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1. INTRODUCTION

The purpose of this modification is extend the design life of the DC essential supply systems of Ankerlig Power Stations and to remedy any non-conformance to Eskom standards. The inverters have reached the end of design life. This modification would also allow for the latest technology to be procured which guarantees spares availability and local maintenance support.

2. SUPPORTING CLAUSES

2.1 SCOPE

The scope of this technical specification covers the inverters only of the DC essential supply systems across the station.

2.1.1 Purpose

The purpose of this technical specification is to state the employer's technical requirements and provide the contractor with the necessary information to submit a comprehensive tender.

2.1.2 Applicability

This document shall apply to Peaking and is to be used as an input to the associated works information.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] ISO 9001 Quality Management Systems.
- [2] 240-53114002 Engineering Change Management Procedure
- [3] 240-53114248 Thyristor and Switched Mode Charger, AC/DC to DC/AC Converters and Inverter/ Uninterrupted Power Supplies Standard
- [4] 240-53114186 Project Plant Specific Technical Document and Records Management Procedure.
- [5] 240-53114248 Thyristor and Switched Mode Charger, AC/DC to DC/AC Converters and Inverter/ Uninterrupted Power Supplies Standard
- [6] 240-71432150 Plant Labelling Standard
- [7] 240-170000055 Installation and Commissioning of Power Electronics Equipment
- [8] 240-86973501 Engineering Drawing Standard
- [9] NRS002 Graphical Symbols for Electrical Diagrams

2.2.2 Informative

- [10] Occupational Health and Safety Act and Regulations (Act 85 of 1993).
- [11] 36-681 Eskom Plant Safety Regulations
- [12] 240-170000055 Installation and Commissioning of Power Electronics Equipment.
- [13] 192/9701833-A Engineering Investigation Report for DC Essential Supply System at Ankerlig 1 Power Station

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- [14] 192/9701833-F Stakeholder Requirement Definition for Ankerlig 1 DC Essential Supply System Replacement
- [15] 192/9701833-G Concept Design Report Ankerlig 1 DC Essential Supply System Replacement
- [16] 192/9701833-K Detail Design Report Ankerlig 1 DC Essential Supply System Replacement
- [17] 193/404775-A Engineering Investigation Report for DC Essential Supply System at Ankerlig 2 Power Station
- [18] 193/404775-F Stakeholder Requirement Definition for Ankerlig 2 DC Essential Supply System Replacement
- [19] 193/404775-G Concept Design Report Ankerlig 2 DC Essential Supply System Replacement
- [20] 193/404775-K Detail Design Report Ankerlig 2 DC Essential Supply System Replacement

2.2.3 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

3. DESCRIPTION OF THE WORKS

3.1 Executive overview

The works make provision for the design, manufacture, FAT, delivery, installation, commissioning and SAT of the inverters, and the decommissioning and removal of the inverters at Ankerlig 1&2 Power Station. The works include the termination of existing cabling onto new equipment.

Ankerlig 1&2 Power Station is located on Neil Hare road, Atlantis, Cape Town on the west coast of the Western Cape.

3.2 Employer's objectives and purpose of the works

The current system equipment has reached the end of design life, The purpose of the works is to extend the design life of the system by replacing the inverters and to ensure that new equipment is replaced with the latest technology. The employers seeks to receive fully functional inverters as specified in the works, with a minimum design life of 15 years.

3.3 Interpretation and terminology

The following abbreviations are used:

Abbreviation	Meaning given to the abbreviation
AC	Alternating Current
AIA	Approved Inspection Authority
AFC	Approved for construction
CPA	Cost Price Adjustment
DC	DC Direct Current
OEM	Original Equipment Manufacturer

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KKS	Kraftwerk Kennzeichen System
LV	Low Voltage < 1000 V AC/DC
OHSA	Occupational Health and Safety Act
PS	Power Station
QC	Quality Control

4. MANAGEMENT AND START UP

4.1 Engineering quality assurance requirements

4.1.1 Quality Plan

The contractor shall submit a quality control plan for the execution of the works, maintaining the below minimum control points:

Activity Interventions		
H	Hold	Employer's representative to verify activity/intervention point is complete. Activity cannot be considered complete and the Contractor may not proceed with his schedule until the activity is signed off by Employer's representative.
W	Witness	Employer's representative to be informed of inspection/activity completion. If Employer's representative does not attend the final sign off inspection, the Contractor may continue with his schedule at his own risk.
S	Surveillance	The Contractor is responsible for ensuring the activity or material requirements are in accordance with the Contract specification. Documented evidence to be submitted to the Employer.

Document/Record Requirements		
R	Review	Employer's representative to review documentation for acceptability. The Contractor's program may not proceed until acceptance of the submitted documentation.
X	Submitted	Documentation or records to be submitted to the Employer
O	Not Required	No documentation required.

Activity	Intervention	Documentation
Approval of installation program	H	R
Material and Equipment certificates	S	R
Final Installation	H	X
Final Commissioning	H	X

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4.1.2 Meetings

Regular meetings of a general nature may be convened and chaired by the project manager as follows:

- Prior to site implementation – At least once a month
- During implementation - Daily progress meetings at the site
- Meetings of a specialist nature may be convened as specified elsewhere in this technical specification or if not so specified by persons and at times and locations to suit the parties, the nature and the progress of the works. Records of these meetings shall be submitted to the project manager by the person convening the meeting within five days of the meeting.
- All meetings shall be recorded using minutes or a register prepared and circulated by the person who convened the meeting. Such minutes or register shall not be used for the purpose of confirming actions or instructions under the contract as these shall be done separately by the person identified in the conditions of contract to carry out such actions or instructions.

4.1.3 Documentation Control

- The contractor implements a comprehensive document control of all documents, their revision status and of the document status in relation to the 'as built' and 'as designed' or commonly known as “approved for construction” plant status. In this regard the contractor ensures that the documentation supplied by the project manager as tie-in information, accurately reflects the contract requirements.
- The contractor submits all documentation throughout the design phases of the project in electronic format to the project manager
- The contractor submits the final documentation on a formal transmittal form in triplicate to the project manager. All correspondence is sequentially numbered.
- The contractor adheres to employer’s technical documents and record management procedure (240-53114186) for all documents submitted.
- The documentation and drawings supplied is in South African English and SI units are used. The employer does not accept scanned electronic copies of documentation or drawings; however the original documentation with signature is scanned for electronic purposes.
- Documentation are of good quality, prepared by suitably qualified personnel and contain the general arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all equipment.

4.1.4 Health and Safety Risk Management

The Contractor shall comply with the South African Occupational Health and Safety Act No. 85 of 1993 and regulations, Eskom Safety, Health, Environment and Quality (SHEQ) Policy 32-727, National Building Regulations as well as SANS 10400 for all works. Furthermore, the Contractor shall comply with any additional current statutory requirements of any relevant Government Departments regarding health and safety and environmental health.

The Project Manager is entitled to request the Contractor to stop work, without penalty to the Employer, when the Contractor’s personnel fail to conform to acceptable health & safety standards or contravene the health and safety sections and regulations. The Project Manager must be informed immediately or before the end of a particular shift of any injury or damage to property or equipment.

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The Contractor to provide all the required safety and personal protective Equipment to his staff for the duration of the contract.

Ankerlig SHE Specification, applicable procedures, policies, guidelines and standards which will be used as Eskom's minimum requirements for Health and Safety will be provided.

The Contractor shall comply with the requirements for COVID-19 as per Government Directive from Department of Employment and Labour (DEL); Consolidate COVID-19 Direction on Health and Safety Measures in Workplaces issued by Minister in terms of Regulation 4(10) of the National Disaster Regulation.

Only the latest version/ revision of the applicable legislation, acts and regulations shall be deemed to be accepted at Ankerlig Power Station. Not limited to the following below legislation, acts and regulations are complied with:

- Compensation for Occupational Injuries and Diseases Act 130 of 1993
- National Water Act 36 of 1998
- Occupational Health and Safety Act and Regulations (85 of 1993)
- Disaster Management Act 57 of 2002.
- National Environmental Management Act 107 of 1998
- Applicable South African National Standards (SANS)
- National Road Traffic Act 93 of 1996
- Basic Conditions of Employment Act 75 of 1997
- National Veld and Forest Fire Act and Regulations 101 of 1998
- Environmental Conservation Act and Regulations 73 of 1989
- Committee of Land Transport Officials (COLTO)
- SACPCMP Act no. 48 of 2000
- Radiation Protection Act

The Contractor shall establish and enforce rules to ensure the health and safety of his own employees and those of its Subcontractors so that high standards of personnel health and safety are achieved and maintained. The Contractor shall exercise and enforce all necessary care and measures to preclude exposure of personnel, labour and nearby residents (if any) to potential health hazards and environmental pollutants.

The Contractor shall ensure that all persons which are employed and or deployed to work on site undergo police clearance and are certified to have no criminal records. This shall be done prior to them being allowed or given access to start work on site.

