SPECIFICATION FOR 22KV, 3.3KV & 400V CABLE NETWORK EXTENSIONS

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ORGANISATION DETAILS

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A	Ampere
ACSR	Aluminium Conductor Steel Reinforced
D-DT	Eskom Distribution – Distribution Technology Standard
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESKOM	South African Electricity Supply Utility
HDPE	High Density Polyethylene
HV/MV/LV	High/Medium/Low Voltage
INFRA SA	SKA1_Mid Infrastructure and Power
IEC	International Electrotechnical Commission
KAPB	Karoo Array Processor Building
kHz	KiloHertz
kV	KiloVolt
kW	KiloWatt
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MHz	MegaHertz
MVA	MegaVolt Ampere
Mvar	MegaVolt Ampere Reactive
NRS	National Rationalized Specification
PEN	Protective Earth and Neutral
PMCS	Power Management and Control System
PVC	Polyvinyl Chloride
p.u.	Per unit
RAM	Reliability Availability Maintainability
RFI	Radio Frequency Interference
r.m.s.	Root Mean Square
RMU	Ring Main Unit
SANS	South African National Standard
SKAO	Square Kilometre Array Office
UPS	Uninterruptable Power Supply
W	Watt

1 Introduction

1.1 Purpose of the Document

The purpose of this document is to provide a detailed scope of work, minimum technical requirements and parameters, materials specifications, safety and quality requirements and any other applicable information to the contractor responsible for the for the expansion of the 22kV underground cable network and associated 400V supply points for the core area of the SKA Observatory.

1.2 Scope of the Document

This report provides the applicable South African and International standards and specifications as well as statutory safety requirements, materials specifications and bills of materials for the LV and MV components of the underground cable network expansion for the SKA1_MID Site. Further it provides drawings, application detail and specific requirements schedules within the ambit of the standards and specifications.

The following components are applicable to the project:

- Cable trenches
- Medium Voltage cables
- Medium Voltage Cable Terminations
- Miniature Substations
- Medium Voltage Ring Main Switchgear
- Low voltage cables
- Low Voltage Cable Terminations
- Protection and control equipment
- LV Distribution Kiosks
- 22kV/3,3kV (or other Intermediate Voltages) transformers
- MV Shunt Reactors
- 400V Standby generators – 100-200kVA with dark chop over facilities
- Surge Arresters
- Pole top connection and securing of cables to wood pole structures
- Connection of 22kV circuits to existing switchgear
- Laying of fibre optic cable alongside MV and LV cables

In case of any contradiction between this project specification, the technical datasheets referenced herein, drawings referenced herein, standard specifications referenced herein, and national / international standards referenced herein, the order of precedence shall be:

1. SKA Reference Documentation, then
2. This Project Specification, then
3. The Technical Datasheets, then
4. The Project Drawings, then
5. Eskom Specifications referenced by this document or the Drawings, then

6. RSA National Standards, then
7. RSA Industry Rationalized Specifications and Codes of Practices (NRS etc.)
8. International standards as issued by the IEC, BS, ISO and EN

The contractor is however advised to bring any discrepancies between the standards, specifications, schedules, bills of materials and drawings to the attention of the SKA for guidance.

2 References

2.1 Applicable Documents

The following documents are applicable to the extent stated herein. In the event of conflict between the contents of the applicable documents and this document, the applicable documents shall take precedence.

[AD 1] Various Authors, Critical Design Report (CDR) for the Power Sub-element, SKA-TEL-INSA-0002118 Rev 1, 30 April 2018.
[AD 2] G. Wiid, EMC Control Plan for SKA1_MID, document SKA-TEL-INSA-0000535 Rev. 1, 31 April 2018
[AD 3] Aurecon, SKA1_MID Infrastructure and Power Safety Analysis Report, document SKA-TEL-INSA-0000542 Rev. 1, 310 April 2018
[AD 4] SKA1 MID Power Budget, SKA-TEL-SKO-0000035;
[AD 5] SKA1 Power Quality Standard, SKA-TEL-SKO-0000293;
[AD 6] Environmental Conditions for the SKA1 MID Site in South Africa, 301-000000-009;
[AD 7] SKA Phase I System (Level 1) Requirements Specification, SKA-OFF.SE.ARC-SKO-SRS-001-A;

2.2 Reference Documents and Applicable Standards

A comprehensive listing of standards and specifications is provided in Appendix B as “informative References”.

