

Toilets and latrines shall be easily accessible and shall be positioned within walking distance from wherever employees are employed on site, and away from sensitive areas. Use of open areas (i.e. the veld) is not allowed. For projects of high mobility a mobile toilet facility shall be made available by the Contractor.

Outside toilets shall be provided with locks and doors and shall be secured to prevent them from blowing over. Toilets must not be placed in areas susceptible to flooding and high winds. The Contractor shall arrange for regular emptying of toilets and shall be entirely responsible for enforcing their use and for maintaining such facilities in a clean, orderly and hygienic condition to the satisfaction of the Transnet CM.

5.18 Waste Management

Waste shall be grouped into “**general**” or “**hazardous**”, depending on its characteristics. The classification shall determine handling methods and the ultimate disposal of material.

General waste which is likely to be generated on site during construction include but not limited to the following:

- Trash (waste paper, plastics, cardboard, etc.) and food waste from offices, warehouses and construction personnel;
- Uncontaminated construction debris such as used wood and scrap metal; and
- Uncontaminated soil and non-hazardous rubble from excavation or demolition.

The Contractor shall classify all waste expected to be generated during the construction period. Examples of typical construction waste which could be expected on the site and how they should be classified are indicated in the following table:

TABLE 2: EXAMPLE OF CONSTRUCTION WASTE CLASSIFICATION

Waste	Classification	
	Hazardous	General
Aerosol containers	X	
Batteries, light bulbs, circuit boards, etc.	X	X
Clean soil		X
Construction debris contaminated by oil or organic compounds	X	
Domestic waste		X
Empty drums (depends on prior use)	X	X
Empty paint and coating containers		X
Explosive waste	X	
PCB waste	X	
Rubble (not contaminated by oil or organic compounds)		X
Waste Cable		X
Waste plastic		X
Waste paint and/or solvent	X	
Waste oil	X	
Waste concrete		X
Waste cement powder	x	
Waste empty cement bags (must be thoroughly decanted)		x
Waste containing fibrous asbestos	X	
Waste timber		X
Sewerage sludge	X	
Scrap metal		X

Waste	Classification	
	Hazardous	General
Chemically-derived sanitary waste	X	

Waste will be managed in accordance with the Waste Management Hierarchy depicted in Figure 1 below:

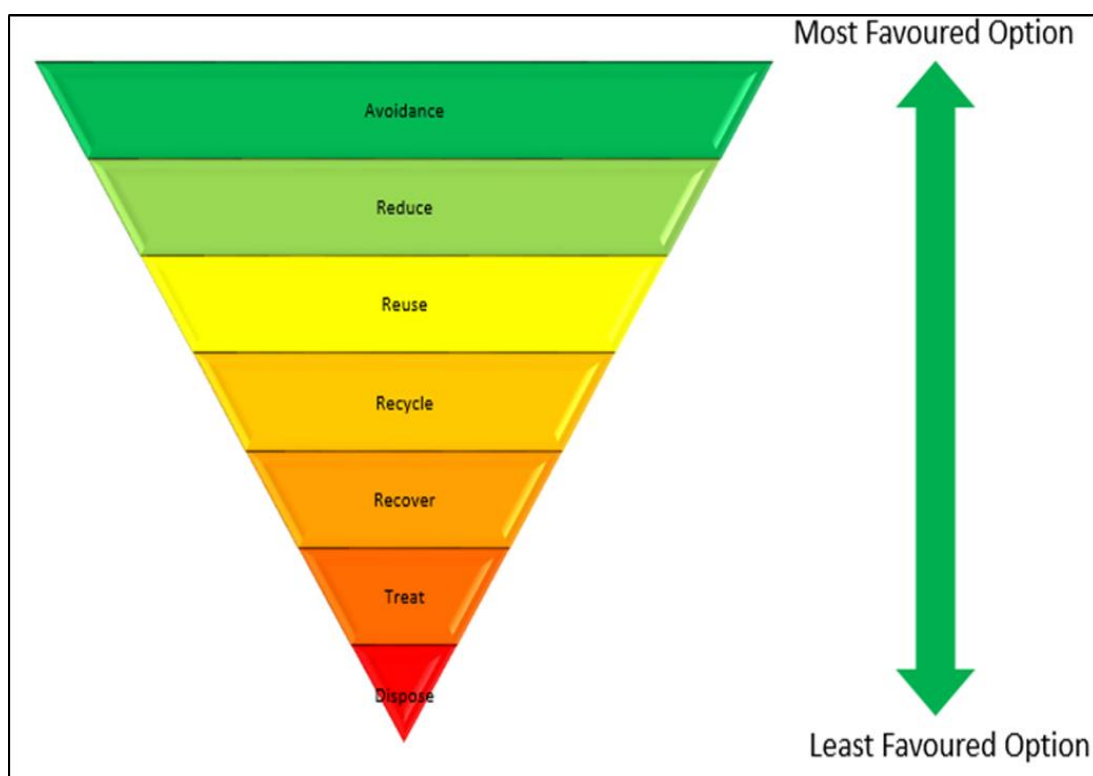


FIGURE 1: THE WASTE MANAGEMENT HIERARCHY

(Transnet Environmental Risk Management strategy and Framework, 2015:42)

- 1. Avoidance/Prevention:** using goods in a manner that minimises their waste components
- 2. Reduction/Minimisation:** reduction of the quantity and toxicity of waste generated during construction
- 3. Re-use:** removing an article from a waste stream for use in a similar or different purpose without changing its form or properties

4. Recycling:	separating articles from a waste stream and processing them as products or raw materials
5. Recovery:	reclaiming particular components or materials, or using the waste as a fuel
6. Treatment:	processing of waste by changing its form or properties in order to reduce toxicity and quantity
7. Disposal:	burial, deposit, discharge, abandoning or release of waste

The Contractor is responsible for the removal of all waste generated from site. The Contractor shall ensure that all waste is removed to appropriate licensed waste management facilities. (For the identification of an appropriate facility, the following source may be utilized: <http://sawic.environment.gov.za/>).

The Contractor shall manage **GENERAL WASTE** that is anticipated to be generated by operations as follows:

- Notify waste hauler when container is full so that it can be removed and replaced with an empty container/skip;
- No littering is allowed on site. In the event where staff mobility is high, refuse bags will be made available by the Contractor;
- Provide documented evidence of proper disposal of waste (Waste Disposal Certificate)

The Contractor shall recycle **GENERAL WASTE** (as far as practically possible) that is anticipated to be generated by its operations as follows:

- Obtain and label recycling containers for the following (whichever relevant) and locate them at secure designated locations on site:
 - Office Waste;
 - Aluminium;
 - Steel;
 - Glass;
 - Ferrous Metals;

- Non Ferrous Metals; and
- Waste Timber
- Establish recycled material collection schedule;
- Arrange for full bins to be hauled away;
- Spent batteries, circuit boards, and bulbs, while non-hazardous, require separate storage, special collection and handling; and
- No burning, burying or dumping of waste of any kind will be permitted.

The Contractor shall manage **HAZARDOUS WASTE** anticipated to be generated by his operations as follows:

- Obtain and provide an acceptable container with correct and visible classification label;
- Place hazardous waste material in allocated container;
- Inspect the container on a regular basis as per the Contractor's EMP;
- Track the accumulation time for the waste, haul the full container to the registered hazardous disposal site;
- Notify the waste hauler when container is full so that it can be removed and replaced with an empty container/skip; and
- Provide documented evidence of proper waste disposal of the waste (Waste Disposal Certificate).

The Contractor shall maintain the following waste records for submission to the Transnet PER on request:

- Date of waste management activity;
- Activity Type (reuse, recycle, recover, treat, dispose);
- Description (e.g. contaminated soil, medical waste, tyres, plastic, domestic waste etc.)
- Classification (General/Hazardous);
- Estimated Quantity in kilograms
- Disposal Site Name and Reference Number (where relevant);
- Method of Transport; and
- Signed Collection or Disposal Records

5.19 Workshops, equipment maintenance and storage

All vehicles and equipment must be kept in good working order to maximise efficiency and minimise pollution. Maintenance, including washing and refueling of plant on site must be done at designated locations approved on the Site Layout Plan. The Contractor must ensure that no contamination of soil or vegetation occurs around workshops and plant maintenance facilities.

All machinery servicing areas must be bunded. Stationary plant that leak harmful substances shall not be permitted on site. Washing of equipment should be restricted to urgent maintenance requirements only. Adequate wastewater collection facilities must be provided and the wastewater should be disposed of appropriately in accordance with its waste classification.

5.20 Vehicle and Equipment Refueling

5.20.1 Stationary/Designated Refuelling

No vehicles or machines shall be serviced or refueled on site except at designated servicing or refueling locations included on the approved Site Layout Plan.

The Contractor shall provide details of his refueling activities in his EMP or Refueling Method Statement. Facility design shall comply with the regulations of the National Water Act, (Act 36 of 1998), the Hazardous Substances Act, (Act 15 of 1973), the Environmental Conservation Act, (Act 73 of 1989), National Environmental Management Act, (Act 107 of 1998), and the Occupational Health and Safety Act, (Act 85 of 1993), mainly the Construction - and Hazardous Chemical Substances Regulations.

5.20.2 Mobile Refuelling

In certain circumstances, the refueling of vehicles or equipment in a designated area is not a viable/practicable option and refueling has to be done from a tank, truck, bowser or container moved around on site. In such circumstances, the Contractor may request approval from the Transnet CM to conduct mobile refueling subject to the following control measures:

- Secondary containment equipment shall be in place. This equipment shall be sized to contain the most likely volume of fuel that could be spilt during transfer.

- Absorbent pads or drip trays are to be placed around the fuel inlet prior to dispensing.
- Mobile refueling units are to be operated by a designated competent person.
- The transfer of fuel must be stopped prior to overflowing. Fuel tanks or refueling equipment on vehicles may only be filled to 90% carrying capacity.
- Mobile fuelling equipment must be stored in areas where they are not susceptible to collisions.
- Mobile refueling operations shall not take place within 30 meters of any watercourses or 7.5 meter from other structures, property lines, public ways or combustible storage.

All mobile refueling tanks are to be properly labelled and fire extinguishers with valid service dates shall be located near the fuel storage areas. These extinguishers must be of a suitable type and size.

5.21 Spill Response

The Contractor shall have adequate spill response materials/equipment on site which must be aligned with the volumes of hazardous substances used on site and the risk of pollution to sensitive environmental features.

The Contractor shall have an approved Spill Response Plan, either in his EMP or in the form of a method statement approved by the Transnet CM and Transnet PER.

The Contractor shall instruct construction personnel on the following spill prevention and containment responsibilities:

- All plants to be inspected daily to ensure that they are in good condition;
- Immediately repair all leaks of hydrocarbons or chemicals;
- Take all reasonable measures to prevent spills or leaks;
- Do not allow sumps receiving oil or oily water to overflow;
- Prevent storm water runoff from contamination by leaking or spilled drums of oil or chemicals; and
- Do not discharge oil or contaminants into storm water or sewer systems.

If a spill occurs on land, the Contractor must:

- Immediately stop or reduce the spill;

- Contain the spill;
- Recover the spilled product;
- Remediate the site;
- Implement actions necessary to prevent the spill from contaminating groundwater or off-site surface water; and
- Manage the contaminated material in accordance with Waste Management requirements in this document.

Any spill to water has the potential to disperse quickly, therefore, the spill must be contained immediately using appropriate containment equipment.

If a spill to water occurs, the Contractor must:

- Take immediate action to stop or reduce the spill and contain it;
- Notify the appropriate on-site authorities;
- Implement actions necessary to prevent the spread of the contamination by deploying appropriate absorbent material;
- Recover the spilled product; and
- Manage the contaminated material in accordance with Waste Management requirements in this document. Water samples to be taken downstream from where the spill took place to trace the extent of pollution.

All spills must be recorded as occurrences and managed in accordance with the requirements for Occurrences in this document.

5.22 Spray Painting and Sandblasting

Spray painting and sandblasting must be kept to a minimum. All painting must, as far as practicable, be done before equipment and material is brought on site. Touch-up painting is to be done by hand painting or as per the approved EMP or Method Statement.

The relevant Contractor will inform his EO when and where spray painting or sandblasting will be carried out prior to commencement of work. The Contractor's EO will monitor these activities to ensure that adequate measures are taken to prevent contamination.

Sand may only be acquired from approved commercial sources and in instances where sand is collected from the natural surrounds, such collection must be approved by the Transnet PER.

If the area is in confined or high (elevated) areas, a protection plan must be issued for approval by the Transnet PER.

5.23 Dust Management

The usage of water for dust management will be minimized as far as practically possible. Discretion must be applied in this regard especially relating to drought conditions. Only water from approved sources may be used. Dust control measures must be approved by the Transnet PER prior to commencement of the Works.