The Contractor is required to compile a SHE File to comply with the Employer's specification, which includes but not limited to the following:

- Safety, Health and Environmental Plan (SHE Plan)
- SHE organization within the Company-Responsibility & Accountability
- OHS Incident management Procedure (32-95)

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- Planning of conduct of work activities including planning for changes and emergency work (Operational Plan)
- Management of PPE- Personal Protective Equipment (Procedure with the matrix)
- Emergency planning and fire risk management
- Vehicle and driver behaviour safety (Competency, Traffic Management, etc.)
- Sub-Contractor or supplier selection and management
- Design and specifications (Drawings)
- Key personnel competency, training, appointments
- Communication and awareness Plan
- Behavioural Based Safety Procedure
- Employer's Baseline SHE Risk Assessment (BRA).
- Contractor's Baseline Risk Assessment in line with the Employer's BRA (Identification, assessment and management of Safety, Health and Environmental risks related to the scope of work. The methodology used for the risk assessment must be provided together with the BRA.)
- Valid Letter of Good Standing (COIDA or equivalent)
- SHE policy signed by CEO/ MD- Comply to OHS Act Section 7 or ISO 45001
- Occupational hygiene and health risk assessment
- Medical surveillance
- Method Statements/ Safe Working Procedures
- COVID-19 Risk Assessments and Workplace Plan

In addition, reference is to be made to Health and Safety Specification, for documents and policies which the Contractor is to adhere to.

4.1.4.1 SHE File

The Contractor is required to compile a SHE File before the commencement of work. The SHE file must be submitted to the employer for review and acceptance, fourteen (14) days before any work can commence.

4.1.5 Work Packages

For all site related work the contractor is required to submit a work package before any type of work can commence on the employers plant. The required format of the work package is accordance with template 167A/158-A and a signed copy is provided by the contractor after the employer has reviewed and accepted the work package as final prior to any work.

4.1.6 Programming Constraints

- The contractor submits a bar chart program (in MS Project format) detailing how the works are executed within the stipulated dates, including weekends and public holidays,
- The contractor submits the program within two week after contract award,
- The program is updated and submitted weekly to the employer for acceptance,
- The program indicates the start date, completion date and duration of each activity,

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- The program is updated and submitted every four weeks during the manufacturing process and daily during site implementation or sooner depending on the urgency of the matter.

4.1.7 Contractor's Management, Supervision and Key People

- The contractor does not modify any plant or materials unless accepted by the employer prior to implementation.
- The contractor notifies the employer at least two days in advance of a hold or witness point on the works.
- The contractor informs the employer of any defect found and notify the employer at least two days in advance of a hold or witness point on the works.
- The contractor does not operate any equipment on site, unless specific authorisation is obtained from the employer.

4.2 Training workshops and technology transfer

Formal training is conducted as part of this contract before completion of the works. The contractor trains the employer's personnel on the equipment specified below. The contractor will provide training to the employers personnel in to separate sessions on separate days in order to accommodate for COVID-19 restriction. The contractor is responsible for providing a training register in order to keep as proof of training provided. The signed off training register by all participants is also be supplied to the employer.

5. ENGINEERING AND THE CONTRACTORS DESIGN

5.1 EXISTING INSTALLATION

The inverters are equipment that forms part of the DC Essential supply systems at the referenced power stations. Each of these systems provide power to the station and all units. The following is the system identification for equipment:

Ankerlig 1

	<u>Description</u>	<u>Floc</u>
Station (OCGT)	Station inverter A	0 0BRU01 GU001
	Station inverter B	0 0BRU02 GU001

Ankerlig 2

	<u>Description</u>	<u>Floc</u>
Station (GAS)	Station inverter A	0 1BRU01 GU001
	Station inverter B	0 1BRU02 GU001

The DC essential supply system supplies the loads via the distribution boards and simultaneously float charge the batteries. Once there is a supply loss or failure of the charger, the batteries will then supply the loads for a certain standby time. The DC-DC converter converts the nominal 220V DC to 24V DC for critical C&I loads. The system is designed with adequate redundancy to maintain high

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reliability. The 230V AC station inverters provide supply to essential AC station and unit loads and are supplied from the nominal 220V DC bus.

The employer shall provide detailed layout drawings of the works for submission to the contractor. The drawings shall clearly define the works boundaries as well as defining the preferred layout for the works and the equipment interfacing points.

5.2 EMPLOYERS DESIGN

5.2.1 Equipment Specifications

The employers has designed the following for work specifications for the equipment:

- Inverters

Ankerlig 1 (Station)				
		measure		tolerance
Input DC	Voltage	V	220	+20/-15%
	Current	A	40	
Input (Bypass) AC	Voltage	V	230	+- 10%, 1 phase
	Current	A	43.4	
	Frequency	Hz	50	+- 3%
Output AC	Voltage	V	230	+- 1%, 1 phase
	Current	A	43.4	
	Frequency	Hz	50	+- 0.1%
	synchronising range	Hz	50	+-3%
	Power	kVA	10	
Dimensions (mm)	H	mm	2200	
	W	mm	600	
	D	mm	800	
Cable Entry			Bottom	
Cooling Mode			natural air cooling	
Overload Behaviour			150% for 60s	
			125% for 10min	
			110% for 20min	
Short Circuit Behaviour			short circuit proof	
Efficiency			>95%	
Temperature			50%	

Ankerlig 2 (Station)				
		measure		tolerance
Input DC	Voltage	V	220	+20/-15%
	Current	A	58.3	
Input AC	Voltage	V	230	+- 10%, 1 phase

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	Frequency	Hz	50	+ - 3%
Output AC	Voltage	V	230	+ - 1%, 1 phase
	Current	A	65.2	
	Frequency	Hz	50	+ - 0.1%
	synchronising range	Hz	50	+ - 3%
	Power	kVA	15	
Dimensions (mm)	H	mm	2200	
	W	mm	800	
	D	mm	800	
Cable Entry			Bottom	
Cooling Mode			natural air cooling	
Overload Behaviour			150% for 60s	
			125% for 10min	
			110% for 20min	
Short Circuit Behaviour			short circuit proof	
Efficiency			>95%	
Temperature			50%	

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5.2.2 Existing Installation Supply and Interfaces

The following electrical supply interfaces with the equipment existing equipment and will be reused for new equipment:

Ankerlig 1

<u>AC Incomers</u>		
	Station Inverters	
	Inverter A (00BRU01 GU002)	Inverter B (00BRU02 GU0020)
Voltage	230VAC	230VAC
Frequency	50Hz	50Hz
Current	43.4A	43.4A
Breaker Rating	50-63A	50-63A
Breaker KKS	(-Q01)	(-Q01)
Board Point of Installation	00BHA52.GA001	00BMA07.GA001
Low Voltage Distribution Board KKS	00BHA	00BMA
Cable No:	00BHA1022	00BMA1050

<u>DC Incomers</u>		
	Station	
	Inverter A	Inverter B
Voltage	220V	220V
Current	40A	40A
Breaker Rating	40-50A	40-50A
Breaker KKS	(-Q01)	(-Q01)
Cable No:	00BUD1005	00BUE1005
Board Point of Installation	00BUD02.LA001	00BUE02.LA001
220 DC Distribution Board	00BUD	00BUE

Ankerlig 2

<u>AC Incomers</u>		
	Station Inverters	
	Inverter 1 (01BRU01 GU002)	Inverter 2 (01BRU02 GU002)
Voltage	230VAC	230VAC
Frequency	50Hz	50Hz

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Current	65.2A	65.2A
Breaker Rating	63-80A	63-80A
Breaker KKS	(-Q01)	(-Q01)
Board Point of Installation	01BMA52.FA001	01BMB52.GA001
Low Voltage Distribution Board KKS	01BMA	01BMB
Cable No:	01BMA1036	01BMB1043

<u>DC Incomers</u>		
	Station	
	Inverter 1	Inverter 2
Voltage	220V	220V
Current	59A	59A
Breaker Rating	63-80A	63-80A
Breaker KKS	(-Q01)	(-Q01)
Cable No:	01BUD1006	01BUE1006
Board Point of Installation	01BUD02.LA001	01BUE02.LA001
220 DC Distribution Board	01BUD	01BUE

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5.3 PARTS OF THE WORKS WHICH THE CONTRACTOR IS TO DESIGN

The contractor shall decommission and remove the existing equipment as identified in Section 5.1

The contractor shall manufacture, procure, supply and install all equipment necessary for completion of the works. This includes, but is not limited to:

Ankerlig 1

- 2 x Station inverters as specified in Section 5.2

Ankerlig 2

- 2 x Station inverters as specified in Section 5.2

The contractor shall ensure that equipment issued complies fully with the specifications as indicated in Appendix A of this document as per schedule A. Any deviations from schedule A should be documented in schedule B and listed in the deviation schedule Appendix B and sent for review/approval to Eskom

5.4 PROCEDURE FOR SUBMISSION AND ACCEPTANCE OF CONTRACTOR'S DESIGN

The contractor shall submit all necessary documentation to the project manager for acceptance prior to any fabrication or procurement taking place. The documentation required for acceptance shall be:

- Data sheets of proposed inverters
- Internal single line diagram diagrams – Inverters
- Decommissioning of existing equipment Procedure
- Installation/Erection Procedure
- Project Schedule
- Quality Control Plan

5.5 OTHER REQUIREMENTS OF THE CONTRACTOR'S DESIGN

5.5.1 Design & Constructability Requirements

- The logistics of installation needs to be considered carefully. A 14 day outage is foreseen for the execution of works. This includes the installation of all equipment specified in this document. Due to the spacial limitation on site the sizing of equipment must be strictly adhered to.
- All plant material provided must be new.
- Existing cabling must be re-used and should be clearly marked before disconnecting from the existing equipment.
- The contractor must adhere to Eskom Installation and Commissioning of Power Electronics Equipment Procedure as indicated in Section 2.2.1[7] when doing the performing installation works on site.