The following documents are “normative references” which circumscribe the proposed works.

In the event of conflict between the contents of the referenced documents and this document, this document shall take precedence.

National Rationalised Specifications (South African ESI agreed standards)	
NRS 012 / SANS 876	CABLE TERMINATIONS AND LIVE CONDUCTORS WITHIN AIR- INSULATED ENCLOSURERS (INSULATION COORDINATION) FOR RATED A.C. VOLTAGES OF 7.2Kv AND UP TO AND INCLUDING 36kV.
NRS 053	ACCESSORIES FOR MEDIUM VOLTAGE POWER CABLES (3.8/6.6Kv TO 19/33kV)
NRS 079-1	MINERAL INSULATING OILS (UNININHIBITED) – PART 1: PURCHASE, MANAGEMENT, MAINTENANCE AND TESTING
NRS 079-2	MINERAL INSULATING OILS (UNININHIBITED) – PART 2 GUIDELINES FOR THE MANAGEMENT OF INSULATING OILS
NRS 091	HEALTH AND SAFETY GUIDELINES
South African National Standards (IEC Equivalent)	

SANS 97	
SANS 156	Moulded case circuit breakers
SANS 121	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test method
SANS 555	Insulating oil for transformers and switchgear
SANS 1029	Miniature substations for rated a.c. voltages up to and including 24 kV
SANS 1186	Symbolic safety signs
SANS 1339	Electric cables –Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3.8/6.6 kV to19/33 kV.
SANS 10142-1	The wiring of premises Part 1: Low voltage installations
SANS 1411	Materials of insulated electric cables and flexible cords
SANS 10198	Selection, handling and installation of electric power cables of rating not exceeding 33 kV
SANS 1507-3:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3 300V) Part 3: PVC Distribution Cables;
SANS 10142-2	The wiring of premises Part 2: Medium voltage installations above 1kV a.c. not exceeding 22kV and up to and including 3 000kW installed capacity.
Eskom Distribution Guidelines, Standards, Specifications and Drawings	
240-56030406	Free Standing metal-Enclosed Ring Main Units for Systems with Nominal Voltages from 11kV to 33 kV
240-56030635	General Information and requirements for Medium Voltage Cable Systems
240-56030619	Accessories for medium voltage power cables for systems with nominal voltages of 11kV to 33kV standard
20-56062752	Specification for Medium Voltage Miniature Substations for Systems with Nominal Voltages of 3.3 kV, 6.6kV, 11kV and 22kV Standard
D-DT-0855	Miniature Substation Earthing for MV Systems
D-DT-0850	Cable termination from substation onto overhead line – general arrangement
D-DT-0859	Precast concrete Plinth for Type B Mini substation (sheet7)
D-DT-0863	Precast concrete Plinth for 3 way ring main units
D-DT-0895	MV / HV cable under-river crossing details of channel type river crossing for use under small / shallow rivers.
D-DT-0896	MV under-stream crossing details of cable stream crossing where base of stream is bedrock
D-DT-8012	Cable Route Marker
240-130615754	Earthing – MV and LV Distribution System Earthing

240-75655504	Corrosion Protection Standard for New Indoor and Outdoor Eskom Equipment, components, materials and Structures Manufactured from Steel Standard
240-45395762	Specific requirements for Distribution Pole and Ground Mounted Transformers up to 33kV and 1MVA
Project Drawings	
SKA-TEL-INSA-0002020	Electrical Reticulation Single Line Diagram
SKA-TEL-INSA-0002021	Carnarvon Spiral Arm - Single Line Diagram
SKA-TEL-INSA-0002022	Williston Spiral Arm - Single Line Diagram
SKA-TEL-INSA-0002023	Brandvlei Spiral Arm - Single Line Diagram
SKA-TEL-INSA-0002033	Electrical Reticulation General Earthing Arrangement
SKA-TEL-INSA-0002036	Miniature Substation T1 Single Line Diagram
SKA-TEL-INSA-0002037	Miniature Substation T2 Single Line Diagram
SKA-TEL-INSA-0002038	Miniature Substation T3 Single Line Diagram
SKA-TEL-INSA-0002039	Miniature Substation T4 Single Line Diagram
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SKA-TEL-INSA-0002146	Trench Layout
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3 General Requirements