The following minimum dust management practices must be implemented on site:

- Vehicles must be operated within speed limits, where no speed limit has been specified, the limit shall be 40km/h;
- Haulage distances must be minimized as far as reasonable practicable;
- Where water suppression is insufficient or impractical, environmentally friendly soil stabilizers must be used;
- Stockpiles and open areas that may cause dust must be stabilized and vegetated where required;
- Dust suppression measures must be implemented on inactive construction areas. (An inactive construction site is one on which construction will not occur for a month or more);
- Disturbance of natural vegetation must be minimized to reduce potential erosion, runoff, and air-borne dust;
- Material in transit must be loaded and contained within the load bin of the vehicle in such a way as to prevent any spillage or creation of dust clouds. If necessary, the load bin of the vehicle shall be covered with a tarpaulin;

5.24 Storm Water and Dewatering Management

Apart from runoff from overburden emplacements and stock piles, storm water can also be contaminated from batch plants, workshops, vehicle wash-down pads, etc., and contaminants during construction may include hydrocarbons from fuels and lubricants, sewerage from employee ablutions and excess fertilizer from rehabilitated areas, etc.

Discharges to controlled waters such as the sea, rivers, and groundwater or to sewerage systems are controlled under South African Water Legislation. The following specific measures are required:

- Temporary drainage must be established and maintained on site during the construction period until permanent drainage is in place. Secondary drainage that prevents erosion must be provided, where necessary.
- Contractors must employ good housekeeping in their areas to prevent contamination of drainage water.
- Stagnant water shall be cleared at a frequency approved by the Transnet PER.
- Any surface water flows off-site must be approved by the Transnet PER. Where necessary, silt traps shall be constructed to ensure retention of silt on site and cut-off ditches shall be constructed to ensure no runoff from the site except at points where silt traps are provided. The Contractor shall be responsible for checking and maintaining all silt traps for the duration of the project.
- The removal from groundwater is defined as a water-use under the National Water Act 36 of 1998. Therefore, it must be ensured that the project has been authorised by the Responsible Authority to remove and discharge groundwater prior to dewatering taking place. If applicable, the Contractor shall be responsible for collection, management, and containment within the site boundaries of all dewatering from all general site preparation activities.
- On-site drainage shall be accomplished in accordance with a plan approved by a suitably qualified civil engineer.

5.25 Erosion Control

Erosion control measures will be designed, implemented, and properly maintained in accordance with best management practices which will include, but not limited to the following:

- Activities must be scheduled to minimise the extent of disturbance of an area at any one time;
- Re-vegetation must be implemented as early as feasible;
- Construction traffic must be properly managed and controlled;
- Areas must be graded to the extent feasible at drainage ditches;
- Loose soil will be compacted as soon as possible after excavation, grading, or filling;
- Silt fences, geo-textiles, temporary rip-rap, soil stabilisation with gravel, diversionary berms or swales, small sedimentation basins must be used;
- The transport of sediment must be minimised;
- An erosion and sedimentation control plan must be developed, approved by the Transnet PER and communicated to staff; and
- The Contractor shall be responsible for checking and maintaining all erosion and sedimentation controls.

5.26 Noise Management

- The following specific measures are required:
- Keep all equipment in good working order;
- Operate equipment within its specification and capacity and don't overload machines;
- Apply regular maintenance, particularly with regards to lubrication;
- Operate equipment with appropriate noise abatement accessories, such as sound hoods;
- Relevant stakeholders shall be notified of any excessive noise-generating activities that could affect them;
- Ensure that the potential noise source will conform to the South African Bureau of Standards recommended code of practice, SANS 10103:2004 or the latest at the time, so that it will not produce excessive or undesirable noise when released;

- All the Contractor's equipment shall be fitted with effective exhaust silencers and shall comply with the South African Bureau of Standards recommended code of practice, SANS 10103:2004 or the latest at the time, for construction plant noise generation
- Contractor's vehicles shall comply with the Road Traffic Act, (Act 29 of 1989) when any such vehicle is operated on a public road.
- If on-site noise control is not effective, protect the victims of noise by ensuring that all noise-related occupational health provisions are met. (Occupational Health and Safety Act, (Act 85 of 1993).

5.27 Protection of Heritage Resources

5.27.1 Archaeological Sites

If an artefact on site is uncovered, work in the immediate vicinity shall be stopped immediately. The Contractor shall take reasonable precautions to prevent any person from removing or damaging any such article and shall immediately upon discovery thereof inform the Transnet CM and Transnet PER of such a discovery. The South African Heritage Resources Agency (SAHRA) or relevant Authority is to be contacted and will appoint an Archaeologist to investigate the find. Work may only resume once clearance is given in writing by the Archaeologist.

5.27.2 Graves

If a grave is uncovered on site, or discovered before the commencement of work, all work in the immediate vicinity of the grave shall be stopped and the Transnet CM and PER informed of the discovery. The South African Heritage Resources Agency (SAHRA) or relevant Authority should be contacted and in the case of graves, arrangements made for an undertaker to carry out exhumation and reburial. The undertaker will, together with the SAHRA, be responsible for attempts to contact family of the deceased and for the site where the exhumed remains can be re-interred.

5.28 Fire Prevention

Fires shall only be allowed in facilities or equipment specially constructed for this purpose.

A firebreak shall be cleared and maintained around the perimeter of the camp and office sites where and when necessary. In cases where construction is taking place in a Critical Biodiversity Area as listed under NEM:BA; it must be ensured that the requirement of a firebreak is screened against the NEMA Listing Notice 3 to confirm legislative requirements.

All conditions incorporated in the requirements of the Occupational Health and Safety Act shall be implemented.

5.29 Water Protection and Management

No water shall be abstracted from any water course (stream, river, or dam) without the expressed permission of the Transnet CM and Transnet PER. Such permission shall only be granted once it can be shown that the water is safe for use, that there is sufficient water in the resource to meet the demand, and once permission has been obtained from the Department of Water and Sanitation in accordance with the requirements of the National Water Act (Act 36 of 1998).

Water for human consumption shall be available at the site offices and at other convenient locations on site. The generally acceptable standard is that a supply of drinking water shall be available within 200m of any point on the construction site.

Method Statement(s) must be prepared by the Contractor for the various water uses. The Contractor shall keep a record of the quantities of water used on-site during construction (including use by sub-contractors), irrespective of the purpose of use.

5.30 Protection of Fauna and the collection of firewood

On no account shall any hunting or fishing activity of any kind be allowed. This includes the setting of traps, or the killing of any animal caught in construction works.

On no account shall any animal, reptile or bird of any sort be killed. This specifically includes snakes or other creatures considered potentially dangerous discovered on site. If such an animal is discovered on site, an appropriately skilled person should be summoned to remove the creature from the site. Consideration should be given to selection and nomination of such a person prior to site establishment. If no-one is available, training should be provided to at least two site staff members.

The Contractor shall provide adequate facilities for all his staff so that they are not encouraged to supplement their comforts on site by accessing what can be taken from the natural surroundings. The Contractor shall ensure that energy sources are available at all times for construction and supervision personnel for heating and cooking purposes.

5.31 Environmental Awareness Training

An Environmental Awareness Program is considered a necessary part of the Construction Environmental Management Plan for the Project. Training of the appropriate construction personnel will help ensure that all environmental regulations and requirements are followed which must be defined in the relevant Method Statement to be prepared by the Contractor.

Objectives of environmental awareness training are:

- Environmental Management – protecting the environment from the effects of construction by making personnel aware of sensitive environmental resources.
- Regulatory compliance – complying with requirements contained in project – specific permit conditions, also complying with requirements in regional and local regulations.
- Problem recognition and communication – training personnel to recognise potential environmental problems, i.e. spills, and communicate the problem to the Contractor's EO for a solution.
- Liability control - non-compliance with regulatory requirements can lead to personal and corporate liability.

All individuals on the Project construction site will need to have a minimum awareness of environmental requirements and responsibilities. However, not all need to have the same degree of awareness. The required degree of knowledge is greatest for personnel in the Safety, Health, and Environmental Sections and the least for the manual personnel.

The Contractor shall present environmental awareness programmes on a weekly/bi-monthly basis (depending on project requirements) and keep record of all the environmental related training of the personnel.

5.32 Handling and Batching of Concrete and Cement

Concrete batching shall only be conducted in demarcated areas which have been approved by the Transnet CM and Transnet PER.

Such areas shall be fitted with a containment facility for the collection of cement-laden water. This facility shall be bunded and have an impermeable surface protection so as to prevent soil and groundwater contamination. Drainage of the collection facility will be separated from any infrastructure that contains clean surface runoff.

The batching facility will not be placed in areas prone to floods or the generation of stagnant water. Access to the facility will be controlled so as to minimise potential environmental impacts. Hand mixing of cement and concrete shall be done on mortarboards and/or within the bunded area with impermeable surface or concrete slab. Bulk and bagged cement and concrete additives will be stored in an appropriate facility at least 10m away from any watercourses, gullies and drains.

Waste water collected in the containment facility shall be left to evaporate. The Contractor shall monitor water levels to prevent overflows from the facility. It is acknowledged that all waste water will evaporate; it must be ensured that the remaining water can be pumped into sealed drums for temporary storage and must be disposed of as liquid hazardous waste at an authorised hazardous waste management facility.

All concrete washing equipment, such as shovels, mixer drums, concrete chutes, etc. shall be done within the approved washout facility. Water used for washing shall be restricted as far as practically possible.

Ready-mix concrete trucks are not allowed to wash out anywhere other than in an area designated and approved by the Transnet CM and PER for this purpose.

The Contractor shall periodically clean out hardened concrete from the wash-out facility or concrete mixer, which can either be reused or disposed of as per accepted waste management procedures.

Empty cement and bags, if temporarily stored on site, must be collected and stored in weatherproof containers. Used cement bags may not be used for any other purpose and

must be disposed of on a regular basis in accordance with the Contractor's solid waste management system.

Sand and aggregates containing cement will be kept damp to prevent the generation of dust.

Concrete and cement or any solid waste materials containing concrete and cement will be disposed of at a relevant registered disposal facility and SDCs kept on the file. Where disposal facilities for general waste are utilised, written consent from the relevant municipality must be obtained by the Contractor and filed in the Green file.

5.33 Stockpiling, Soil Management and Protection of Flora

The Contractor shall measure the extent of all areas cleared for construction purposes and keep this figure updated. Sensitive areas shall be cordoned off and avoided in this regard.

Stockpiling may only take place in designated areas indicated on the approved site layout plan. Any area to be used for stockpiling or material laydown shall be stripped of all topsoil.

Clearance of vegetation shall be restricted to that which is required to facilitate the execution of the works. Vegetation clearance shall occur in a planned manner, and cleared areas shall be stabilised as soon as possible when and where necessary. The detail of vegetation clearing shall be subject to the Transnet CM's approval and shall occur in consultation with the Transnet PER.

Stockpiles must be positioned in areas sheltered from the wind and rain to prevent erosion and dispersion of loose materials. Stockpiled soil shall be protected by adequate erosion-control measures. Soil stockpiles shall be located away from drainage lines, watercourses and areas of temporary inundation. Stockpiles containing topsoil shall not exceed 2m in height unless otherwise permitted by Transnet.

Topsoil shall be stockpiled separately from other materials and prevented from movement. Excavated subsoil, where not contaminated, must be used for backfilling, if possible, and topsoil for landscaping and rehabilitation of disturbed areas. Where topsoil

has become mixed with subsoil or is not up to the original standard, fertiliser or new topsoil shall be provided by the Contractor.

No vegetation located outside the construction site shall be destroyed or damaged. As far as is reasonably practicable, existing roads must be used for access to the site. Before site clearance takes place, vegetation surveys must be conducted and protected species identified.

No protected plant species shall be removed without written consent from the relevant authorities. The development of new embankments or fill areas must be undertaken in consultation with the Transnet PER.

No dumping of solid waste or refuse shall be allowed within or adjacent to areas of natural vegetation.

The Contractor shall identify and eradicate all declared alien and invasive plant species occurring on site.

5.34 Traffic Management

Vehicles usage is permitted only on access roads. Vehicles should only be parked within designated parking areas as demarcated on the site layout plan.

Turning of vehicles should only take place within a clearly demarcated "turn area" located within the approved construction footprint.

The Contractor must co-ordinate the loading and offloading of material during the construction phase so as to ensure that vehicular movement is in one direction only at any one time and that side-tracks are not created on the site.

5.35 Transportation of Materials

The Contractor is responsible for ensuring that all suppliers and delivery drivers are aware of procedures and restrictions (e.g. no-go areas) in terms of the SOP CM and this Specification. Material must be appropriately secured to ensure safe passage between destinations during transportation. Loads must have appropriate cover, where ADTs are not utilised, to prevent spillage from the vehicles. The Contractor will be held responsible for any clean-up resulting from the failure to properly secure transported materials.

5.36 Borrow Pits and Quarries

The Contractor shall ensure that suppliers of rock and sand raw materials are in possession of the required permit/license and keep record of the quantity of material supplied.

The Contractor will not make direct use of any borrow pits and quarries unless the borrow pit has a valid permit, he has obtained written approval from the Transnet CM and Method Statement has been submitted and approved. The Method Statement will provide the detailed description of the location of the borrow pits and/or quarries and the procedures that will be followed to adhere to any pertinent national or local legislation (e.g. mineral extraction, rehabilitation, safety and noise levels).

5.37 Social and Labour Issues

The criteria for and selection of labourers, sub-contractors and suppliers for the project shall demonstrate preference for the local community and shall be aligned with the criteria set by Transnet SOC Ltd in appointing the Contractor. The Contractor shall keep records of the identity of all staff.