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5.5.2 Software and Firmware

5.5.2.1 General

- Software for equipment equipped with serial and network interfaces whereby fault recordings, sequence of events, settings and marshalling can be accessed by a PC and are downloadable in an acceptable format (e.g. csv, xls, and txt), shall be made available as it is deemed to be an integral part of the required inverter system functionality. This software shall be compatible with the current Eskom approved Microsoft Windows (latest available) operating system. Software with DOS as the operating system will not be acceptable. Details of various operating systems supported shall be included in the tender documentation.
- Any future software versions shall be backward compatible.
- The cost of the software, including software manuals, disks and serial cable, shall be limited to a fair cost that shall be included in the tender documentation. A “fair cost” is deemed to be an amount sufficient to cover the material cost and overhead of such items and not the perceived intellectual value of the software. Eskom shall have the right to freely copy the software and reproduce the manuals for exclusive use within Eskom and the successful tenderer shall issue Eskom with a Corporate Software Licence. Preference will be given to on-board web based software which does not require additional software installation.
- The supplier shall provide software support for the full, guaranteed, lifetime of the hardware.
- The supplier shall, on request from Eskom, provide Eskom with the necessary software detail when this is required for the inverter system interfacing with future or existing systems.
- The supplier shall adhere to the software control standard 240-76624509: Control of New Metering Product and Version Changes in Technical, Software, Firmware and Hardware.
- All settings and display features available on the front keypad / display of the inverter system shall be available on the operating software for remote or local applications.
- The alarm / event log page shall be able to be downloaded as a text (*.txt) or excel (*.xls) file to the host PC.
- The software shall be able to save all alarm / charge mode settings as a file (settings sheet) which can be uploaded to the inverter system. All the inverter settings shall also be downloadable into the setting template format.
- The software shall display the status of any modules connected to the inverter system
- During an AC mains failure condition or equipment system failure, the inverter system shall record the discharge curve (battery bank voltage and current, as a minimum) of the battery until the inverter system shut down due to low volts. The recording function shall be optimised to save memory space. This discharge information shall be downloaded when the inverter system is back to normal for review purposes. This file shall also be able to be downloaded to the remote PC, for viewing with the front- end software. This data shall not be stored on or reduce the required memory allocated for normal event logging purposes.

5.5.2.2 Software verification and validation

- To meet the requirements of future contracts based on this specification, if a microprocessor based inverter is being offered, the contractor shall supply evidence on request in the form of reports from a mutually acceptable third party that:
- An adequate formal specification for the software has been produced, based on a requirement document and comprehensive hazard analysis.

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- The software has been developed using tested tools, adequately trained staff and using an acceptable quality management system. In particular, all stages of design, development and testing process shall have been adequately planned and documented.
- The software has been formally verified to ensure that it matches its specification.

5.5.2.3 System firmware

- The equipment system firmware version shall be displayed on the rectifier and controller module display and on the operating software.
- Any inverter system based firmware (EPROM or Flash ROM) supplied to Eskom, shall not be changed unless Eskom requests the modification or Eskom gives written approval to the supplier to do the proposed modification. Any modification shall be subject to testing and verification and formal approval, in writing by Eskom, shall be required prior to the supplier placing the altered firmware into operation. The requirements of 240-76624509: Control of New Metering Product and Version Changes in Technical, Software, Firmware and Hardware, shall be adhered to.
- The estimated data retention time of EPROM or FLASH ROMs used in the inverter systems shall be the design life of the equipment.
- The equipment firmware shall be upgradeable via remote communication and security checks shall be in place to ensure that such remote upgrade has been successfully completed. In the event of the remote upgrade being unsuccessful, the inverter shall resume normal operation on the older firmware version.

5.5.2.4 The equipment system software operational features

- All settings and display features available on the front keypad / display of the inverter system shall be available on the operating software for remote or local applications.
- The alarm / event log page shall be able to be downloaded as a text (*.txt), excel (*.xls), Comma-separated values (*.csv) file to the host PC.
- The software shall be able to save all alarm / charge mode settings as a file (settings sheet) which can be uploaded to the inverter system. All the inverter settings shall also be downloadable into the setting template format.
- The software shall display the status of any modules connected to the inverter system.
- The software shall display the status of the remote communications connection.
- During an AC mains failure condition or equipment system failure, the inverter system shall record the discharge curve (battery bank voltage and current, as a minimum) of the battery until the inverter system shut down due to low volts. The recording function shall be optimised to save memory space. This discharge information shall be downloaded when the inverter system is back to normal for review purposes. This file shall also be able to be downloaded to the remote PC, for viewing with the front-end software. This data shall not be stored on or reduce the required memory allocated for normal event logging purposes.

5.5.3 Configuration Management

The contractor shall label the equipment in accordance with the Eskom Plant Labelling Standard as indicated in Section 2.2.1 [6]. The employer shall provide the contractor with the desired label description and KKS code and the contractor shall print the label as given by the employer

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5.5.4 Civil Requirements

Ankerlig 1 and 2 Station

The allowable point load for the location of the inverters is $G=4\text{kN}$. Since the new equipment will replace the old equipment in the exact same positions, the floor plan will not change. The new equipment shall not exceed the permissible loading as illustrated in the loading schedule as per drawing issued in section 9.1 of this document. The following are the weight specifications for the equipment:

- Inverter – may not exceed 400Kg

5.5.5 Mechanical Requirements

5.5.5.1 General

- The Inverter ASSEMBLY shall comply with the fundamental safety requirements of Clause 5 of SANS 10142-1 and SANS 62040-1, Uninterruptible power systems (UPS) Part 1: General and safety requirements for UPS.
- The Inverter ASSEMBLY shall as a minimum be designed, constructed and tested in accordance with the requirements of Clause 6.6 of SANS 10142-1.
- All components and electric conductors fitted to the ASSEMBLY shall be certified as safe by means of a valid Regulatory Certificate of Compliance (RCC) in accordance with SANS 10142 - 1 Table 4.2 or an SABS Mark of approved performance.

5.5.5.2 Doors and covers

- For easy access, each cable compartment and each fixed pattern functional unit sub -section shall be provided with individual hinged doors.
- All removable covers shall require the use of a tool for their removal.
- All opening doors shall be pad lockable.
- Doors shall have not less than the following points of hinging:
 - up to 450mm - 2 hinges,
 - up to 800mm - 3 hinges
 - more than 800mm - 4 hinges.
- All doors shall be secured by square key latches as follows:
 - up to 450 mm - 2 latches,
 - up to 800 mm - 3 latches and
 - more than 800 mm - 4 latches
- Any other proven design shall be submitted to Eskom for approval.
- Door latches shall be of robust construction and be manufactured from steel. At least the centre square key latch shall be padlock able.
- Provision shall be made on the cable compartment door hinges to allow the doors to be lifted off.

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- Metal hinges shall be of robust construction and shall ensure effective electrical bonding to the enclosure is maintained. Plastic and die cast material is not acceptable.
- The method of fastening the latches and hinges shall be such that it will not wear loose due to vibration or rough handling of the door.
- The door latches and hinges shall be able to withstand an internal severe fault.
- Doors shall have stops to prevent over swing when opening and to avoid interference with adjacent compartments.
- Doors of 800mm or longer shall be provided with webs or other methods to prevent wobbling when the door is operated.

5.5.6 Nameplate/Rating plate/Declared Electrical Performance

Each cubicle shall have a stainless steel or anodized aluminium plate on which the electrical performance of the product is declared. The following information as a minimum is engraved:

- As per IEC requirements
- Manufacturer
- Month/year of manufacture
- Type/model of unit
- Serial number
- INVERTER
 - Inverter input supply voltage and tolerance
 - Nominal input current of inverter
 - Nominal AC output voltage
 - Electrical output supply configuration
 - Nominal AC output current
 - Output frequency
 - Power factor output
 - Rated output active power
 - Rated output apparent power
- BYPASS SUPPLY
 - Bypass input supply voltage and tolerance.
 - Electrical supply configuration
 - Bypass supply nominal input current
 - Input frequency and tolerance
 - Nominal output voltage
 - Nominal input power
- A mimic single line of the equipment is to be provided either via the electronic display or via an engraved label on the front of the panel.

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5.5.7 Measurements, Controls, Indications and Alarms

5.5.7.1 Inverter Measurement

A mimic display panel showing the various main components of the Inverter is provided in the front panel of the Inverter unit. This mimic display panel has digital indicators for panel monitoring and digital display is of the auto-ranging 3.5 digit type.