3.1 Introduction

This specification covers the works required for the supply, delivery and installation including design, manufacture, testing and commissioning of all equipment for the extension of the power reticulation network required for the provision of power to SKA1_MID dishes and supporting Infrastructure.

The current configuration of the SKA1-MID telescope due to be built in South Africa comprises of a core area that is densely populated with dishes. This core area accommodates approximately 75% of the dishes for SKA1, while the remaining dishes will be distributed along three spirals arms which extend out from the core up to a distance of approximately 120km.

This document extensively refers to Eskom Distribution Technical standards and specifications which are used with permission. **Eskom assumes no liability for the correctness of the specifications nor their application.** The overall cable installation shall be carried out in compliance with the Eskom Distribution standard DST_34-1175 and all documents and provisions referenced therein.

3.2 Scope of Work

The work concerns the provision of a 400V, 3 Phase supply to the SKA1_MID dish locations in accordance with the requirements of this document and all Applicable Documents listed in Section 2.

The General Scope under this contract is:

a) The contractor will be responsible for designing, planning, co-ordinating and managing all work related to the provision of a 400V supply to the SKA1_MID dish locations;
b) Project Planning and execution;
c) Assessment of existing on-site infrastructure as well as assessment of relevant design and construction specifications;
d) Testing of equipment before shipment;
e) Delivery to site;
f) Supply and installation of all equipment and materials, including all necessary testing equipment required to prove compliance to the requirements;
g) Site Testing & Handover

3.3 Design Review

This specification is a functional specification which gives the parameters and requirements for the network to be constructed. It is the responsibility of the successful tenderer to carry out detailed designs and to determine

cable sizes etc. as well as choose suitable materials for the construction of the project. All designs shall be submitted to the SKAO for review at least 21 days prior to implementation. The SKAO will review and comment on designs within 14 days. Review by the SKAO does not constitute approval and does not relieve the contractor of any design, contractual or legal responsibilities and liabilities.

4 Cable Trenches and Cable Support Systems

4.1 Trenches

a) The depth, dimensions, cable layout, bedding and blanket layers as well as final cover shall be in strict accordance with the relevant cable trench drawings.
b) Before the cable laying work is carried out, the SKAO engineer must be notified to approve the trench.
c) All cable trenches shall be free of loose rocks, debris and sharp objects which could damage the cable.
d) The bottom of all cable trenches shall be level and follow the contour of the natural ground.
e) All surplus material from excavations is to be suitably disposed of by the contractor at his own cost.
f) The contractor shall take the necessary safety precautions to ensure the safety of persons on site. This shall include necessary warning signs, shoring, barricading, supervision etc.
g) Trenching in the core area or where there is a risk of coming into contact with existing services are to be done by hand. All existing cable routes should be identified (and marked) prior to any excavation work in the core area to ensure all construction staff are aware of any potential underground infrastructure.

4.2 Trench Routes

a) The contractor shall appoint a registered surveyor to layout the cable installation / trench routes.
b) Where applicable, trench routes must fall within SKA approved servitudes
c) It is specifically recorded that the contractor is required to measure cable lengths at site and to reconfirm all relevant quantities prior to ordering any material
d) The cable trenches shall be excavated to follow the routes as shown on the relevant drawings.
e) As built drawings shall be supplied showing the cable routes to an accuracy of <=0.5m. The drawings must accurately locate any cable joints (to approval only), turning points and termination locations with added GPS co-ordinates.
f) Should the contractor encounter and obstacle or area that requires avoidance, the route may only be revised or varied after receiving written instructions from the SKAO.
g) The cable route shall be kept completely straight between necessary turning points
h) It must be noted that a large number of existing MV & LV and fibre optic cables are installed in the core area. New cable trench routes shall take into account the routing of all existing infrastructure and shall attempt to minimise either crossing or running parallel to existing routes to avoid potential damage to existing infrastructure, particularly during excavation activities.