Under no circumstances shall the Contractors engage in formal discussions with landowners without prior consent by the Transnet CM.

No activity on private property shall be allowed without written consent by the relevant landowner and Transnet CM/Transnet PER.

Any damage to private property caused by the Contractor during the construction period, shall be repaired to the satisfaction of the Transnet CM, the Transnet PER and the landowner.

The Contractor shall keep record of any complaint raised during the construction period relating to the Contractor's activities.

No job-seekers shall be allowed on site and signs reflecting such shall be displayed on the notice boards.

5.38 Energy Management

The Contractor shall measure and keep updated records of the following:

- Electricity consumption (to be measured in Kilowatt Hours)
- Fuel consumption (to be measured in liters)

5.39 Handling, Storage and Management of Hazardous Substances

All hazardous materials/substances shall be stored in a secured, designated area that is fenced, bunded and has restricted entry.

All storage shall take place using suitable containers to the approval of the Transnet CM and PER.

All hazardous liquids shall be located in a secure, demarcated area and an adequate bund wall (110% of the total volume stored) shall be provided. The floor and wall of the bund area shall be impervious to prevent infiltration of any spilled/leaked liquids into the soil.

No spillages or accumulated stormwater within this bunded area will be allowed to be flushed from the bund into the surrounding area.

Hazard signs indicating the nature and volume of the stored materials shall be displayed on the storage facility or containment structure.

Weigh bills of hazardous substances shall be sourced from suppliers and kept on site for inspection by the Transnet PER.

The Contractor must provide a method statement detailing the hazardous substances that are to be used during construction, as well as the storage, handling and disposal procedures for each substance. Emergency procedures in the event of misuse or spillage that might negatively affect the environment must be specified.

Information on each hazardous substance will be available to all persons on site in the form of MSDS/SDS. Training and education about the proper use, handling, and disposal of the material will be provided to all workers handling the material.

The Contractor's EO must be informed of all activities that involve the use of hazardous substances to facilitate prompt response in the event of a spill or release.

5.40 Housekeeping

The Contractor must ensure proper housekeeping of the site for the duration of the project. If practical the contractor shall amongst construction personnel, assign one to be responsible for good housekeeping

Materials shall be stored in a neat and tidy manner in designated areas as per the approved site layout plan.

5.41 Rehabilitation

Contractors shall rehabilitate the entire site upon completion of work. Where applicable, rehabilitation must be in line with the measures outlined in the Project Environmental Specification. A rehabilitation plan will be submitted to the Transnet CM and PER for approval at least six weeks before project completion. The following, but not limited are critical issues to be included in the rehabilitation plan:

- Details of soil preparation procedures including proposed fertilisers or other chemicals being considered for use;
- A list of the plant species that will be used in the rehabilitation process. Note that these should all be indigenous species, and preferably species that are endemic to the area. The assistance of an appropriately qualified Botanist/Horticulturist should be sought in developing this list;
- Procedures for watering the planted areas (frequency of watering, methodology proposed etc.);
- An indication of the monitoring procedures that will be put in place to ensure the successful establishment of the plants (duration and frequency of monitoring, proposed criteria for declaring rehabilitation as being successful); and
- Procedures for the prevention of the establishment and spread of alien invasive species.

5.42 Documentation and Records Management

The Contractor's EO will complete and maintain copies of all documents and records and ensure that these documents and records are kept up to date.

The Contractor's EO will submit these documents to the Transnet PER on a frequency as agreed to with the Transnet PER, except where documents have remained unchanged in which case written notification to this effect must be provided to the Transnet PER. The Contractor's EO must ensure that electronic copies of these documents are saved on the Transnet system.

Once the construction activities have been completed and the Transnet PER has conducted a site closure inspection and notified the Contractor that site closure will be granted, all documents described above must be handed over to Transnet after which a Site Closure Certificate will be issued by the Transnet Project Manager.

NOTE: All documents/records are to be retained, within the Transnet Document Control System, for a period of 10 years. In the event of environmental documentation/record being lost before receiving a Site Closure Certificate, the Contractor will be penalised according to the specifications laid down in the Contract.

6. RECORDS

Refer to CEM SOP.

7. ANNEXURES

None.

SCOPE OF WORKS SUPPORTING ANNEXURES:

**Annexure U: Standard Operating Procedure Construction
Environmental Management (CEM SOP) (009-
TCC-CLO-SUS-11386)**

STANDARD OPERATING PROCEDURE

CONSTRUCTION ENVIRONMENTAL MANAGEMENT

Document number	009-TCC-CLO-SUS-11386
Version number	1.0
Classification	Unclassified
Effective date	01 October 2023
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[illegible]

DOCUMENTATION SIGN-OFF SHEET

I, the undersigned hereby approve this procedure.

ROLE	CAPACITY/ FUNCTION	SIGNATURE	DATE
Process Owner:	Senior Specialist: Environmental Compliance and Permitting		01/10/2023
Accepts document for adequacy and practicability. Comments:			
Sponsor:	General Manager: Corporate Sustainability		01/10/2023
Approves document for use. Comments:			

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1. PURPOSE

- 1.1** The purpose of this Standard Operating Procedure (SOP) is to define how environmental management will be practiced on any construction project under the management of Transnet to ensure that the environment is considered, negative impacts avoided or minimized, and positive impacts are optimized and/or enhanced throughout the lifecycle of the asset.
- 1.2** It further defines environmental management responsibilities for key stakeholders involved in the construction management process.
- 1.3** It must be read in conjunction with the Contractor Environmental and Sustainability Specification Guidelines (CESSG) and the Project Environmental Specification (PES) relevant to the project.
- 1.4** In this document, unless the context clearly indicates otherwise:
- Words importing any one gender shall include the other gender.
 - The singular shall include the plural and vice versa; and
 - Any reference in this document to legislation or subordinate legislation is to such legislation or subordinate legislation at the date of promulgation thereof and as amended and/or re-enacted from time to time.

2. APPLICABILITY

- 2.1** The SOP applies to any construction project under the management of Transnet SOC Ltd or its Construction Agent.

3. REFERENCE DOCUMENTS

Name	Applicable Section
Constitution of South Africa, Act 108 of 1996	Section 24 (a) right to an environment that is not harmful to health or wellbeing Section 24(b) (i) right to have environment protected for current and future generations through legislation and measures that prevents pollution and ecological degradation.
Capital Governance and Assurance Policy	Entire document
Capital Governance and Assurance Framework	Entire document
Capital governance and Assurance Manual	Entire document.
PLP Manual – Execution	Entire document
National Environmental Management Act, 107 of 1998	Section 2 National Environmental Management Principles (4) (viii), (e), (h), (j) and (p).
National Water Act, 36 of 1998	Section 164, Permissible Water Use Section 19
National Environmental Management: Waste Act, 58 of 2008	Part 1 15 (1) (i) and (2) Part 6 26 (10) (a) and (b) Scheduled 3, Defined Wastes Category B: Hazardous Wastes Part 8: Contaminated Land
Environment Conservation Act, 73 of 1989	Section 20
Occupational Health and Safety Act, 85 of 1993	Asbestos Regulations, 2001 Government Notice R155 in Government Gazette 23108 of February 2002

Name	Applicable Section
	General Safety Regulations-Reg. 2 (2) PPE
GNR 326, 7 April 2017 as amended, EIA Regulations	Chapter 15
Integrated Management System – Policy Statement Procedure (TRN-IMS-GRP-PROC-002)	Whole document
Integrated Management System – Competency, Awareness and Training Procedure	Whole document
Integrated Management System¹ – Document, Data and Record Management Procedure (TRN-IMS-GRP-PROC-010)	Whole document
Integrated Management System – Occurrence and Non-Conformance Management Procedure (TRN-IMS-GRP-PROC-013)	Whole document
Transnet Environmental Risk Management Strategy and Framework	2015:42
Environmental Management Systems ISO 14001: 2015	Clause 5, 6, 7, 8, 9 and 10

¹ Management of certain documents, data and records will be in accordance with NEC3 – Engineering and Construction Contract prescripts

4. DEFINITIONS AND ABBREVIATIONS

4.1 DEFINITIONS

Compliance	The action or fact of complying with legislation or regulations.
Conformance	The action or fact of conforming to this standard and other internal Transnet policies, procedures, guidelines and best practice.
Contractor	The Principal Contractor as engaged by Transnet for infrastructure construction operations, including all sub-contractors appointed by the main contractor of his own volition for the execution of parts of the construction operations; and any other contractor from time to time engaged by Transnet directly in connection with any part of the construction operations which is not a nominated sub-contractor to the Principal Contractor.
Contractor Environmental and Sustainability Specification Guidelines (CESSG)	A set of minimum environmental standards for all Transnet SOC Ltd-managed construction sites.
Corrective Action	It is generally a reactive process used to address problems after they have occurred. Corrective action may be triggered by a variety of events, e.g. Non-conformance to documented procedures and work instructions, non-conformances raised through internal audits, unacceptable monitoring and measurement results, internal & external SHEQ complaints, etc.
Emergency	Sudden unforeseen event needing immediate or prompt action.

Environment	Surroundings in which the Contractor operates, including air, water, land, natural resources, flora, fauna, humans and their interrelations.
Environmental Aspect	Element of an organization's activities or products or services that interacts or can interact with the environment
Environmental Authorisation (EA)	Environmental Authorisation is the authorisation granted by a competent authority of a listed activity or specified activity in terms of National Environmental Management Act 107 of 1998 (as amended).
Environmental Impact	Change to the environment whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects
Environmental Management Plan (EMP)	A plan generated by the Contractor describing the relevant roles and responsibilities and how potential environmental risks will be assessed and managed including the monitoring and recording thereof.
Environmental Management Programme (EMPr)	A programme that has been approved by the Competent Authority in terms of NEMA, 107 of 1998 stipulating information on any proposed management, mitigation, protection or remedial measures that will be undertaken to address the environmental impacts that have been identified
Environmental Risk	The product of the likelihood and severity of an unforeseen occurrence/incident/aspect and the impact it would have, if realised, on the environment

Incident/Occurrence	An undesired event occurring at work that results in physical harm to a person or death, or damage to the environment, plant and/or equipment, and/or loss of production.
Non-conformance	An action or situation that does not conform to Transnet's SHEQ standards, procedures or legislative requirement(s) and that can be, or lead to, an unacceptable SHEQ incident.
Non-compliance	Contravention to environmental legislative requirements.
Project Environmental Specification (PES)	Describes standards specific to a particular project. Variations and additions to the CESSG are set out in this PES. These would include the EA issued to the project or elements generally drawn from the EA or permits for that project or from specific requirements set by the Transnet Operating Divisions. The PES may also require a more stringent standard to that described in the CESSG if required by the EA or a particular industry code to which Transnet subscribes including any environmental constraints at a construction site.
Sub -Contractor	A person or organisation who has a contract with the contractor to - Construct or install part of the contractors work. - Provide a service necessary to provide the works; or - Supply plant and materials which the person or organisation has wholly or partly designed specifically for the works.

4.2 ABBREVIATIONS

Acronym	Meaning in Full
CESSG	Contractor Environmental and Sustainability Specification Guidelines
CM	Construction Manager
CV	Curriculum Vitae
CEM	Construction Environmental Management
DFFE	Department of Forestry, Fisheries and the Environment
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
ECO	Environmental Control Officer
EO	Environmental Officer
EMI	Environmental Management Inspectorate
NCR	Non-conformance Report
NEMA	National Environmental Management Act 107 of 1998 (as amended)
PER	Project Environmental Resource
PES	Project Environmental Specification
PLP	Project Life-cycle Process
PM	Project Manager

Acronym	Meaning in Full
SAHRA	South African Heritage Resources Agency
SOP	Standard Operating Procedure
SHEQ	Safety, Health, Environment and Quality
Transnet	Transnet SOC Ltd

5. ACCOUNTABILITY, RESPONSIBILITY AND AUTHORITY

5.1 Transnet Procurement Department

5.1.1 Ensures that this SOP (and relevant associated environmental specifications) is included in any construction-related request whether open market, quotation or confinement process.

5.1.2 The Procurement Department shall further ensure that the relevant environmental personnel are consulted during tender review, tender evaluation and contract award.

5. Transnet Project Manager (PM)

5.2.1 Takes overall accountability for the project including ensuring that this SOP is implemented by all relevant stakeholders.

5.2.2 The specific tasks during construction will include:

- Appointment of the Transnet Environmental Resource/s;
- Certifying site access to the Contractor;
- Giving instructions to the Contractor on recommendation from the Transnet Environmental Resource/s (e.g. defects, non-conformances etc.); and
- Certifying site closure to the Contractor.

5.3 Transnet Project Environmental Resource

5.3.1 The Transnet Project Environmental Resource (PER) will be responsible for ensuring that this SOP and associated specifications or requirements are complied with. The Transnet PER will report functionally to the relevant PM.