Selection of the required measurements shall be by means of labelled latching as specified in Schedule A. The following selections are provided:

- Inverter output voltage per phase
- Inverter output current per phase
- Inverter output frequency
- Static Bypass input voltage and waveform recording
- Static bypass input current and waveform recording

5.5.7.2 Inverter Controls

The following controls are provided on the mimic display panel:

- Alarm acknowledge
- Alarm reset
- Inverter on/off switch.

5.5.7.3 Inverter Indications

The following indications shall be available on the facia of each inverter/static bypass as part of functional single line mimic:

- Output healthy,
 - Inverter on
- Static bypass healthy,
 - Mains supply to static bypass available and within limits
- Manual bypass on
- Where LEDs are used, green LEDs shall indicate active or operational circuits, and red LEDs shall be used to indicate non-operational circuits.
- All indications shall be clearly labelled.

5.5.7.4 Inverter Alarms

- OUTPUT FAILURE,
 - Inverter –off, failure or stopped;
 - Voltage or frequency out of limits; and
 - Inverter overload
- STATIC BYPASS INPUT FAILURE,

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- Mains failure or out of limits to the static bypass
- Static bypass unavailable

Any additional alarms shall be specified.

5.6 USE OF CONTRACTOR'S DESIGN

- All designs, drawings, specifications, instructions, manuals and other documents created, produced by or on behalf of the contractor for the purposes of providing the works (collectively, the "Contractor's Copyright Documents") and copyright therein and all intellectual property rights relating thereto, are, will be, and will remain the property of the contractor.
- The contractor hereby grants to the employer, with effect from the contract date or in the case of documents or other matter not yet in existence, with the effect from the creation thereof (and notwithstanding the completion or abandonment of the works or termination of this agreement) an irrevocable, royalty-free, non-exclusive and perpetual licence to use those of the contractor's documents and other matter supplied to the employer under this contract, for any purpose whatsoever connected with the works, including for the purpose of maintenance, operation, construction, retrofit, refurbishment, upgrade, repair or demolition of the works or any parts thereof.
- The employer uses the contractor's copyright documents and all intellectual property rights relating thereto for the sole purpose of all its needs at Ankerlig 1&2 Power Stations, which includes any employer processes and procedures pertaining to use, maintenance, operation, construction, retrofit, refurbishment, upgrade, repair or demolition of the works.
- The employer may copy and submit, without restriction, all documentation to others employed or contracted by the employer who has duly signed a confidentiality agreement with the employer.
- The contractor may not use any Copyright Documents (and the copyright therein and all intellectual property rights relating thereto), which are owned by the employer and/or others and provided to the contractor, for any other purpose than to provide the works. The contractor may not copy and therefore not retain copies of any such Copyright Documents. At completion of the whole of the works, or earlier termination, the contractor returns to the employer all such documentation provided to him by the employer and/or others.

5.7 DESIGN OF EQUIPMENT

N/A.

5.8 EQUIPMENT REQUIRED TO BE INCLUDED IN THE WORKS

Contractor to provide all equipment needed for works.

5.9 AS-BUILT DRAWINGS, OPERATING MANUALS AND MAINTENANCE SCHEDULES

The following minimum documentation is to be supplied to the project manager for acceptance prior to commencement of installation.

- Data sheets of proposed inverters
- Internal single line diagram diagrams – Inverters

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- Decommissioning of existing equipment Procedure
- Installation/Erection Procedure
- Project Schedule
- Quality Control Plan

5.9.1 Drawings

- All drawings are created electronically and 100% compatible with Micro station V8 software in a DGN file format.
- In conjunction with the electronic DGN copies the contractor also provides a merged set of *.pdf electronic copies upon first issue and each time drawing updates are required. All drawings are signed and the revisions noted as per employer's specifications.
- The electronic files are provided in A3 size and conform to the requirements of The Engineering Drawing Standard 240-86973501 as indicated in Section 2.2.1[8].
- Graphical symbols are used in accordance with the NRS002 Graphical Symbols for electrical diagrams standard.as indicated in Section 2.2.1 [9]
- All drawings are submitted to the project manager for his acceptance.
- The contractor produces the following types of drawings:
 - Cover sheet
 - Index sheet
 - List of symbols
 - List of components with values, tolerances, ratings, type numbers, purchasing specification numbers, manufacturer and circuit reference numbers
 - General layout drawing of the proposed panels
 - Single line diagram
 - Panel internal wiring drawings, including cross referencing and wire numbers
 - Cable block diagrams with termination points
- The contractor is liable for updating drawings till after the final commissioning of the last unit when the employer has signed off and approved the final "As Built" state of the drawings. After commissioning of each unit the contractor supplies two sets of drawing hardcopies within two separate files and in A3 format.

5.9.2 Technical Maintenance and operating Manuals

- All manuals are specific to each of the 2 power stations namely, Ankerlig 1&2 Power Stations. The file descriptions include the following on the front as well as the spine. The Contractor incorporates all necessary technical data, design, data literature and drawings into his operating and maintenance manuals.
- An electronic PDF copy and hardcopies of each equipment is to be supplied to the project manager.
- The technical, maintenance and operating manuals also contains the information and course material of the training manuals
- All design information forming part of the works Information is included in the manuals.

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- All documentation including drawings and operating and maintenance instruction manuals is uniquely identified and cross-referenced with all related documents.
- The manuals are complete with:
 - Power station name and order number
 - Content list
 - List of reference drawings
 - Details of all components
- Manuals are of good quality prepared by suitably experienced personnel. The contractor ensures that the manuals/files are complete with the following information represented as a minimum
 - Details and descriptions of all hardware and software
 - Detailed product descriptions and features
 - Datasheets of all components used
 - Operating, maintenance and testing requirements
 - Installation procedures of each equipment
 - Isolation procedures
 - Test certificates
 - Certificates of compliance to international standards
 - Routine test results reports
 - Commissioning test results reports
 - Training information
 - Technical tender submission information
- Any special instructions pertaining to storage of spare parts or to their shelf life are included in the manual.
- All drawings required for component location, dismantling, and re-assembly for maintenance is provided in the manual.
- All special tools required for maintaining and operating the plant and material are identified in a schedule and described in the manual.
- Manuals are produced such that a synopsis is first presented, followed by a first draft, then a pre-print proof and finally by the final manual.

6. PROCUREMENT

6.1 PLANT AND MATERIALS

6.1.1 Quality

- The contractor establishes and implements a system that, as a minimum, meets the requirements of the ISO 9000 series for quality management systems.
- The contractor defines the level of QA/QC or inspection imposed on his sub-contractors and suppliers.

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- The programming of inspections, hold and witness points is agreed between the employer and the contractor prior to undertaking any work.
- The contractor ensures that appropriate quality requirements are placed to comply with the services.
- The contractor notifies the employer of any proposed changes to the quality management system that will affect the contract quality requirements, prior to implementing such changes.
- The contractor rectifies, at his own cost and to the satisfaction of the employer all defects, or other faults, which may appear during the defect liability period.
- In case of specialized work based on the contractors own design and their standard manufacturing product in the works being defective or any components used found to be defective due to manufacturing defects and thus forcing, any improvement to be implemented to rectify such inherent defects, the cost of such an undertaking would be the responsibility of the contractor.

6.1.2 Guarantee Inspection

- All equipment supplied will carry a warrantee of minimum 36 months starting from the completion commissioning date.
- The contractor will supply a written and electronic warrantee to the project manager by 15 days after completion of commissioning.

6.1.3 Product Support

- All equipment supplied by the contractor need to have local support available within the Republic of South Africa.
- The contractor should provide product support of the provided solution for the entire life cycle of the equipment.

6.1.4 Defects correction

- The employer will provide the contractor access to correct any post commissioning defects that may arise.
- It will be the responsibility of the contractor to rectify any defects prior to the defects date being reached.

6.1.5 Reliability, security, dependability, maintainability and life expectancy

- The supplier / tenderer shall submit a full track record which shall include the following:
 - Equipment hours of installed units per voltage or model / type.
 - Customers indicating the number of units employed per model / type.
 - Environmental conditions where such equipment is installed.
- All inverters to be used shall have:
 - A proven service record of at least two years and one hundred equipment years.
 - All tendered equipment shall be designed for a minimum working lifetime of 10 years for electronic equipment and 20 years for the balance as indicated in schedule A.
 - Written guarantees to this effect shall be made available as part of the tender.

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- The supplier shall make a statement regarding re-calibration of the equipment to keep it in perfect working order or any other required intervention by the supplier, subsequent to the sale of equipment that will have a financial impact on Eskom.
- Any internal battery requirements for inverters/ controllers, i.e., battery lifetime, type of battery etc. shall be stated during tender and on a label attached to the front of the equipment.

6.1.6 Plant & Materials provided “free issue” by the Employer

No Plant and Materials will be free issued by the Employer.

6.1.7 Contractor’s procurement of Plant and Materials

- The employer requires warranties from the contractor’s suppliers to be in favour of the Employer.
- The contractor provides all their supplier’s information to the employer.

6.1.8 Spares and consumables

N/A.

6.2 TESTS AND INSPECTIONS BEFORE DELIVERY

The equipment and components making up the works shall be of standard construction and shall be supplied with factory acceptance test certificates from the manufacturer.

6.3 MARKING PLANT AND MATERIALS OUTSIDE THE WORKING AREAS

The contractor is requested to mark all identified items of plant and material with the contract and order numbers.