5.3.2 The specific tasks will include:

- Preparation of the PES;
- Tender evaluation, development of environmental criteria and adjudication thereof;
- Liaison with the relevant environmental Competent Authorities;

- Review and approve site layout plan including any subsequent revisions thereof;
- Environmental Induction of Contractor's staff;
- Generate an inspection checklist prior to construction commencement;
- Review and Sign off Method Statements prepared by Contractor;
- Prepare environmental monitoring protocols/checklists to be used during construction;
- Prepare monthly conformance audit reports, including sign-off on Monthly Inspection Reports;
- Conduct monthly observation & inspections of all work places based on the approved inspection checklist;
- Audit conformance to Method Statements;
- Monitor the Contractor's compliance with this SOP and any other environmental requirements relevant to the site;
- Develop an Audit Finding and Close out Register that documents all audit findings, close out actions and the time frame allowed for in order to close the finding/s;
- Ensure that all environmental monitoring programmes (sampling, measuring, recording etc. when specified) are carried out according to protocols and schedules;
- Measurement of completed work (e.g. areas top soiled, re-vegetated, stabilised etc.);
- Attendance at scheduled SHE meetings, as and when required, and project coordination meetings;
- Ensure that site documentation (permits, licenses, EA, EMP, SOP-CEM, method statements, audit reports, waste disposal slips etc.) related to environmental management is maintained on the relevant Document Control System;
- Inspect and report on environmental incidents and check corrective action;
- Keep a photographic record of all environmental incidents;

- Environmental incident management as required by Transnet policies and procedures;
- Implementation of environmental-related actions arising out of the minutes from scheduled meetings;
- Management of complaints register;
- Conduct any environmental incident investigations;
- Coordinate and/or facilitate any environmental monitoring programmes e.g. EMI Inspections, ECO Audits, Transnet Environmental Assurance Audits etc.
- Collate information received, including monitoring results into a monthly report that is supported with photographic records to the Transnet CM and Transnet PM showing progress against targets; and
- Report environmental performance of the project on a monthly basis through relevant governance channels.

5.3.3 The tasks stipulated above may be conducted by one or more Project Environmental Resource, depending on the scale, complexity and sensitivity of the environment. Discretion to be taken by the Environment Lead within the area of control of the project site.

5.4 Transnet Construction Manager (CM)

5.4.1 The Transnet Construction Manager (CM) has overall responsibility for environmental management on site and reports to the Transnet PM. The Transnet CM is supported by the Transnet PER.

5.4.2 The specific tasks during the construction stage will include:

- Reviewing the monthly reports compiled by the Transnet PER;
- Approving method statements prepared by the Contractor;
- Communicating directly with the Contractor on environmental issues observed on-site; and
- Escalating any relevant environmental matters to the Transnet PM.

5.6 Environmental Control Officer

5.6.1 The Environmental Control Officer is an independent person legally appointed to monitor compliance of construction related activities with the conditions of the Environmental Authorisation. The ECO fulfils an autonomous role and submits reports to the Competent Authority at timeframes specified in the Environmental Authorisation.

5.6.2 The Environmental Control Officer will conduct the following tasks:

- Monitors compliance to the conditions of the EA, Environmental Management Programme (EMPr) and can include permits and licences applicable to a project;
- Attends project meetings as and when required;
- Conducts audits at a frequency stipulated on the EA/EMPr; and
- Compiles audit reports and submits them to relevant authorities.

5.7 Contractor's Environmental Officer

5.7.1 The Contractor's Environmental Officer (EO) must ensure implementation of the requirements of this SOP on site.

5.7.2 The Contractor's EO will liaise with the Transnet PER on site. It will be the responsibility of the Contractor's EO to ensure that all work is conducted according to the approved Method Statements and that the Contractor team's roles and responsibilities as set out in this document are fulfilled.

5.7.3 The Contractor EO's tasks will include:

- Developing an appropriate environmental file for approval by the Transnet PER prior to site access, including but not necessarily limited to (the environmental file must always be available and up to date on the construction site):
 - All environmental documents provided by Transnet in the tender e.g. policies, SOPs, standards, environmental approvals;

- Contractors commitments to comply with this SOP and associated documents as signed during tender;
- The Contractor's EMP;
- His/her CV;
- An organogram indicating reporting lines of all Contractor's staff (with names included);
- Contact Information for: the overall responsible person acting on behalf of the Contractor to execute the construction works; Contractor's CM; Contractor's EO; all relevant emergency personnel;
- A list of the Contractor's plant and equipment indicating a description of the plant/equipment, its fuel capacity, any hazardous components (oils, greases etc.), individual service/maintenance cycles and noise levels;
- A list of hazardous substances to be used during construction indicating: official substance name from Material Safety Data Sheet (MSDS); quantity on site; storage method; transport method to site; period to be used on site (all substances listed must have an MSDS on site in the environmental file);
- Site Layout Plan indicating but not necessarily limited to, access roads, site offices, material laydown areas, stockpile areas and parking areas, waste and effluent storage and handling facilities, entire construction footprint, no-go-areas, sewage and sanitary facilities. The plan must be appropriately drawn on a computer and must be clearly visible and properly scaled;
- A site establishment method statement (for more details on what method statements should entail the Contractor must refer to the Minimum Requirements for Construction Environmental Management)
- Conducting an activity-based environmental risk assessment based on the Contractor's scope of work;
- Agreeing on an appropriate inspection schedule with the Transnet PER (either daily or weekly);

- Ensuring that all required Contractor staff attends the environmental induction to be given by the Transnet PER (any Contractor's staff, sub-contractors or visitors to site must subsequently be inducted by the Contractor's EO);
- Inspection of the work area(s) as per schedule or authorised through written instruction by Transnet PER;
- Preparing activity-based Method Statements that indicate how environmental risks will be managed on site OR ensuring that the necessary environmental information is included in the Contractor's method statements (all method statements must be maintained in the Contractor's Environmental File);
- Identify local, provincial and national environmental legislation that applies to the Contractor's activities;
- Conduct ongoing Environmental Awareness Training of the Contractor's site personnel;
- Reporting, investigating and recording of any environmental incidents caused by the Contractor or due to the Contractor's activities, including their sub-contractors and visitors;
- Close out of environmental incidents;
- Attendance at all SHE meetings and induction programmes, and toolbox talks where required
- Monitor Waste Management;
- Monitor Water Management;
- Monitor Energy Management;
- Ensure that environmental signage and barriers are correctly placed;
- Taking required corrective action within specified time frame and close out of non-conformances; and
- Maintain site documentation related to environmental management on site.

5.7.4 The Contractor's EO will be expected to submit reports to the Transnet PER on a daily/weekly basis.

5.8 The Contractor

- 5.8.1 The Contractor shall comply with the requirements of this SOP and abide by the Transnet PM's instructions regarding the implementation of this SOP.
- 5.8.2 The Contractor must confirm that he will conform to the requirements of this SOP and any other documents provided to him by Transnet during tender.
- 5.8.3 The Contractor must recommend a suitably qualified, competent person to fulfill the role of the Contractor's EO at tender and if accepted by Transnet this person must be appointed when the Contract is awarded for the duration of construction. Should this person be replaced for whatever reason, the Contractor shall ensure that a person of similar qualification and competency is appointed in his/her place before the previous incumbent vacates his/her position.
- 5.8.4 The Contractor must obtain any relevant environmental approvals required by his activities that have not been obtained by Transnet e.g. permits for the destruction of protected plant species; grave relocation permits etc.
- 5.8.5 The Contractor shall have overall accountability for environmental compliance on site and will be held liable for any non-compliance with environmental statutes or non-conformances with this SOP due to his negligence.

5.9 Reporting Lines

- 5.9.1 The organisational structure identifies and defines the responsibilities and authority of the various entities involved in the project. All instructions and official communications regarding environmental matters will follow the organisational structure shown in Figure 1.
- 5.9.2 All instructions that relate to the SOP will still be given to the Contractor via the Transnet PM. In an emergency situation, however, the Transnet PER may give an instruction directly to the Contractor. Environmental Management of the site will be an item on the agenda of the monthly site meetings, and the Transnet PER will attend these meetings on request by the contractor. If at any time the Transnet

PM is uncertain in any way with respect to an environmentally related issue or specification in the SOP, he will consult with the Transnet PER .

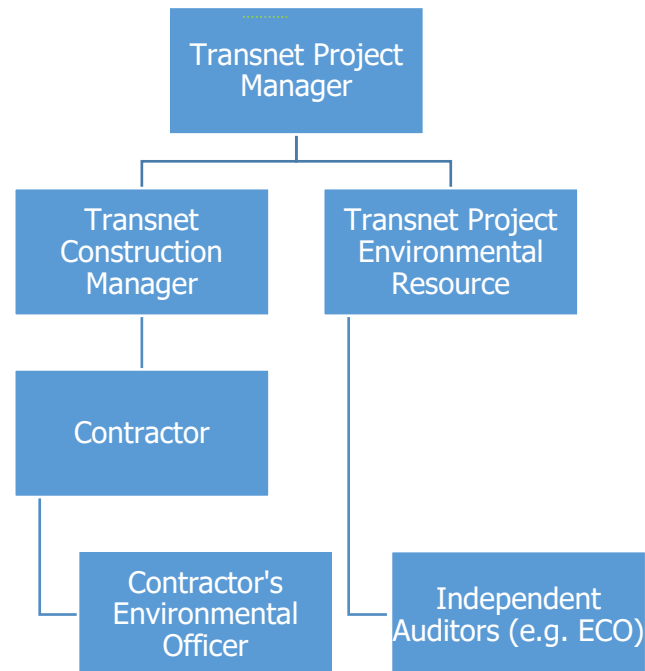


Figure 1: Typical Transnet Organogram for Construction Environmental Management²

6. STANDARD OPERATING PROCEDURE

6.1 Tender Stage (prior to Contract Award)

- The Transnet PM appoints or assign a Project Environmental Resource/s³.
- The Transnet PER requests the draft tender from the Transnet Procurement Department
- Transnet Procurement routes the draft tender to the Transnet PER

² Structure dependent on OD own structure and organizational operating model

³ Project complexity will determine the final environmental management structure on the project.

- The Transnet PER ensures the tender includes all relevant environmental documents and signs the routing slip.
- The Transnet Procurement Department issues the tender to prospective Contractor(s).
- The Contractor submits his bid which MUST include: a commitment to conform to this SOP signed by the duly delegated person; recommendation of a suitably qualified, competent person to fulfill the role of the Contractor's EO; Environmental Policy; and EMP
- After submission the Transnet Procurement Department will invite the Transnet PER to evaluate tender submissions (environmental section);
- The Transnet PER evaluates the prospective Contractor's environmental submission.
- The Contract is awarded to the successful bidder.

6.2 Construction Stage (prior to Site Access)

- The Contractor appoints the Contractor's Environmental Officer (EO) accepted by Transnet SOC Ltd.
- The Contractor provides his EO with all documents submitted during tender, including but not necessarily limited to:
 - All environmental documents provided by Transnet in the tender e.g. policies, SOPs, standards, environmental approvals etc;
 - commitment to conform to this SOP; and
 - The EMP.
- The Contractor's EO conducts an activity-based environmental risk assessment;
- The Contractor's EO develops an appropriate environmental file for approval by the Transnet PER, including but not necessarily limited to all the documents specified in Section 5.7 above (the environmental file must always be available and up to date on the construction site);
- The Contractor's EO submits the environmental file for acceptance to the Transnet PER;

- Once accepted, the Transnet PER recommends that site access be granted to the Transnet PM; and
- The Transnet PM issues the Contractor with a Site Access Certificate

6.3 Construction Stage (post Site Access)

- The Transnet PER inducts all Contractor's staff on the environmental requirements of the site;
- The Transnet PER has an inception meeting with the Contractor's EO on site where the following is agreed:
 - The contents of the contractor's environmental file (in addition to what was approved prior to granting site access). This will include but not necessarily be limited to: a list of interested and affected parties that may be impacted by construction e.g. surrounding landowners, nearby communities etc.; energy consumption information; water use information; environmental induction and awareness information; activity-based environmental method statements; complaints records; record of external communications; environmental incident reports; minutes of contractors environmental meetings.
 - The composition of the Project Environmental Specification (PES) and how it will be implemented. This will include but may not necessarily be limited to: Environmental Approvals (e.g. Environmental Authorisations, Water Use Licenses, Waste Management Licences, Atmospheric Emissions Licences etc.); Environmental Management Programmes/Plans approved by external parties/authorities; and any third party auditors/monitoring specialists (e.g. Environmental Control Officers; Independent Auditors; Transnet Environmental Assurance Specialists; Water Quality Monitoring experts etc.) that have a bearing on the contractor's scope of work.
 - The frequency of inspections to be conducted by the Contractor's EO (e.g. daily, weekly etc.)
 - The frequency of inspections to be conducted by the Transnet PER (e.g. daily, weekly and/or monthly). Notwithstanding that the frequency of

Transnet PER inspections will be agreed, the Contractor may never refuse the Transnet PER

- The format used and elements to be checked during Contractor's inspections
 - Reporting frequency and requirements
 - The process to be followed in handling Environmental Occurrences and – Non-conformances
- **Note:** All the aforementioned agreements will be formalized in the form of minutes which the Transnet - and Contractor's EO must sign and must subsequently be approved by the Transnet Project Environmental Resource.
 - The Transnet PER reviews the Contractor's activity-based environmental risk assessment and instructs the Contractor's EO to submit activity-based method statements for construction activities that may pose an environmental risk (for more details on what method statements should entail the Contractor must refer to the Minimum Environmental Requirements for Construction). Only once a method statement has been approved by the Transnet PER and Transnet CM and ECO (where relevant) may the Contractor execute the relevant activity.
 - The Contractor's EO submits the method statements to the Transnet PER for approval (these must also be approved by the Transnet CM);
 - The Transnet PER compiles a site audit checklist (covering all environmental compliance and conformance requirements) for approval by the Transnet Project Environmental Manager
 - Whilst the Contractor executes the work in terms of the requirements of the Contract, the Contractor's EO and Transnet PER execute their monitoring functions as per this SOP and other monitoring stakeholders/auditors as per the PES.
 - The Transnet PER shall submit monthly reports to the Transnet CM and PM indicating the following:
 - Date of the inspection(s);
 - Details and expertise of the Transnet PER;

- Scope and purpose for which the report was prepared;
- Description of the methodology used during the inspection and report compilation;
- Compliance and/or conformance status of all relevant/individual elements as per the inspection checklist culminating in an overall compliance/conformance percentage for the project;
- Assumptions;
- Description of consultation processes undertaken during the inspection(s) with a summary and associated records of such consultations;
- Environmental incidents and non-conformances;
- Photos of pertinent construction and environmental matters that occurred on site;
- Water abstracted/withdrawn during the month (in kiloliters) as well as an indication of the source;
- Water recycled and/or reused during the month (in kiloliters);
- Waste water discharged (in kiloliters);
- Waste (both general and hazardous) disposed (in tonnages) with an indication of waste type;
- Waste recycled (in tonnages);
- Alien invasive species eradicated (in hectares);
- Number of listed species safely relocated;
- Environmental Fines, Non-Compliances or Directives issues by authorities;
- Any NEMA Section 30 or NWA Section 19 incidents;
- Environmental Grievances;
- Rehabilitated Land (in hectares);
- Number of graves and/or heritage artifacts moved;
- Energy consumption for the project [Electricity(kWh); Gas (GJ); Oil(l); Diesel(l); Petrol(l); LPG(GJ)];
- Status of previous findings and/or observations; and
- Recommendations for improvement.

6.4 Post Construction

- The Contractor's EO submits a rehabilitation and site closure method statement for approval by the Transnet PER and Transnet CM.
- Once approved, the Contractor implements the rehabilitation method statement accordingly.
- The Contractor's EO submits a site close-out report for acceptance by the Transnet PER and CM.
- Post rehabilitation, the Transnet PER conducts a site closure inspection to ensure all requirements of the rehabilitation method statement have been met.
- Once rehabilitation has been accepted by the Transnet PER, the Contractor's EO sends the Transnet PER a copy of the entire environmental file (original to be handed over to Transnet as per document handover requirements of the Contract).
- On receipt of the environmental file, the Transnet PER recommends that a site closure certificate can be issued to the Transnet PM.
- The Transnet PM issues the Contractor with a Site Closure Certificate.

7. RECORDS

7.1 The responsibility for maintaining all records required by this SOP shall rest with the Contractor's EO; Transnet PER as specified below:

Record	Maintained By
1. Transnet PER Appointment Letter	Transnet PER
2. Signed Tender Routing Slip	Transnet PER
3. Contractor's Confirmation to conform to this CEM SOP	Transnet PER; Contractor's EO
4. Recommendation of Contractor's EO	Transnet PER

Record	Maintained By
5. Contractor's Environmental Policy	Transnet PER; Contractor's EO
6. Contractor's Environmental Management Plan	Transnet PER; Contractor's EO
7. Tender Evaluation Records from Transnet PER	Transnet PER
8. Contract	Transnet PER
9. Contractor EO's Appointment Letter and CV	Transnet PER
10. Activity-Based Environmental Risk Assessment	Transnet PER; Contractor's EO
11. Contractor's Organogram	Transnet PER; Contractor's EO
12. Contractor's Contact Information	Transnet PER; Contractor's EO
13. List of Contractor's Plant and Equipment	Contractor's EO
14. List of Hazardous Substances used by Contractor	Contractor's EO
15. Material Safety Data Sheets	Contractor's EO
16. Site Layout Plan	Transnet PER; Contractor's EO
17. Site Establishment Method Statement	Transnet PER; Contractor's EO
18. Minutes of Transnet PER – Contractor's EO Inception Meeting	Transnet PER; Contractor's EO
19. Environmental Induction Attendance Register (including material used during induction)	Transnet PER; Contractor's EO
20. Activity-based Method Statements	Transnet PER; Contractor's EO

Record	Maintained By
21. Contractor's Inspection Reports	Transnet PER; Contractor's EO
22. Transnet PER Inspection Reports	Transnet PER
23. List of Local, Provincial and National Environmental legislation applicable to the site	Contractor's EO
24. Environmental Awareness Attendance Registers (including material used)	Contractor's EO
25. Environmental Incident Reports	Transnet PER; Contractor's EO
26. Minutes of SHE Meetings	Transnet PER; Contractor's EO
27. Waste Records	Transnet PER; Contractor's EO
28. Water Records	Transnet PER; Contractor's EO
29. Energy Records	Transnet PER; Contractor's EO
30. Non-Conformance Records	Transnet PER; Contractor's EO
31. Approval of Contractor's Environmental File	Transnet PER
32. Site Access Certificate	Transnet PER
33. Approved Transnet PER Checklist	Transnet PER
34. Transnet Monthly PER Reports	Transnet PER
35. Rehabilitation Method Statement	Transnet PER; Contractor's EO
36. Contractor's Site Close-Out Report	Transnet PER; Contractor's EO
37. Transnet PER Site Closure Report	Transnet PER
38. Contractor's Environmental File Handover Transmittal	Transnet PER; Contractor's EO
39. Site Closure Certificate	Transnet PER

8. ANNEXURES

8.1 List of Construction Environmental Management Templates, Forms and Guidelines

8.2 009-TCC-CLO-SUS-TMP-11386.22 - Construction Environmental Management File Index

8.3 009-TCC-CLO-SUS-TMP-11386.23 - *Construction Environmental Management Process Flow*

Annexure 8.1 List of Construction Environmental Management Templates, Forms and Guidelines

No	Item Description	Document No
1.	Construction Environmental Management File Index	009-TCC-CLO-SUS-TMP-11386.1
2.	Project Environmental Specification (PES)	009-TCC-CLO-SUS-TMP-11386.2
3.	Declaration of Understanding (Signed)	009-TCC-CLO-SUS-TMP-11386.3
4.	Contractor's Information	009-TCC-CLO-SUS-TMP-11386.4
5.	Appointment of Contractors EO and Declaration of Understanding (Including CV and Job Profile)	009-TCC-CLO-SUS-TMP-11386.5
6.	Schedule of Contractor's Construction Plant and Equipment	009-TCC-CLO-SUS-TMP-11386.6
7.	Hazardous Substances Register	009-TCC-CLO-SUS-TMP-11386.7
8.	Emergency Contacts Register	009-TCC-CLO-SUS-TMP-11386.8
9.	Energy Consumption Register	009-TCC-CLO-SUS-TMP-11386.9
10.	Water Usage Register	009-TCC-CLO-SUS-TMP-11386.10
11.	Project Start-Up Checklist	009-TCC-CLO-SUS-TMP-11386.11
12.	Site Access Certificate	009-TCC-CLO-SUS-TMP-11386.12
13.	Method Statement Register	009-TCC-CLO-SUS-TMP-11386.13
14.	Method Statements	009-TCC-CLO-SUS-TMP-11386.14
15.	Waste Disposal Register	009-TCC-CLO-SUS-TMP-11386.15
16.	Daily Inspection Checklist	009-TCC-CLO-SUS-TMP-11386.16
17.	Weekly Inspection Checklist	009-TCC-CLO-SUS-TMP-11386.17
18.	Monthly Inspection Checklist	009-TCC-CLO-SUS-TMP-11386.18

No	Item Description	Document No
19.	Public Complaints Register	009-TCC-CLO-SUS-TMP-11386.19
20.	Application for Exemption	009-TCC-CLO-SUS-TMP-11386.20
21.	Site Closure Certificate	009-TCC-CLO-SUS-TMP-11386.21
22.	Contractor's Environmental Management File Handover	009-TCC-CLO-SUS-TMP-11386.22
23.	Basic Environmental Rules for Visitors	009-TCC-CLO-SUS-GDL-11386.23
24.	Basic Environmental Rules for Contractors	009-TCC-CLO-SUS-GDL-11386.24
25.	Basic Site Procedure	009-TCC-CLO-SUS-GDL-11386.25
26.	Contractor Environmental and Sustainability Specification Guidelines (CESSG)	TRN-IMS-GRP-GDL-014.04

Annexure 8.2 Construction Environmental Management File Index

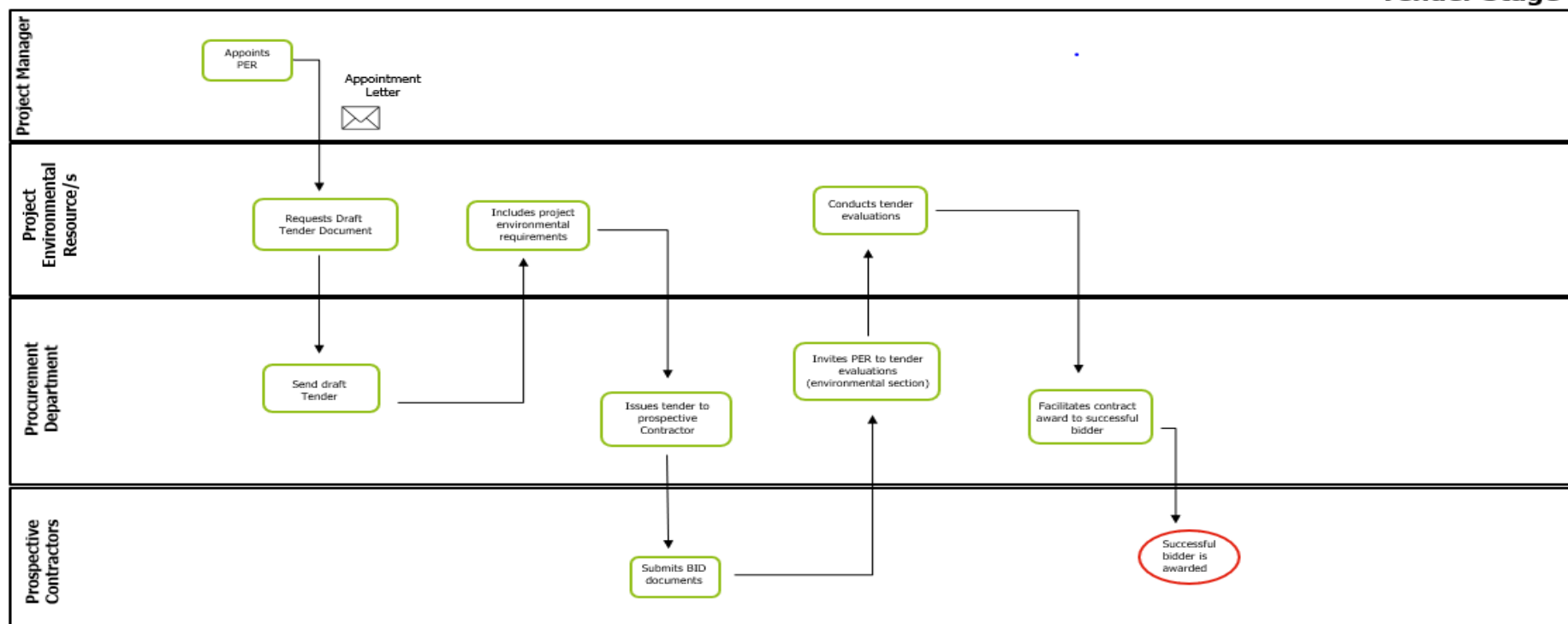
No	Item Description	Document No
1	Transnet Integrated management System (TIMS) Policy Statement	-
2.1	Standard Operating Procedure (SOP) - Construction Environmental Management (CEM)	009-TCC-CLO-SUS-11386
2.2	Environmental and Sustainability Specification Guidelines	TRN-IMS-GRP-GDL-014.04
3	Project Environmental Specification (PES)	009-TCC-CLO-SUS-TMP-11386.2
4	Declaration of Understanding (Signed)	009-TCC-CLO-SUS-TMP-11386.3
5.1	Contractor's Information	009-TCC-CLO-SUS-TMP-11386.4
5.2	Contractor's Environmental Policy	-
5.3	Contractor's Organogram	-
5.4	Contractor's Environmental Management Plan	-
5.5	Appointment of Contractors EO and Declaration of Understanding (Including CV and Job Profile)	009-TCC-CLO-SUS-TMP-11386.5
6	Schedule of Contractor's Construction Plant and Equipment	009-TCC-CLO-SUS-TMP-11386.6
7	Hazardous Substances Register	009-TCC-CLO-SUS-TMP-11386.7
8	Emergency Contacts Register	009-TCC-CLO-SUS-TMP-11386.8
9	Energy Consumption Register	009-TCC-CLO-SUS-TMP-11386.9
10	Water Usage Register	009-TCC-CLO-SUS-TMP-11386.10
11	Training Attendance Register	TIMS Procedure
12	Project Start-Up Checklist	009-TCC-CLO-SUS-TMP-11386.11
13	Site Access Certificate	009-TCC-CLO-SUS-TMP-11386.12
14	Method Statement Register	009-TCC-CLO-SUS-TMP-11386.13