Plant and material is delivered to either the site or the contractor’s works.

The following requirements apply to the off-site marking of plant, materials and equipment:

- The contractor gives two (2) weeks’ notice to the project manager and it is shown in the programme.
- The notification to the project manager is accompanied by a comprehensive inventory of all plant, materials and equipment ready for marking.
- Plant, materials and equipment located at the contractor’s subcontractor/s or sub-suppliers are not considered ready for marking.
- Only plant, materials and equipment physically located at the contractor’s facility are considered ready for marking.

6.4 CONTRACTOR’S EQUIPMENT (INCLUDING TEMPORARY WORKS).

N/A.

6.5 CATALOGUING REQUIREMENTS BY THE CONTRACTOR

N/A.

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7. CONSTRUCTION

This part of the technical specification addresses constraints, facilities, services and rules applicable to the contractor whilst he is doing work on the site during the construction and maintenance phase. It does not specify the work itself as that is included in Section 6 of the Works Information.

7.1 TEMPORARY WORKS, SITE SERVICES & CONSTRUCTION CONSTRAINTS

7.1.1 Contractor's equipment

- The contractor provides the employer with a complete list of materials, tools, equipment and or machinery before bringing it onto site.
- Records are to be kept of equipment on site including whether it is owned or hired. The contractor is responsible to provide his own scaffolding, lifting equipment, mobile cranes and fork lifts where required.
- The contractor provides and maintains all tests and measuring equipment required for all tests to the required accuracy. The accuracy of test equipment is required to be better than ± 0.1 %.
- The type and class of equipment used is subject to the acceptance by the employer.
- The contractor's measuring equipment is accompanied by valid calibration certificates from an approved authority.
- The project manager may at any stage during the contract require such equipment to be checked by an approved laboratory or the South African Bureau of Standards.

7.1.2 Equipment provided by the Employer

No equipment will be provided by the employer.

7.1.3 Site services and facilities

Electricity Supply:

- All points of supply are provided in terms of availability and location
- The Employer indicates which supply points may be used.
- 220V electrical supply is generally available in the power station complex. 380V supply is also available – the contractor shall ensure they have the correct matching plugs.
- The contractor verifies extension lead requirements.

7.1.4 Facilities provided by the Contractor

- The contractor provides, erects and maintains for own use, adequate size office accommodation and stores together with such, lighting and heating as may be required in the area designated by the employer.
- The contractor dismantles and clears off site all such temporary structures and associated foundations and infrastructure.

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- The contractor makes provision for accommodation, vehicles, kitchen - and office space (mobile container) and equipment etc.
- The contractor removes all this equipment and waste which was generated during the installation and commissioning within 24 hours after completion.

7.1.5 Existing premises, inspection of adjoining properties and checking work of Others

N/A.

7.1.6 Survey control and setting out of the works

N/A.

7.1.7 Excavations and associated water control

N/A.

7.1.8 Underground services, other existing services, cable and pipe trenches and covers

- The contractor minimises interference of any nature with regards to existing services, cable and pipe trench covers.
- In the event that the contractor damages one of the above, the penalty would be for the contractor.

7.1.9 Sequences of construction or installation

The sequence of installation is to be in accordance with the contractor's program, which needs to be accepted by the project manager prior to commencement.

7.1.10 Hook ups to existing works

N/A.

7.2 COMPLETION, TESTING, COMMISSIONING AND CORRECTION OF DEFECTS

7.2.1 Work to be done by the Completion Date

On or before the completion date the contractor shall have done everything required to provide the works except for the work listed below which may be done after the completion Date but in any case before the dates stated.

The project manager cannot certify completion until all the work except that listed below has been done and is also free of defects which would have, in his opinion, prevented the employer from using the works and others from doing their work.

	Item of work	To be completed by
	As built drawings of all inverters	Within 30 days after Completion
	Maintenance and Operating Manuals	Within 30 days after Completion

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7.2.2 Use of the works before Completion has been certified

N/A.

7.2.3 Materials, facilities and samples for tests and inspections

N/A.

7.2.4 Commissioning

The testing and commissioning of all equipment will be done in accordance with the commissioning procedures supplied by OEM and Eskom Installation and Commissioning of Power Electronics Equipment Procedure as referenced in Section 2.2.1 [7] of this document.

7.2.5 Start-up procedures required to put the works into operation

Following successful commissioning the works will be put into immediate operation.

7.2.6 Take over procedures

The employer takes over the works on completion.

7.2.7 Access given by the Employer for correction of Defects

Clause 43.4 requires that the Project Manager arranges for the employer to allow the contractor access to and use of a part of the works which has been taken over if needed to correct a defect. After the works have been put into operation, the employer may require the contractor to undertake certain procedures before such access can be granted.

7.2.8 Performance tests after Completion

Commissioning results is captured a commissioning report that will include all commissioning and pre-commissioning tests and results which will be shared with the system operator.

7.2.9 Training and technology transfer

- The contractor provides training on the equipment included as part of the works to various categories of the employer's technical staff for the duration of the works.
- Training provided by the contractor is directly applicable to the actual plant and material supplied for the works.
- Generalised training based on similar plant and material is not acceptable.
- The local facilities for training provided by the employer are a suitably sized air-conditioned room, to accommodate 12 trainees as well as trainee and trainer desks, an overhead projector and flipchart or white board
- The employer bears the cost of salaries, accommodation, travelling expenses and other allowances of his personnel during the training, but all other training costs are borne by the contractor.
- The contractor provides 2 additional (repeat) training courses as and when instructed by the project Manager.
- Practical hands-on training for each individual trainee forms an integral part of each of the following courses:

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- Operating Training
- Maintenance Training
- Engineering / Commissioning Training
- The engineering / commissioning training are of such a standard that experienced staff are able to commission and re-engineer some parts of the system after such training has been obtained.
- The contractor incorporates all necessary technical data, design data literature and drawings into his training manuals.
- The course material is in English and includes all third party documentation.
- A copy of the training documentation is supplied for each trainee.
- Training manuals are continuously updated by the contractor up to the date of issue of the defects certificate for the whole of the works.

7.2.10 Operational maintenance after Completion

N/A.

8. PLANT AND MATERIALS STANDARDS AND WORKMANSHIP

8.1 INVESTIGATION, SURVEY AND SITE CLEARANCE

The contractor is responsible to survey the current equipment location, layout and positioning of the panels and need to clearly specify any additional requirements.

8.2 BUILDING WORKS

N/A.

8.3 CIVIL ENGINEERING AND STRUCTURAL WORKS

N/A.

8.4 ELECTRICAL & MECHANICAL ENGINEERING WORKS

Reference number	Title / Description	Tick if Publicly available
240-53114248	Thyristor and Switched Mode Charger, AC/DC to DC/AC Converters and Inverter/ Uninterrupted Power Supplies Standard	*
SANS 10142-1:2020 Edition 3	The wiring of premises Part 1 Low Voltage installations	✓
240-170000055	Installation and Commissioning of Power Electronics Equipment Procedure	

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240-56227443	Requirements for Control and Power Cables for Power stations Standard	*
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8.5 PROCESS CONTROL AND IT WORKS

N/A

8.6 OTHER

Reference number	Title	Tick if publicly available
QM-58	Supplier Contract Quality Requirements Specification	*
ISO 9001:2008	Quality Management Systems	✓
OHASA (1993)	Occupational Health and Safety Act of South Africa, Act 85 of 1993	✓
ESKARAAG4	Eskom Operating Regulations for High Voltage Systems, ESKARAAG4	*
	National Environmental Management Act of 1988	✓
32-136	Contractor Health and Safety Requirements	*
32-245	Eskom Waste Management Standard	*
36-681	Generation Plant Safety Regulations	*
240-62196227	Eskom Life-saving Rules Directive 23-421	*
240-71432150	Plant Labelling and Equipment Description Standard	*
240-54179170	Classification and designation of technical documentation	*
240-86973501	ESKOM General documentation standard	*
32-644 Rv1	ESKOM Documentation Management Standard	*
167A/49	Drawing and documentation standard for Contractors	*
167A/49	Documentation Process Procedure	*

9. LIST OF DRAWINGS

9.1 DRAWINGS ISSUED BY THE EMPLOYER

This is the list of drawings issued by the employer at or before the contract date and which apply to this contract.

Note: Some drawings may contain both works information and site information.

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Ankerlig 1

Drawing number	Revision	Title
0.86/8966		Unit Single Line Diagram
0.86/8967		Station Single Line Diagram
0.86/9011		PCC Power Control General Arrangement
0.86/8998		Admin & Control Building
0.88/1		Ankerlig Power Station Layout Drawing Gas 1 Station Layout
0.88/3451		GAS Turbine building Load Plan
0.88/3449		Plan View Central Control and Office Building Load Input

Ankerlig 2

Drawing number	Revision	Title
0.88/2622		Unit Single Line Diagram
0.88/2623		Station Single Line Diagram
0.88/2441		PCC Power Control General Arrangement
0.88/3434		Admin & Control Building
0.88/1		Ankerlig Power Station Layout Drawing Gas 1 Station Layout
0.88/3451		GAS Turbine building Load Plan
0.88/3449		Plan View Central Control and Office Building Load Input

10. ACCEPTANCE

This document has been seen and accepted by:

Name & Surname	Designation	Signature
Ian Kuiler	Senior Technologist Engineering (Reviewer)	
Mfundo Sijeku	Engineer: C&I	
Zubair Johannes	Senior Technician: Civils	

11. REVISIONS

Date	Rev.	Compiler	Remarks
December 2021	0.1	AM Juries	First Compiled
January 2022	0.2	AM Juries	1 st Comments Reviewed

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Date	Rev.	Compiler	Remarks
February 2022	0.3	AM Juries	2 nd Comments Reviewed – Combined all 3 stations under 1 technical specification
February 2022	0.4	AM Juries	3 rd Comments Reviewed – Health and Safety information updated
April 2022	1	AM Juries	4 th Comments Review – Tables edited and formatted

12. DEVELOPMENT TEAM

The following people were involved in the development of this document:

N/A.

13. ACKNOWLEDGEMENTS

N/A.

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14. APPENDIX A: INVERTER REQUIREMENTS

- 1) Schedule A: Eskom Requirements
- 2) Schedule B: Guarantees and technical particulars of equipment offered All Standards quoted will be the Latest revision

NOTES: REGARDING THE COMPLETION OF SCHEDULE A & B:

- 3) The requirements of this section specified under "Schedule A & B" form part of the Works Information. Schedule B shall be completed by the Contractor and submitted with his tender. Filling in Instructions
 - Where the Contractor does not fully comply with the Engineering requirement, any deviations shall be clearly indicated in Schedule B and listed in the Deviation Schedule, with the cost of the deviation.
 - Where there is a need to substantiate or further describe an item in Schedule B, especially in instances of non-compliance with Schedule A, particulars are furnished on a separate sheet clearly marked with the notation of the Schedule A item referred to.
 - If a blank space is left in Schedule B next to certain requirements specified in Schedule A, this constitutes a confirmation that the tender does not comply with that specific requirement.
 - Where xxxxx is indicated for an item in Schedule A, the Contractor is required to fill in the appropriate information in Schedule B, for the equipment offered.
 - Where t.b.c. (to be confirmed) is indicated for an item in Schedule A, the Engineer will fill in the appropriate information in Schedule A, when confirmed.

A Evidence Reference

- 4) Each evidence reference shall be filled in with a reference to the delivery documentation where the word "REQUIRED" is stated. The evidence reference section will refer to the documentation that backs-up the statement made in Schedule B. If no evidence is received or it is not referenced to correctly, it shall be taken as non-compliance with regard to Schedule A

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
1.0	General Requirements					
1.1	Elevation (Atlantis) and (Mosselbaai)	m.a.s.l	226.62 and 110.17			
1.2	Relative humidity	%	10-90 non condensing			
1.3	Lighting		SANS 1652 and SANS 61439 -1 Table G1			
1.4	Outdoor air temperature					
1.4.1	Maximum	°C	60			
1.4.2	Daily average	°C	30			
1.4.3	Minimum	°C	-15			
1.5	Equipment room air temperature					
1.5.1	Maximum	°C	50			
1.5.2	Daily average	°C	35			
1.5.3	Minimum	°C	-5			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
2.0	Electrical input supply					
2.1	Input supply configuration	SANS 10142-1	TN-S			
2.2	Input voltage fluctuations as percentage of nominal voltage	%	220DC +20%/-15% , 230AC +-10%			
2.3	Input frequency fluctuations as percentage of nominal frequency	%	50Hz±5			
2.4	Input voltage deviation from specified voltage maximum to minimum within 1 second.	Yes/No	Yes			
2.5	Input voltage fluctuation between specified minimum to maximum value within one to ten cycles	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
2.6	Input voltage total distortion		Table 1 IEC 61000-2-2			
3.0	Operational requirements					
3.1	Output requirements					
3.1.1	Standard output operating voltage tolerance	%	230V AC $\pm 1\%$, 1 phase			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.2	Cooling requirements					
3.2.1	Natural	Yes/No	Yes			
3.3	Inrush current					
3.3.1	Inrush current determined as specified in IEC 62040-3	Yes/No	Yes			
3.4	No-load operation					
3.4.1	No-load operation maximum voltage	%	+10			
3.5	Step load capability					
3.5.1	Voltage regulation during 10 to 90% step variation	% after sec 1	2			
3.6	Overload capability					
3.6.1	Overload capability	Duty class	II			
3.7	Short-circuit and current limit capability					
3.7.1	Short circuit capability as stipulated in IEC 62040-3	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.8	Internal protection					
3.8.1	Internal protection	Yes/No	Yes			
3.9	Hardwire/hardware independent protection					
3.9.1	Hardwire/hardware independent protection: Overvoltage protection on load Over temperature monitoring	Yes/No Yes/No	Yes Yes			
3.10	Active load sharing					
3.10.1	Active load sharing	%	≤10			
3.11	Efficiency					
3.11.1	a) @ 25% load	%	>87.5			
3.11.2	b) @ 50% load	%	>90			
3.11.3	c) @75% load	%	>92.5			
3.11.4	d) @ 100% load	%	>95			
3.12	Electromagnetic environment and immunity requirements					
3.12.1	Conducted and radiated emissions					

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.12.1.1	Conducted and radiated emissions as specified in IEC 62040-2 for category C3	Yes/No	Yes			
3.12.1.2	Low frequency emissions THDI as per IEC 6100-3-2	%	≤10			
3.13	Immunity					
3.13.1	IEC 62040-2 for category C3	Yes/No	Yes			
3.14	Audible noise					
3.14.1	Audible noise	dB	<65			
3.15	Lightning protection					
3.15.1	Input	kV	6			
3.16	Electrical Requirements					
3.16.1	General					
3.16.1.1	Combined fused switches	IEC 60947-3	IEC 60947-3			
3.16.1.2	Moulded case circuit breakers	IEC 60947-2	IEC 60947-2			
3.16.1.3	Transformers	IEC 60067	IEC 60067			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.16.1.4	Contactors	IEC 60947-4	IEC 60947-4			
3.16.1.5	Transfer switches	IEC 60947-6	IEC 60947-6			
3.16.1.6	Terminal blocks	IEC 60947-7 and Eskom standard 240-70413291	IEC 60947-7 and Eskom standard 240-70413291			
3.16.1.7	Control circuit devices and switching elements	IEC 60947-5	IEC 60947-5			
3.17	Input isolation and overload protection	CFS/MCCB/MC B				
3.17.1	Input isolation and overload protection provided	Yes/No	Yes			
3.17.2	Aux contacts provided	Yes/No	Yes			
3.18	Output isolation and overload protection	CFS/MCCB/MC B				
3.18.1	Output isolation and overload protection provided	Yes/No	Yes			
3.18.2	Aux contacts provided	Yes/No	Yes			
3.19	Input – output isolation	Yes/No				