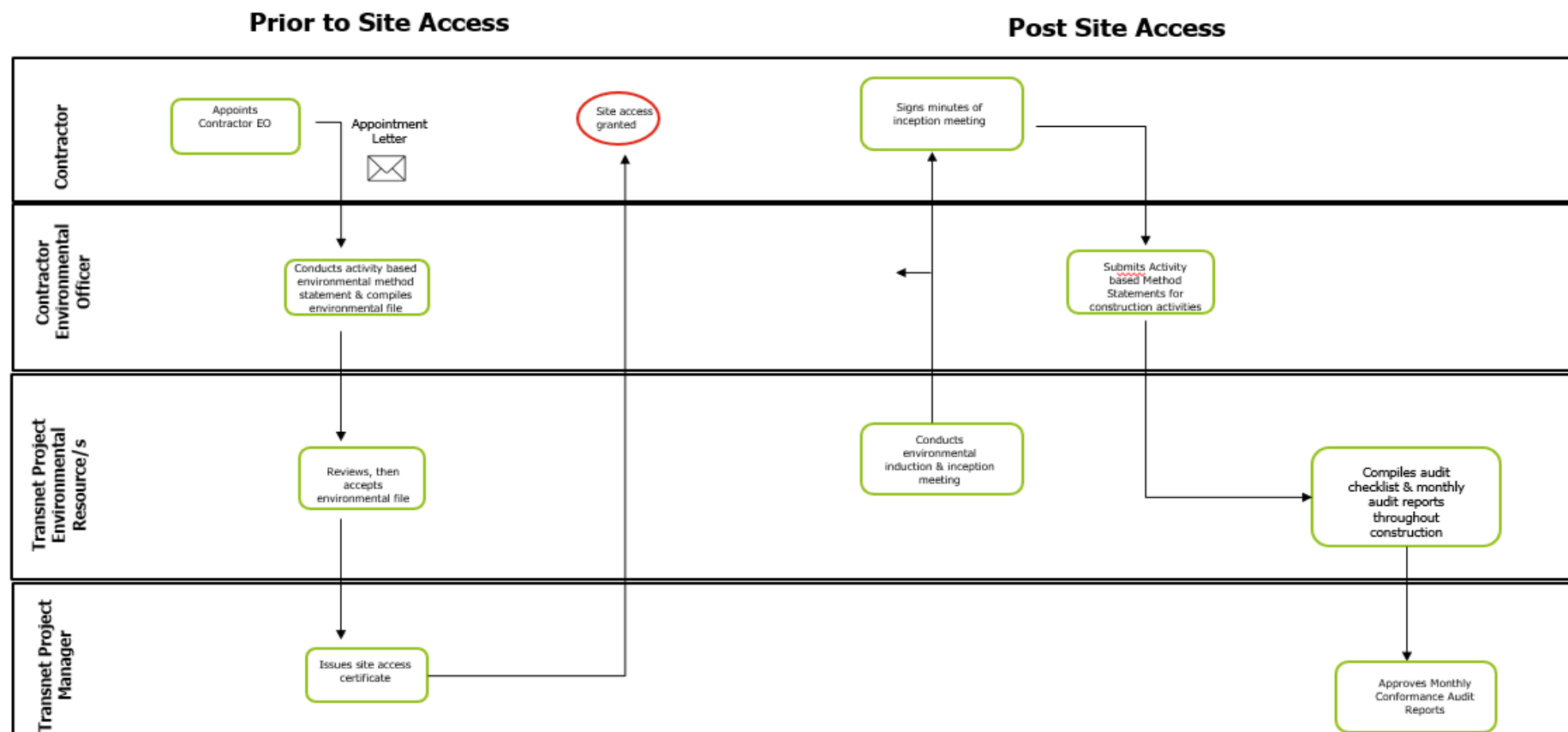
No	Item Description	Document No
15	Method Statements	009-TCC-CLO-SUS-TMP-11386.14
16	Waste Disposal Register	009-TCC-CLO-SUS-TMP-11386.15
17.1	Daily Inspection Checklist	009-TCC-CLO-SUS-TMP-11386.16
17.2	Weekly Inspection Checklist	009-TCC-CLO-SUS-TMP-11386.17
17.3	Monthly Inspection Checklist	009-TCC-CLO-SUS-TMP-11386.18
17.4	Environmental Inspection Findings Close-out Register	TIMS Procedure
18	Public Complaints Register	009-TCC-CLO-SUS-TMP-11386.19
19	Occurrence Register	TIMS Procedure
20	Transnet Occurrence Notification Report	TIMS Procedure
21.1	Environmental Occurrence Technical Form	TIMS Procedure
21.2	On-site Investigation Form – Incident Commander Report	TIMS Procedure
21.3	Investigation Form Report for Level 3 & 4 Occurrences	TIMS Procedure
21.4	Incident Commander Appointment Letter	TIMS Procedure
22	Non-Conformance Register	TIMS Procedure
23	Non-Conformance Report Form	TIMS Procedure
24	Non-Compliance Stop Certificate	TIMS Procedure
25	Application for Exemption	009-TCC-CLO-SUS-TMP-11386.20
26.1	Site Closure Inspection Form	TIMS Procedure
26.2	Site Closure Certificate	009-TCC-CLO-SUS-TMP-11386.21
26	Contractor's Environmental Management File Handover	009-TCC-CLO-SUS-TMP-11386.22

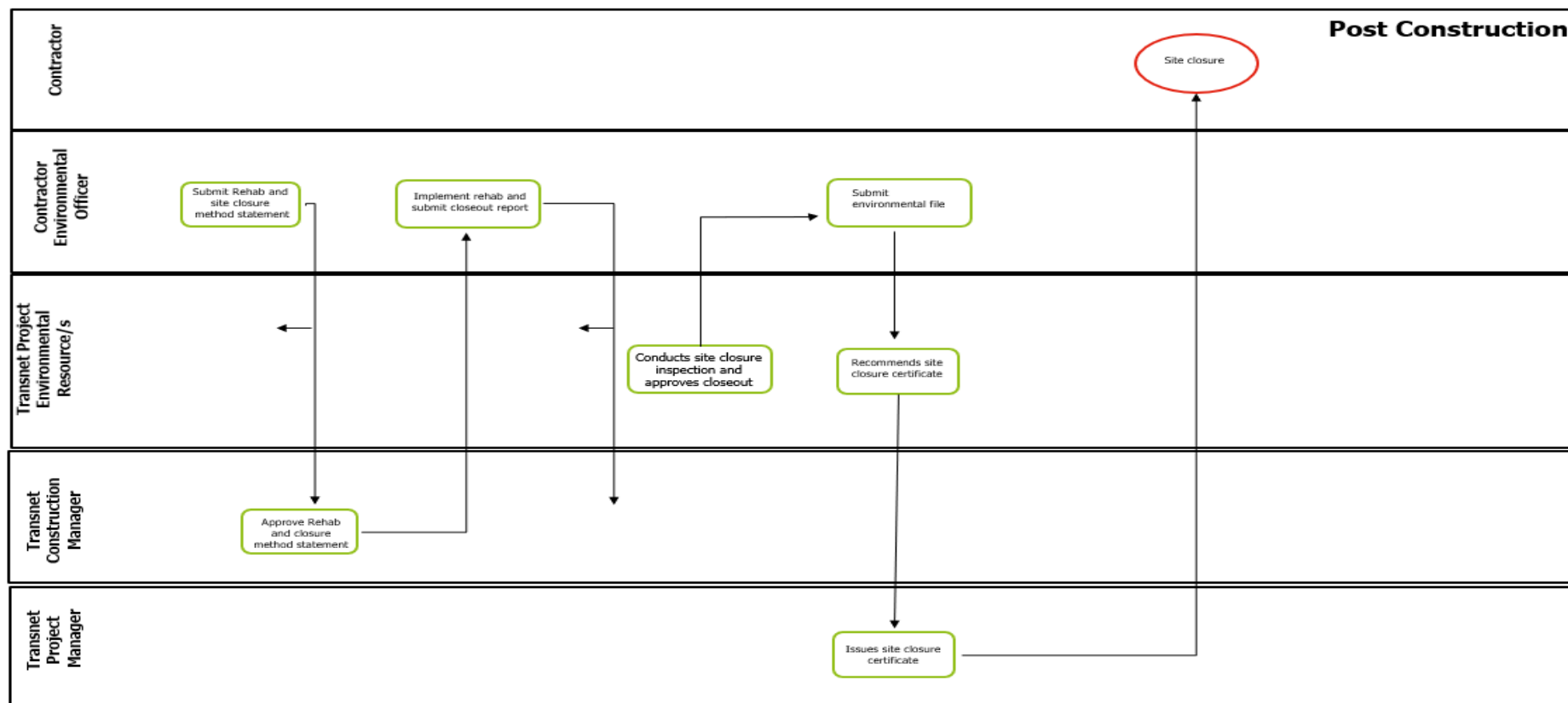
No	Item Description	Document No
27.1	Basic Environmental Rules for Visitors	009-TCC-CLO-SUS-GDL-11386.23
27.2	Basic Environmental Rules for Contractors	009-TCC-CLO-SUS-GDL-11386.24
27.3	Basic Site Procedure	009-TCC-CLO-SUS-GDL-11386.25

Annexure 8.3 Construction Environmental Management Process Flow

Tender Stage







SCOPE OF WORKS SUPPORTING ANNEXURES:

Annexure V: General Quality Requirements for Contractors and Suppliers (TNPA-QUAL REQ-014.1)



TRANSNET

GENERAL QUALITY REQUIREMENTS FOR CONTRACTORS AND SUPPLIERS

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1	Replacing Transnet Group Capital with Transnet		11/08/2020
2	Updated with ISO 9001:2015 referencing and adding clause numbering against requirements,		01/09/2023
3	Document number changed from TNPA-QUAL-STD-0001 to TNPA-QUAL-REQ-014.1		01/09/2023

Note: Only the latest amendments and/or additions are reflected in italics in the body of the document.

DOCUMENTATION SIGN-OFF SHEET

I, the undersigned hereby approve this procedure.

ROLE	CAPACITY/ FUNCTION	SIGNATURE	DATE
Process Owner	Quality Manager		01/09/2023
Accepts document for adequacy and practicability. Comments:			

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1. Purpose

This Specification outlines the minimum requirements to ensure that products and services supplied to TRANSNET are manufactured, provided, constructed or installed in accordance with all specified requirements as defined in the Contract, all associated specifications, drawings, codes and standards.

2. Definitions / Abbreviations

Term, Abbreviation	Meaning
<i>Contract</i> :	Formal document evidencing agreement between <i>Employer</i> and <i>Contractor</i> for supply of on site or off-site services (generic term used for Purchase Orders, Contracts and Service Orders in this Standard).
<i>Contractor</i> :	The party to a <i>contract</i> that provides services to the <i>Employer</i> (Generic term used for Vendors, Suppliers, Contractors, Consultants, etc.).
<i>Contractor</i> Documentation Schedule (CDS)	A schedule specifying the <i>Employer's</i> requirements for the document types to be submitted by the <i>Contractor</i> at various stages of the <i>Contract</i> and the timing of the submissions.
<i>Data</i> :	All drawings/documents/data/information/DPs and IOMs required to be supplied under the <i>Contract</i> .
<i>Data Pack (DP)</i> :	A compilation of manufacturing data, certification, inspection and testing records prepared by the <i>Contractor</i> to verify compliance with the Contractual requirements.
<i>Employer</i> :	The party to a <i>Contract</i> or Purchase Order to whom the goods are supplied or for whom the work or services are performed. In the context of this document, Transnet Capital Projects is the <i>Employer</i> .
<i>Field Inspection Checklist (FIC)</i> :	A document that details the checks, requirements and test parameters for each type of equipment to permit field installation and pre-commissioning of the equipment
<i>Inspection Release Report (IRR)</i> :	A document issued to the <i>Contractor</i> by TRANSNET advising release of materials for shipment. This does not relieve the <i>Contractor</i> of its obligations in accordance with the Terms and Conditions of the <i>Contract</i> .
<i>Inspection Waiver Report (IWR)</i> :	A document issued to the <i>Contractor</i> by TRANSNET advising that TRANSNET has waived final inspection for the materials listed in this document. The issue of this report does not preclude further inspections by TRANSNET. It is issued without prejudice and does not relieve the <i>Contractor</i> from the guarantees and obligations included in the <i>Contract</i> .
<i>Installation and Operating Manual (IOM)</i> :	A document prepared by the <i>Contractor</i> providing relevant information applicable to the installation and maintenance of the specific equipment, including data relating to consumables (e.g., Oils, etc.)
<i>ISO 9001:2015 terms</i>	"shall" indicates a requirement
<i>Non-Conformance (NC)</i>	Material, product or workmanship which is not in accordance with the requirements of the <i>Contract</i> .
<i>Non-Conformance Report (NCR)</i> :	A document initiated by either TRANSNET or the <i>Contractor</i> advising that certain materials/products/workmanship provided by the <i>Contractor</i> do not conform to the required standards and specifications.
<i>Project Quality Plan (PQP)</i> :	A document that outlines the <i>Contractor's</i> strategy, methodology, resources allocation, Quality Assurance and Quality Control coordination activities to ensure that Goods and Services supplied meet or exceed the requirements defined in the <i>Contract</i> drawings, codes and standards.