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.19.1	Input – output isolation galvanically	Yes/No	Yes			
3.20	Earthing					
3.20.1	Exposed non-current carrying parts earthed onto earth bar	Yes/No	Yes			
3.20.2	External earthing point	Yes/No	Yes			
3.20.3	Neutral (grounded circuit conductor) bonded to safety- earthing	Yes/No	Yes			
3.20.4	Earthing compliant with IEEE142:1991	Yes/No	Yes			
3.12	Measurements, controls, indications and alarms					
3.21.1	Inverter measurement					
3.21.1.1	Meter types	Panel Meters/ LCD	LCD			
3.21.1.2	Meter accuracy	%	1			
3.21.1.3	Input voltage measurement	Yes/No	Yes			
3.21.1.4	Output voltage measurement	Yes/No	Yes			
3.21.1.5	Output current measurement	Yes/No	Yes			
3.22	Inverter controls					
3.22.1	Alarm reset	Yes/No	Yes			
3.22.2	On-off switch	Yes/No	Yes			
3.22.3	Lamp test if not LCD	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.23	Inverter indications					
3.23.1	Input healthy	Yes/No	Yes			
3.23.2	Output healthy	Yes/No	Yes			
3.24	Local Alarms	Remote Alarm				
3.24.1	Output failure	Output Failure	Yes			
3.24.2	Mains failure	Input Failure	Yes			
3.25	Communication and control design requirements					
3.25.1	General					
3.25.2	Remote communication link	Yes/No	Yes			
3.25.3	Communication Protocols DNP 3.0 level 2 or 3 and IEC 61850	Yes/No	Yes			
3.25.4	Micro-processor controlled	Yes/No	Yes			
3.25.5	Diagnostic and telemetry capability	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.26	Real time clock and time synchronization					
3.26.1	Real time clock and time synchronization for 30 years	Yes/No	Yes			
3.26.2	Real time clock drift	Seconds/month	<60			
3.26.3	Resettable clock with resetting other parameters	Yes/No	Yes			
3.26.4	Maintain time of clock for 7 days during loss of supply	Yes/No	Yes			
3.26.5	Synchronization of IEDs	Yes/No	Yes			
3.26.6	Synchronization indicated in event log	Yes/No	Yes			
3.27	Communication ports					
3.27.1	Communication ports	2 x Rs-232 1x Rs485 1 x Ethernet or Fibre optic	Yes Yes Yes			
3.28	Monitoring and control					
3.28.1	Interface to local PC	Yes/No	Yes			
3.28.2	Remote interface with Inverter	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.28.3	Software and firmware upgradeable	Yes/No	Yes			
3.28.4	Settings, indications and alarm display via front panel	Yes/No	Yes			
3.28.5	Password controlled	Yes/No	Yes			
3.28.6	Real time control	Yes/No	Yes			
3.28.7	Default values for stand-alone operation	Yes/No	Yes			
3.28.8	Interface with optional unit	Yes/No	Yes			
3.28.9	Unique remote controller identification	Yes/No	Yes			
3.29	Software and firmware					
3.29.1	General					
3.29.1.1	Software to access equipment	Yes/No	Yes			
3.29.1.2	Software updates compatible with supplied systems	Yes/No	Yes			
3.29.1.3	Software license and documentation copyright	Yes/No	Yes			
3.29.1.4	Software support	Yes/No	Yes			
3.29.1.5	Software detail to be supplied	Yes/No	Yes			
3.29.1.6	Adhere to software control standard	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
3.29.1.7	Settings and display features available from front panel display	Yes/No	Yes			
3.29.1.8	Alarm/event lock downloadable	Yes/No	Yes			
3.29.1.9	Software capable to upload and download alarm/ event log or settings	Yes/No	Yes			
3.29.1.10	Software display the status of any modules connected	Yes/No	Yes			
3.29.1.11	Software to display the status of remote communication connections	Yes/No	Yes			
3.30.1	Software verification and validation	Yes/No	Yes			
3.30.2	System firmware					
3.30.2.1	Equipment system firmware displayed on the equipment	Yes/No	Yes			
3.30.2.2	Firmware alterations to be controlled	Yes/No	Yes			
3.30.2.3	Data retention for the expected life of the equipment	Yes/No	Yes			
3.30.2.4	Firmware upgradeable	Yes/No	Yes			
4.0	Mechanical Requirements					
4.1	General					
4.1.1	Compliance to clause 5 of SANS 10142-1 and SANS 62040-1	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.1.2	Designed, constructed and tested in accordance to clause 6.6 of SANS 10142-1	Yes/No	Yes			
4.2	Doors and covers					
4.2.1	Individual hinged doors for each cable compartment and each fix pater functional unit sub-section.	Yes/No	Yes			
4.2.2	All removable covers shall require the use of a tool	Yes/No	Yes			
4.2.3	All opening doors shall be padlockable	Yes/No	Yes			
4.2.4	As a minimum the center square key latch shall be padlockable with hole > 8mm	Yes/No	Yes			
4.2.5	Cable compartment hinges to allow lifting off	Yes/No	Yes			
4.2.6	Durable hinge and latch fastening	Yes/No	Yes			
4.2.7	Doors stops required	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.2.8	Door latches and hinges to withstand internal faults	Yes/No	Yes			
4.2.9	Doors >800mm to be fitted with webs	Yes/No	Yes			
4.3	Main, Distribution, Equalizing and Collection Busbars					
4.3.1	Main and distribution busbars manufactured from electrolytic tough pitch high conductivity copper as per SANS 804	Yes/No	Yes			
4.3.2	Condition of temper for busbar copper designation H2 for half-hard cold working as per SANS 1195	Yes/No	Yes			
4.3.3	Main busbar design maximum permissible surface temperature rise at rated current, Distribution busbar	K K	65 55			
4.3.4	Neutral busbar sizing relative to main busbar rating on input and relative to the associated distribution busbars	% of main busbar % of distribution busbar	≥50 100			
4.3.5	Neutral busbar connected to protective earth via removable bolted link	Yes/No	Yes			
4.3.6	Joints and tees in busbar compliance Bolts high tensile	T-22 8.8 to ISO 898-1	T-22 8.8 (ISO 898-1)			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.3.7	Joints: Minimum number of bolts Busbar overlap Washers	# Multiple of thickness or relative to width Conical or spring	≥2 ≥6 or equal Conical			
4.3.8	All busbar supports with minimum rating of the respective fault current rating	Yes/No	Yes			
4.3.9	Span of distribution busbar shall not interfere with cable entry zone.	Yes/No	Yes			
4.3.10	Busbar identification marking: 230 V AC Busbars and DC Busbars 220V	Yes/No Red - positive and Black - Negative	Yes Red - positive and Black - Negative			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.3.11	Collection busbars need to be constructed where SCPD's and mcb's need to be connected in cascaded circuits	Yes/No	Yes			
4.3.12	Sufficient supports for equalizing busbars to withstand fault current	Yes/No	Yes			
4.4	Protective earth conductor and screened earth busbar					
4.4.1	A separate protective earth connected	Yes/No	Yes			
4.4.2	Non-current carrying conductive parts connected to PE	Yes/No	Yes			
4.4.3	Earth conductor size connected to doors	mm ²	6			
4.4.4	PE rating	SANS 10142-1	SANS 10142-1			
4.4.5	Protective circuit parts rated for the highest fault condition	Yes/No	Yes			
4.4.6	PE conductor colour	Green with yellow stripes	Green with yellow stripes			
4.5	Power and control cabling					
4.5.1	Power circuit wiring and connections rated according to the de-rated operating current of the associated protective gear	Yes/No	Yes			
4.5.2	Control wiring connected to source of fault energy rating	1.5 times fuse rating and	1.5 times fuse rating			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
		withstanding I ² t fuse rating	and withstanding I ² t fuse rating			
4.5.3	Connections to equipment mounted on swing doors	Yes/No	No			
4.5.4	Type of conductor cable	Stranded, single or solid	Stranded			
4.5.5	Multistrand cable conductor diameter	mm ²	1.5			
4.5.6	Multistrand cable conductor diameter for current and voltage transformers	mm ²	2.5			
4.5.7	Joints and splices in any circuit, more than one conductor in one lug.	Not allowed	Not allowed			
4.5.8	Terminals assembly and labels shall be accessible		xxxx			
4.5.9	Terminals which are on the live side of fuses and isolating switches shall be completely shrouded	Yes/No	Yes			
4.5.10	Coils in-line with normally open contacts connected to positive	Yes/No	Yes			
4.5.11	Compression joints standard	BS EN 61238	BS EN 61238			
4.5.12	Grommets installed on all holes through which cables are passing	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.5.13	Conductors >100A and passing through metal	Conductor all three phases (both poles of DC conductors) or metal barrier split	xxxx			
4.5.14	AC and DC conductors allowed in same wireway	Yes/No	No			
4.5.15	Power circuit cable sizing standard for the specified volt-drop	SANS 1973-1	SANS 1973-1			
4.5.16	Stripping of insulation standard		xxxx			
4.5.17	Crimping standard		xxxx			
4.5.18	Correct torque standard		xxxx			
4.6	Conductor identification					
4.6.1	Conductor identification	Yes/No	Yes			
4.6.2	Control conductor identification AC circuits DC circuits	Black Grey	Black Grey			
4.6.3	Control bus wiring identification DC AC	Red – positive Black – negative	Red - positive Black - negative			
4.6.4	Conductor of CT and VT circuits identification	Phase colours	Phase colours			
4.6.5	Control conductor wiring		xxxx			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.7	Enclosure and Assembly					
4.7.1	EMC testing required with door open when MCB and MCCB are fitted behind the door	Yes/No	Yes			
4.7.2	Individual segregation for input, DC port, output, signal and control cabling	Yes/No	Yes			
4.7.3	inverter modules and controller sub rack assemblies	Swing/fix frame assembly	Swing/fix frame assembly options			
4.7.4	Handling and lifting facilities	Removable lifting facility. Forklift handling	Removable lifting facility. Forklift handling			
4.8	Sub-rack assemblies and input/output power distribution modules					
4.8.1	Sub-rack inclusions: <ul style="list-style-type: none"> Controller sub-assembly in-front 	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
	<ul style="list-style-type: none"> Terminal plate sub-assembly rear Segregated wire loom 	Yes/No Yes/No	Yes Yes			
4.8.2	Input/output power modules : Front distribution modules Terminal plate sub assembly rear Segregated wire loom	Yes/No Yes/No Yes/No	Yes Yes Yes			
4.8.3	Sub-rack expandable to maximum modules power rating	Yes/No	Yes			
4.8.4	Sub-rack pre wired for expansion	Yes/No	Yes			
4.8.5	Blanking plates installed on unused module positions	Yes/No	Yes			
4.8.6	Ingress protection	IP	IP2X			
4.8.7	Individual MCB module locking facility	Yes/No	Yes			
4.8.8	Terminal plate and top drawer plate thickness	mm	1.6			
4.8.9	Terminal plate width	mm	482.6			
4.8.10	Slotted mounting hole dimensions as per IEC 60297-1 <ul style="list-style-type: none"> Width Height Horizontal distance between hole center's 	IEC 60297-1 mm mm mm	IEC 60197-1 10.3 6.80 465.1			
4.8.11	Overall aesthetically pleasing appearance	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.8.12	Earthing stud fitted on terminal plate	Yes/No	Yes			
4.9	Ingress protection					
4.9.1	IP rating Panel doors closed Panel doors open	IP IP	31 2X			
4.9.2	Additional IP rating requirements	IP	As options IP45 IP55 IP65			
4.10	Cable entry					
4.10.1	Cable entry	Top/Bottom	Bottom			
4.11	Gland plate					
4.11.1	Gland plate height	mm	300mm above point of bottom entry			
4.11.2	Fire retardant and sealing of floor slot	Yes/No	Yes required as part of installation			
4.11.3	Undrilled gland-plate, corrosion protected as per SANS 1652	Yes/No	Yes			
4.11.4	Adequate gland plate support	Yes/No	Yes			
4.11.5	Non-magnetic gland plates	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.11.6	Bonding of gland plate to PE conductor	Yes/No	Yes			
4.12	Corrosion protection					
4.12.1	Corrosion protection standard	SCSSCAAP9	SCSSCAAP 9			
4.12.2	AC input supply assembly colour	G29	G29			
4.12.3	DC input supply assembly colour	A11	A11			
4.13	Terminations					
4.13.1	Termination standard	240-70413291	240-70413291			
4.13.2	Terminations for all input output and alarming	Yes/No	Yes			
4.13.3	Maximum number of cable cores per termination point	#	2			
4.13.4	Input terminal rating at input minimum voltage	Yes/No	Yes, alternatives can be specified as an option			
4.13.5	DC port terminal size	mm ²	95 Alternatives can be specified as an option			
4.14	Internal wiring					
4.14.1	Wire ways and trunking shall be smooth and free of sharp edges	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
4.14.2	Trunking temperature rating	°C	90			
4.14.3	All wiring in trunking or wire looms clipped or laced	Yes/No	Yes			
4.15	Conformal coatings					
4.15.1	Conformal coatings required	Yes/No	Yes			
4.16	Accessibility					
4.16.1	Accessibility for cable termination	Yes/No	Yes			
4.16.2	Normal maintenance accessibility following installation	Yes/No	Yes			
4.16.3	Accessibility	Front/rear	Front and rear			
4.17	Minimum clearances					
4.17.1	Pole-to-pole and pole-to-earth clearance standard	SANS 10142-1	SANS 10142-1			
4.17.2	Terminals for input, DC port and output	Segregated/ barriers	Segregated/ barriers			
4.17.3	Minimum creepage distance rating as per SANS 60439-1 clause 7.1.2	Pollution Degree 3, material group 111a with the specified insulation voltage	Pollution Degree 3, material group 111a with the specified insulation voltage			
4.17.4	Clearance and creepage distances	SANS 60439-1	SANS 60439-1			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
		Table 14 and 16	Table 14 and 16			
4.18	Nameplate/rating plate/declared electrical performance					
4.18.1	Nameplate material	Stainless steel/anodized aluminum	Stainless steel/anodized aluminum			
4.18.2	Nameplate information	Clause 3.4.18	Clause 3.4.18			
5.0	Settings and Commissioning					
5.1	Settings					
5.1.1	Settings standard	240-56176168	240-56176168			
5.1.2	Settings document for each piece of equipment required based on specific application	Yes/No	Yes to be compiled by OEM based on application.			
5.1.3	Microprocessor shall be programmed with these settings as default	Yes/No	Yes			
5.1.4	Revision indicated on document	Yes/No	Yes			
5.1.5	SCPD indicated on settings document	Yes/No	Yes			
5.2	Commissioning					
5.2.1	Commissioning standard	240-56177186	240-56177186			
5.2.2	As commissioning routine, operational and functional tests shall be performed	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.3	Upgrading/modifications					
5.3.1	Upgrade/modification report required	Yes/No	Yes			
5.3.2	Hardware upgrade identification	Yes/No	Yes			
5.4	Equipment performance					
5.4.1	Warranty					
5.4.1.1	Warranty period	36 months from date of	36 months from date of			
5.4.2	Reliability, security, dependability, maintainability and life expectancy					
5.4.2.1	Equipment hours of installed units per voltage or model/type	Yes/No	Yes			
5.4.2.2	Customers indicating the number of units employed per model/type	Yes/No	Yes			
5.4.2.3	Environmental conditions where such equipment is installed	Yes/No	Yes			
5.4.2.4	Equipment proven record	>2 years and one hundred equipment years	>2 years and one hundred equipment years			
5.4.2.5	Life expectancy Electronic equipment Other hardware	≥15years ≥20 years				
5.4.2.6	Written guarantee to meet life expectancy	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
5.4.2.7	Supplier product health statement	Yes/No	Yes			
6.0	Type testing					
6.1	Inverter tests	Type Tests Required as per IEC 60146-1-1				
6.1.1	Insulation test	Yes/No	Yes			
6.1.2	Light load functional test.	Yes/No	Yes			
6.1.3	Functional test	Yes/No	Yes			
6.1.4	Rated current test	Yes/No	Yes			
6.1.5	Power loss determination for assemblies and equipment	Yes/No	Yes			
6.1.6	Temperature rise test	Yes/No	Yes			
6.1.7	Power factor measurement	Yes/No	Yes			
6.1.8	Checking of auxiliary devices	Yes/No	Yes			
6.1.9	Measurement of inherent voltage regulation	Yes/No	Yes			
6.1.10	Checking the properties of the control equipment	Yes/No	Yes			
6.1.11	Checking the protective devices	Yes/No	Yes			
6.1.12	Immunity test	Yes/No	Yes			
6.1.13	Overcurrent capability test	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
6.1.14	Radio frequency generated interference and conducted noise	Yes/No	Yes			
6.1.15	Audible noise	Yes/No	Yes			
6.1.16	Measurement of ripple voltage and current	Yes/No	Yes			
6.1.17	Additional tests	Yes/No	Yes			
6.2	Type Tests Required as per SANS 1652	Yes/No	Yes			
6.2.1	Dielectric strength test	Yes/No	Yes			
6.2.2	Insulation resistance test	Yes/No	Yes			
6.2.3	Temperature rise test	Yes/No	Yes			
6.2.4	Power efficiency test	Yes/No	Yes			
6.2.5	Test for protection against lightning surges	Yes/No	Yes			
6.2.6	Short-circuit test on output terminals	Yes/No	Yes			
6.2.7	Ripple voltage limits and ripple current test	Yes/No	Yes			
6.2.8	Audible noise level test	Yes/No	Yes			
6.2.9	Salt fog test	Yes/No	Yes			
6.2.10	Glow-wire test on non-metallic enclosures	Yes/No	Yes			
6.2.11	Lightning surge test	Yes/No	Yes			
6.2.12	Parallel operation test	Yes/No	Yes			

Technical Specification for Ankerlig DC Essential Supply Replacement - Inverters

Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
7.0	Marking, labeling and packaging					
7.1	Labelling					
7.1.1	Labeling	0.54/3695 sheet 1 & 2 or 240-62629353	0.54/3695 sheet 1 & 2 or 240-62629353			
7.1.2	Package labelling	Yes/No	Yes			
7.2	Packaging					
7.2.1	Packaging	High specification impact resistant corrugated cardboard with waterproof outer plastic covering	High specification impact resistant corrugated cardboard with waterproof outer plastic covering			
7.2.2	Additional packaging requirements	Crating	Crating as an option			
8.0	Spares					
8.1	General					
8.1.1	Spares list	Yes/No	Yes			
8.1.2	Maintenance spares list	Yes/No	Yes			
8.1.3	Spares pricing	Yes/No	Yes			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
8.1.4	Spares life expectancy within packaging	Years	15			
8.1.5	Spares available for warranty period	Yes/No	Yes			
8.1.6	Delivery	hr ex-works	24			
8.1.7	Spares availability	Years	15			
9.0	Documentation					
9.1	General					
9.1.1	Sets of hard copies	#	3			
9.1.2	Drawings format Drawings size	.dgn A3	.dgn A3			
9.2	Drawings					
9.2.1	General arrangement drawings	Yes/No	Yes			
9.2.2	Single line diagrams	Yes/No	Yes			
9.2.3	Schematic drawings	Yes/No	Yes			
9.2.4	Installation, operating and maintenance instruction manuals					
9.2.4.1	All instruction detailed manuals shall be comprehensively	Number of copies including .pdf software copy				

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.4.2	The manuals shall cover all equipment forming part of the assembly including: <ul style="list-style-type: none"> • Content list • List of reference drawings • Detail of all components 	<p>Yes/No</p> <p>Yes/No</p> <p>Yes/No</p>	<p>Yes</p> <p>Yes</p> <p>Yes</p>			
9.2.4.3	Manual in loose leaf binder to ISO standard in A4 size	Yes/No	Yes			
9.2.4.4	Manual content	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc	General arrangement drawings, installation drawings and instructions, operating and maintenance instructions for all components, detailed parts list, spare parts ordering instructions etc			

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Item	Description	Description	Schedule A	Schedule B	Evidence reference	Comments
9.2.4.5	Additional content	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.	Special instructions pertaining to spares storage, drawings for component locations, dismantling and re-assembly.			
9.2.4.6	Special tool requirements		xxxx			
9.2.5	Engineering design system					
9.2.5.1	EDS source document of design	Yes/No	Yes			
10.0	Language					
10.1	Language on display ,drawings, documentation and software	US or UK English				