Term, Abbreviation	Meaning
Quality Assurance (QA):	A formal methodology designed to assess the quality of products or services provided.
Quality Control (QC):	A set of activities intended to ensure that quality requirements are being met.
Quality Control Plan (QCP):	A document outlining specific manufacturing/construction inspection and testing requirements, including responsibilities, test acceptance criteria, nomination of witness and hold points.
Technical Query Note (TQN):	A document used by the <i>Contractor</i> to formally clarify a Technical Query related to the scope of supply. This should not be used where a Non-Conformance Report has already been initiated.
TRANSNET:	Transnet SOE Limited
Works Information:	Refers to the <i>Works Information</i> as defined in the <i>Contract</i>

3. Applicable Documents

3.1 General

All work performed shall comply with the requirements of this Specification, the documentation referenced in the *Contract* and the latest revision/edition of the relevant Codes and Standards referenced herein.

3.2 Statutory Regulations

Occupational Health & Safety Act, Act No 85, of 1993 and Regulations as amended.

3.3 Codes; Standards and Procedures

Document No.	Title
ISO 9001: 2015	Quality management systems – Requirements
ISO 10005:2018	Quality Management systems- Guidelines for Quality plans
PROCEDURE 014	Contractor Management

4. Quality System

4.1 General

4.1.1 The Contractor will be responsible for all quality activities necessary to ensure the Work meets the requirements specified in the Contract and shall manage and coordinate all Quality aspects of the Work in accordance with the requirements of this Specification, together with the Contractor's PQP and QCPs once reviewed and accepted by TRANSNET.

4.2 Contractor Quality System Requirements

4.2.1 The *Contractor* shall have and maintain a documented Quality Management System. The *Contractor* may be required to demonstrate its use to TRANSNET. The *Contractor's* Quality Management System should be in accordance with the requirements of *International Standard ISO 9001:2015 Clause 4.4.1 Quality Management System and its process*.

4.3 Kick Off Meeting

4.3.1 After the *Contract* start date, and prior to manufacture or construction activities, TRANSNET will require a Kick-Off Meeting with the *Contractor* to discuss fully the importance of meeting TRANSNET's quality requirements. This meeting may be held as part of the *Contract* kick-off meeting for each package or may be a separate meeting, subject to the critical or complex nature of the work. This requirement for a pre-inspection meeting may be repeated when Sub-Contractors of key equipment are engaged.

Note: The above requirement must be applied in conjunction with ISO 9001:2015 Clause 8.4.3

4.4 Contractor / Supplier Documentation Submittal Requirements

4.4.1 The *Contractor* shall make a formal submission of his Quality Documentation on award of the *Contract* and at the times defined in the *Contractor's* Documentation Schedule, included in the *Works Information* for the *Contract*.

4.4.2 The Contractor's responsibilities are defined in terms of *DOC-STD-0001* which outlines the standard requirements for preparation, submission, receipt, review, and collection of Technical and (or) Deliverable Documentation, as detailed in the Contractor Documentation Schedule (CDS).

4.4.3 TRANSNET uses the *Contractor's* Documentation Schedule (CDS), included in the *Works Information* for the *Contract*, to indicate those documents required to be submitted for information/review and/or acceptance.

4.4.4 The *Contractor* shall develop and maintain a comprehensive register of documents (*Contractor's* Documentation Register – CDR) that will be generated throughout the project. The CDR includes all quality-related documents. The CDR is a 'live' document and is submitted to TRANSNET for review following each revision by the *Contractor*. The CDR indicates the dates of issue of the documents considering sufficient time to allow for the TRANSNET review/acceptance cycle prior to the document being required for use. A sample of a CDR (DOC-FAT-0002) is issued by TRANSNET at the start of every *contract*.

Note: The above requirements must be applied in conjunction with ISO 9001:2015 Clause 8.4.3 Information for external providers

4.5 Project Quality Plan

4.5.1 Where specified, the *Contractor* submits a PQP to TRANSNET within the period stated in the CDS and in any event not later than 28 days after the *Contract* start date. The PQP details how the *Contractor's* Quality System will be applied to the Scope of Work specified in the *Contract*, and shall address the following:

- a) Satisfying the technical and quality requirements of the Contractor's Scope of Work, and relevant elements of the applicable ISO 9001:2015 standard and should be developed with the reference to ISO 10005:2013 Guidelines.
- b) Include all quality activities relevant to the Scope of Work, identifying all procedures, reviews, audits, controls, objectives, and records used to control and verify compliance with the specified Contractual requirements.
- c) 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.
- d) Include all proposed method statements (for site-based work activities).
- e) Include a description of the Contractor's project organisation, with key positions and responsibilities identified and individuals named. The organisation structure shall also indicate the resources committed to the management and coordination of QA / QC activities.
- f) Include a listing of all Quality Control Plans (QCPs), and associated Field Inspection Checklists (FICs), as applicable.
- g) Identify in the PQP any Sub-Contractor/Sub-Supplier work. Sub-Contractor/Sub-Supplier plans are approved by the Contractor, and a copy forwarded to TRANSNET for information.
- h) Include the proposed Authorised Inspection Authority (where applicable - for pressurised equipment and systems).
- i) Include proposed quality records.

4.5.2 The PQP shall be controlled and re-submitted for approval when required to incorporate any change necessary during the *Contract* duration to ensure that the document is maintained as an effective control, change management and records. The change management will be done to an agreed policy or procedure.

Note: Where the *Contractor* is required to provide a PQP, no work shall commence until the PQP is accepted by TRANSNET.

Note: The above requirements must be applied in conjunction with ISO 9001:2015 Clause 8 Operations

4.6 Procedures

4.6.1 The *Contractor's* PQP and procedures shall address the system elements and activities appropriate to the Scope of Work, in compliance with the specified Quality Standard.

4.6.2 Where specified, the *Contractor* shall submit copies of Quality Procedures for review. In addition, the *Contractor* shall ensure that copies of all Procedures relevant to the Scope of Work are available for reference by TRANSNET at each work location.

4.6.3 These will include, as applicable, the following:

- a) Document Control, the *Contractor's* PQP shall provide a description of how documents provided by TRANSNET to the *Contractor* are to be managed. The description shall address as a minimum:
 - Management tools and databases
 - Receipt, registration and maintenance
 - Internal and external distribution to Employer, third parties and Sub-Contractors
 - Management of Codes, Standards and Specifications
 - Internal review and approval routines and authorities
 - How it is ensured that the correct revisions of documents are available at the point of use including retention periods for all documentation

Note: The above requirement must be applied in conjunction with ISO 9001:2015 Clause 7.5 Documented Information

- b) Design Control procedure, where the *Contractor* is responsible for any aspect of design related to the Scope of Work, the Quality Plan shall describe the *Contractor's* methods and procedures for the control of these design activities.

Note: The above requirement must be applied in conjunction with ISO 9001:2015 Clause 8.3 Design and development of products and services

- c) Procurement procedure, where the *Contractor* is responsible for any aspect of procurement related to the Scope of Work, the Quality Plan shall describe the *Contractor's* methods and procedures for the control of these activities.

5. Quality Audits

5.1 Contractor Audits

5.1.1 The *Contractor* shall Carry out audits in accordance with its Quality System at its own and Sub-Contractor's facilities to ensure project quality requirements are being achieved.

5.1.2 The *Contractor* shall include a QA Audit Schedule in the *Contractor* PQP submitted to TRANSNET prior to commencement of the Scope of Work. The Audit Schedule shall include all audits to be implemented by the *Contractor* and Sub-Contractor during the execution of the *Contract*.

5.1.3 The *Contractor* shall, where stipulated in the *Contract*, perform an audit within three months after the *Contract* start date and thereafter at a minimum frequency of three months. Audit reports are submitted to TRANSNET at the completion of each Audit. Where unsatisfactory performance is evident, TRANSNET will direct the *Contractor* to perform additional audits.

Note: The above requirements must be applied in conjunction with ISO 9001:2015 Clause 9.2 Internal Audit

5.2 Transnet Audit

5.2.1 Upon the appointment of the Contractor, the project Quality Officer will schedule and conduct the QMS Audit at the contractor's head office to assess the *Contractor's* ISO 9001:2015 Quality Management System status.

5.2.2 TRANSNET reserves the right to perform quality audits or participate as an observer in *Contractor* audits to verify compliance with the Contractual requirements. The *Contractor* shall, within the time frame as agreed upon, correct any adverse audit finding advised by TRANSNET.

5.2.3 The *Employer* may, at own discretion, require a Quality Audit of sub-contractor(s) to ensure that the sub-Contractor(s) have the necessary management, facilities, skilled staff, and quality control facilities to carry out the Works to ensure compliance with the Works Information.

6. Quality Control Plans

Note the of requirements of 6.1 to 7.7 must be applied in conjunction with ISO 9001:2015 Clause 8.5 Production and Service; ISO 10005:2018

6.1 Quality Control Plans

6.1.1 The *Contractor* shall prepare and submit QCPs to TRANSNET for review in accordance with the requirements of the Contract and PQP.

6.1.2 QCPs must clearly identify all inspection, test and verification requirements to meet the Contractual obligations, specifications, drawings and related details including destructive and non-destructive testing, acceptance criteria, witness and hold points.

6.1.3 The *Contractor* shall NOT commence fabrication or manufacture prior to review and approval of the applicable QCP by TRANSNET.

6.1.4 QCPs shall include reference to all tests specified in the *Works Information*.

6.2 Intervention Points

6.2.1 The QCP identifies points in the fabrication, manufacturing and/or installation process that are selected for inspection. These points are denoted by the following inspection codes:

a) Hold Point (H)	Inspection points in the manufacturing cycle, beyond which work shall not proceed without the specified activity, work or function being witnessed. Hold points require written notification to TRANSNET.
b) Witness Point (W)	An inspection point in the manufacturing cycle that will be witnessed or verified. If TRANSNET confirms it is unable to attend after being provided with the written notification, then manufacture may proceed. Witness points require written notification to TRANSNET.
c) Review Point (R)	A point at which products and quality records are verified and endorsed. Review points are not points that require notification to TRANSNET.
d) Surveillance (S)	An inspection point in the manufacturing cycle during which any activity, work or function is observed. No formal notification is required.

6.3 Field Inspection Checklists

6.3.1 For site installation and construction activities, the *Contractor* shall prepare Field Inspection Checklists (FICs) to permit inspection and testing of installed equipment and constructed facilities in accordance with the respective QCPs.

6.3.2 FICs are used to record the results of inspection and testing (where applicable). On completion, FICs are submitted to TRANSNET to confirm satisfactory completion of the tests and inspections at nominated QCP witness and hold points.



7. Inspection and Testing

7.1 General

7.1.1 Inspection means all activities such as measuring, examining, testing, gauging one or more characteristics of material or service and comparing these with specified requirements to determine conformity.

7.1.2 TRANSNET may, at its discretion, perform surveillance inspections at the *Contractor's* premises, the premises of any Sub-Contractor or at the location of the Scope of Work.

7.1.3 Dependent on the nature of the Scope of Work and the frequency of inspections, TRANSNET may elect to have inspection personnel resident at the place of manufacture, fabrication, or assembly.

7.1.4 The Contractor shall ensure free entry and access is given to TRANSNET, certifying authorities and statutory authorities to inspect the Scope of Work and review procedures and quality records at all parts of the *Contractor's* and Sub-Contractor's premises, or at the location of the Scope of Work while any work or test is in progress.

7.1.5 The *Contractor* shall provide TRANSNET with all necessary tools, calibrated measuring equipment, safety equipment and workspace to verify or witness tests in progress.

7.1.6 While TRANSNET is at the *Contractor's* premises, the *Contractor* shall provide, free of charge, reasonable facilities including office facilities and reasonable access to a telephone, facsimile machine and computer connection point.

7.1.7 The *Contractor* shall provide written notice within a time frame as agreed upon, to allow the attendance of TRANSNET and other representatives at nominated witness and hold points.

7.2 Schedule of Inspection

7.2.1 The *Contractor* shall submit a Schedule showing the proposed dates for inspections and tests nominated in the QCP where witness and hold points are required. The Schedule shall be regularly updated with progress and issued to TRANSNET to show the current inspection and test status.

7.3 Contractor's Inspection

7.3.1 The Contractor shall, as a minimum, carry out the inspections as detailed in the Quality Control Plan and maintain the required records for verification by the Employer and/or Third-Party Inspection Authority.

7.3.2 For sub-contracted material or services, the Contractor shall ensure that controls are effective, including, where necessary, monitoring of the Subcontractor's works and retention of the necessary records.

7.3.3 Signing-off of the Quality Control Plan progressively by all relevant parties is a mandatory requirement following the indicated inspection activity.

7.4 Readiness for Inspection

7.4.1 Material or services shall be deemed ready for inspection by the Employer and/or Project Manager only when:

- a) The Contractor has firstly carried out his own inspection at the stage identified on the relevant Quality Control Plan and is satisfied that material, workmanship and services meet the specified requirements. Documented evidence shall be maintained by the Contractor including signing-off the Quality Control Plan.
- b) The Contractor shall ensure that the latest revisions of approved drawings and/or procedures with evidence of acceptance by Transnet, his nominated representative or Third-Party Inspection Authority are available.



7.5 Inspection Notification

7.5.1 The *Contractor* shall notify TRANSNET in writing for inspections or tests within the country, arrangements are confirmed at least two working days before the event. For inspection and tests outside of the country, arrangements are confirmed at least seven working days before the event.

Inspection notifications include the following essential information:

- Contract Number
- Location of Inspection or Test
- Nature of Inspection or Test
- Date and Time of Inspection or Test
- Name and telephone number of the *Contractor's* Representative.

7.6 Cancellation of Inspection

7.6.1 Contractors are advised that it is a condition of Purchase / Contract that all costs of Employer's representative and/or Third-Party Inspection Authority will be passed on to the Contractor for cancellation of inspection visits.

7.6.2 A visit is considered cancelled if:

- a) The Contractor advises "readiness" for inspection and upon arrival of Employer's representative or Third-Party Inspection Authority, the material, or Services and/or the associated documentation is not ready; or
- b) If Employer's personnel identify that material or services are to specification such that the Contractor's Inspector should have identified the non-conformity prior advising readiness for Employer's or Third-Party Inspection Authority inspection.

7.7 Inspection Waiver

7.7.1 Any Employer's Witness, or review or Hold point may, at the sole discretion of Employer, be waived, which will be followed by an inspection waiver report.

8. Fabrication Process and Factory Acceptance Test

8.1 Fabrication Process

8.1.1 It is the *Contractor's* responsibility to ensure that all processes which require prequalified procedures and/or work methods are tested and qualified before work begins at the manufacture's premises. This typically covers such activities as welding, non-destructive testing, special fabrication techniques and painting. When such procedures are requested, no work shall commence at the manufacturer's premises until procedures are approved by TRANSNET.

8.1.2 It is the *Contractor's* responsibility to ensure all operators are qualified for the processes in accordance with the procedure and/or applicable standards. Records of qualification of operators shall be maintained by the *Contractor* and made available to TRANSNET when requested.

8.1.3 Records of qualification of procedures and processes shall be maintained by the *Contractor* in accordance with the applicable procedure or code.

8.1.4 The Employer's representatives are also required to do inspections during fabrication to ensure that the fabrication process is in accordance with the designs, specifications, and standards to ensure the work meets the requirements specified in the Contract. 8.1.1 Welding Procedures

8.1.5 Where the *Contractor's* Scope of Work includes fabricated weldments, Welding Procedure Specifications (WPS) defining the method, preparation and sequences to be adopted to achieve a satisfactory welded joint shall be provided for all weld types required in the execution of the *Contractor's* Scope of Work. The procedure shall only be submitted to TRANSNET when requested in the *Contract*.



8.1.6 WPS includes all welding essential and non-essential variables for each process used, including appropriate test results. WPS comply fully with the standard or code pertaining to welding required in the execution of the *Contractor's* Scope of Work.

8.1.7 When requested in the *Contract*, a suitably marked "weld map" is completed by the *Contractor* for all items to be fabricated. A summary of WPS is prepared and, when used, is identified on the weld map.

8.1.8 Where TRANSNET approval is required, fabrication is not to commence until written approval of WPS and Welding Procedure Qualification Records (WPQR) is received by the *Contractor*. No welding fabrication will be accepted that is not covered by a TRANSNET approved WPS/WPQR.

8.1.9 Welding Procedure Qualification (WPQ) tests may be witnessed by TRANSNET and/or an independent inspection authority. Testing of the specimens prepared during the WPQ Tests is carried out by an approved testing laboratory, independent of both TRANSNET and the *Contractor*. In certain instances, a certificate to EN 10204 3.1 B may be required which will be clarified at Tender review and clarification stage.

8.1.10 Where actual weld deposit analysis and weld metal physical properties are required for procedure qualification, the information is taken from the procedure qualification tests. Data listed in the catalogues of the manufacturer of welding consumables is not acceptable.

8.1.11 Welders/welding operators are qualified in accordance with the relevant welding code prior to commencing production fabrication. Specific Welder Qualification (WQ) records will be reviewed by TRANSNET in the *Contractor's* works and should NOT be submitted for review.

8.1.12 A register of welders qualified to work shall be maintained by the *Contractor*.

8.2 Material Traceability

8.2.1 Where, and to the extent that material traceability is required, the *Contractor* shall provide its procedures for the maintenance of material identification throughout all phases of manufacture. Methods of identification, routines for re-stamping or stenciling as appropriate shall be defined and agreed with the *Employer*.

8.2.2 Adequate records shall be maintained throughout construction enabling traceability of key materials from final product back to original material certificates. The material traceability records shall form part of the DP.

8.2.3 The *Contractor* shall prepare a schedule of materials and equipment that are subject to traceability requirements.

8.3 Material Certification

8.3.1 Where specified in the Contract the following certificates shall be provided to TRANSNET and included in the DP.

- a) *Type A*: A *Contractor's* certificate of compliance with the *Contract*. This certifies that the goods or services are supplied in compliance with the *Contract* without mention of any test results (EN10204 certificate 2.1).
- b) *Type B*: A certificate issued by a laboratory or test facility independent of the *Contractor's* works. It shall quote test results carried out on the product supplied and state whether compliance with the relevant technical standard, code, etc., has been complied with. (EN10204 certificate 3.1B).
- c) *Type C*: The same as Type B, the tests are to be witnessed by a third party (EN10204 certificate 3.1C).

8.4 Factory Acceptance Test

8.4.1 The factory acceptance test (FAT) is a process that evaluates the equipment during and after the assembly process by verifying that it is built and operating in accordance with design specifications.

8.4.2 The Contractor shall conduct a Factory Acceptance Test for all Plant's to be installed as part of the Works to be executed in this Contract prior to delivery to site. The Factory Acceptance Test shall be conducted in the presence of the Employer's representatives (Quality, Engineering and/or the Third-Party Inspection Authority).

8.5 Inspection Release

8.5.1 At completion of the Scope of Work, either in total or in phases, TRANSNET may issue an Inspection Release Report (IRR) or an Inspection Waiver Report (IWR).

8.5.2 The issue of either an inspection release or waiver of inspection does not relieve the *Contractor* of its obligations under the *Contract*. The *Contractor* ensures that a copy of the release note and final expediting release note for transport, where appropriate, is attached to the delivery docket and accompanies the Work to the designated destination indicated in the *Contract*. Items delivered to TRANSNET without a copy of these documents may not be accepted.

8.5.3 A copy of the inspection release or waiver of inspection is included in the DP.

9. Non-Conforming Products

9.1 General

Note the requirements of 9.1 to 9.3 must be applied in conjunction with ISO 9001:2015 Clause 10.2 Nonconformity and Corrective action

9.1.1 The *Contractor* shall establish and maintain procedures to control material or products that do not meet the specified requirements.

9.1.2 All Contractor product and/or materials identified as not conforming to requirements shall be dealt with promptly as follows:

- a) If the *Contractor* discovers material or product which is not in accordance with the requirements of the *Contract*, i.e., a non-conformance, the *Contractor* shall immediately initiate the non-conformance procedure in terms of the *Contractor's* Quality Management System, advise TRANSNET promptly, and provide a copy of the non-conformance report (NCR) to TRANSNET
- b) If TRANSNET or its agent identifies a non-conformance, a TRANSNET NCR may be raised.

9.1.3 Originals of all closed out NCRs shall be included in the DP.

9.2 Defects

9.2.1 The project Quality officer will notify the NEC supervisor / Construction Manager of any defects observed and long them on the snag list.

9.3 Corrective and Preventative Action

9.3.1 If the Contractor proposes a disposition of any non-conforming materials or product which varies from the requirements of the Specification or *Contract*, such a proposal shall be submitted in writing to TRANSNET whose decision on the proposal shall be obtained in writing before the non-conforming material or product is covered up or incorporated into the Works, or is the subject of any other disposition.

9.3.2 The disposition of non-conformances which do not vary the requirements of the *Contract*, specification or drawings may be approved by the *Contractor* following discussion and agreement with TRANSNET.

10. Concession Requests and Technical Queries

10.1 Concession Requests

10.1.1 Where a *Contractor* requests a Concession to deviate from the requirements of the *Contract* or specified requirements, the *Contractor* raises the request for TRANSNET review and approval.

10.1.2 The Concession Requests shall clearly identify all elements of the proposed deviation together with any resulting technical, commercial and/or schedule impacts.

10.1.3 Completed original Concession Requests shall be included in the DP.

Note: The above requirements must be applied in conjunction with ISO 9001:2015 Clause 8.7 Control of Non-Conforming outputs

10.2 Technical Queries

10.2.1 For clarification of technical issues (only), the *Contractor* may submit a Field Engineering Query (FEQ) to TRANSNET in accordance with the *Contract*.

10.2.2 The FEQ shall clearly identify all elements of the query, and all supporting documentation and/or drawings shall be attached where appropriate.

Completed original FEQ's shall be included in the DP.

11. Inspection, Measuring and Test Equipment

Note the requirements of 11.1 to 11.3 must be applied in conjunction with ISO 9001:2015 Clause 7.1.5.1 & 7.1.5.2 General and Measurement traceability

11.1 Calibration

11.1.1 The *Contractor*, including its Sub-Contractors/Sub-Suppliers, shall ensure the calibration of test and measuring equipment is performed and maintained in accordance with the relevant *Contractor* procedures and/or the equipment manufacturer's specifications.

11.1.2 Where calibration is required by an external laboratory, the *Contractor* shall ensure that the facility selected for calibration possesses current certification. Calibration certificates shall contain a statement that the test equipment is accurate to within specified tolerances.

11.1.3 The Contractor should establish the frequency of calibration for each item of equipment (including jigs, fixtures or templates) and record the details in a 'Measuring and Test Equipment Register' (or similar).

11.2 Use of Inspection, Measuring and Test Equipment

11.2.1 The *Contractor* shall ensure that authorized equipment users:

- a) Use the equipment in accordance with manufacturer's instructions, and accepted industry practices
- b) Ensure the equipment is covered by a current calibration certificate
- c) Conduct the measurements or tests in accordance with the equipment manufacturer's specifications or other relevant specification
- d) Prior to commencement of each inspection or test activities:
 - Identify the measurements to be made
 - Determine the accuracy required
 - Select the appropriate inspection, measuring or test equipment for the scope of work.

11.3 Verification of Previous Test Results

11.3.1 Where the calibration status of the equipment is unknown, expired or has doubtful accuracy, the equipment shall immediately be quarantined, and tagged according to *Contractor's* Quality System procedures. The *Contractor* shall then arrange for either in-house or external calibration, and:

- a) review all previous test results associated with the suspect equipment;
- b) identify the inspections, measurements or tests required to re-validate the results;
- c) ensure that suitable re-testing is performed with calibrated equipment;
- d) record the results of the re-testing on the respective inspection and test documentation.

12. Quality Personnel Qualifications

12.1.1 The contractor shall nominate/appoint a Quality officer with minimum experience and qualifications specified in the Tender documents.

12.1.2 The Contractor shall submit the CV and relevant qualifications of its nominated/appointed quality representative for the Project Manager's review and approval.

12.1.3 Should the approved qualify officer be no longer available, the contractor will notify the Project Manager in writing and upon agreement the contractor will provide the CV and qualifications of the proposed resource that is equivalent to the previously approved.

Note: The above requirements must be applied in conjunction with ISO 9001:2015 Clause 7.2 Competence

13. Quality Records

13.1.1 *Contractors* shall maintain Quality Records necessary to provide objective evidence that demonstrates and verifies achievement of the QA / QC requirements associated with the Scope of Work.

13.1.2 All Quality Records, including original source material test certificates and non-destructive test reports, shall be retained by the *Contractor* during the project, and be provided to TRANSNET at the times, and in the quantities specified in the *Contract*.

13.1.3 The *Contractor* shall collate all quality records in the Data Pack (DP) and submit the DP to TRANSNET in accordance with the *Contract* and all referenced standards and specifications. This DP shall be compiled progressively and shall be available for review at all phases of manufacture or construction activities.

13.1.4 The Scope of Work shall not be complete until the *Contractor's* DP, including the quality records from Sub-Contractors/Sub-Suppliers, has been reviewed and accepted by TRANSNET.

13.1.5 The *Contractor* compiles the DP progressively during the execution of the Scope of Work and makes the DP available for review by TRANSNET as required.

13.1.6 The *Contractor* shall retain a copy of all Quality documentation generated during the *contract*, including a copy of the complete DP, for his own records for a minimum period of five years after the completion of the work.

Note: The above requirements must be applied in conjunction with ISO 9001:2015 Clause 7.5.3 Control of Documented Information