4.3 Backfilling

a) Prior to any cables being installed in trenches, the full width of the trench shall be covered with at least a 50mm sand bedding layer.
b) The bedding layer shall comprise of sifted sand using a sieve with holes no greater than 6mm.
c) Once the cables have been laid, a further layer of bedding shall be used to cover the cables. This cover should be at least 50mm thick (measured from the top of the cable).

d) Once the cables have been covered with a bedding layer, the trench shall be backfilled with suitable material. This material must not contain any stones or rock greater than 100mm in diameter.
e) Should suitable soil not be available on site, the contractor shall import adequate material for backfilling purposes.
f) The trench shall be backfilled and compacted in layers of 150mm. The SKAO may request that a mechanical vibrator be used to compact the trench.
g) The contractor shall make allowance for final settlement by refilling and compacting the trench should settling occur.

4.4 Cable Installation and Laying

a) Cable rollers shall be used for laying cables into trenches. The rolled shall be adequately to ensure that the cable does not come into contact with any part of the trench during the laying operation.
b) Cable socks/stockings may be used to draw the cable. The maximum tension exerted on the cable during laying operations shall not exceed the supplier's recommendations.
c) Should the SKAO determine that the method of cable laying by the contractor is inadequate, they may instruct the contractor to draw the cable by hand or any other suitable method.
d) The contractor shall leave sufficient slack at the end of the cables to allow for the necessary terminations. A 5m slack is to be left on the dish foundation to ensure the dish contract has sufficient slack to terminate the cable inside the dish.
e) The cable installation procedure shall include accurate recording keeping of the cables laid. These records shall be submitted to the SKAO in the form of a cable schedule which shall include as a minimum the cable size, material, route details (i.e. from where to where), length of cable and any joints (if applicable).
f) All cables shall be labelled above the cable gland at both ends of the cable using aluminium or brass tags.
g) Cable warning tape shall be installed 300mm above all cables. The tape shall be plastic marking tape, yellow in colour and have a black triangle and an electric flash symbol and the words "Danger, Gevaar, Ingozi" printed on it. The printing intervals shall not exceed 1m along the tapes length.

4.5 Crossings

a) Trenches that cross roads or any other access points, shall not be left open or uncovered. Sleeves shall be installed immediately so that the road can be re-instated
b) The shall be at least four off 110mm sleeves per road crossing (1 off for power cable, 1 off for fibre ducting & 2 off spares)
c) There shall be no bends in the sleeves installed under the roads
d) All sleeves shall be installed at right angles to the road crossing and extend at least 1m beyond the road edge.
e) Sleeves shall comprise of a heavy duty uPVC pipe at least 1.5mm thick with a smooth finish inside
f) Suitable plugs shall be used to seal both ends of the sleeve. A galvanised steel draw wire shall also be installed inside the sleeve prior to sealing the ends.

4.6 Cable Markers

a) Cable route markers shall be installed along all cable routes to indicate the position of the cable run, change in direction and cable joints.
b) The cable route markers shall be installed at every joint location, the beginning and end of each cable run and at every change of direction.
c) The top of the cable route marker shall protrude 50mm above the ground and shall be installed at distance no greater than 100m apart.
d) The cable route marker shall comprise of precast concrete (Mixture 1 : 2 : 4) and should be dimensioned as follows: 300mm (High); 150mm x 150mm (Top); 220mm x 220mm (Base). A 100mm x 100mm x 2mm aluminium plate shall be securely fixed and embedded in the concrete. There shall be a 5mm deep recess around the perimeter of the aluminium plate.
e) The plates shall be stamped with an arrow indicating the cable direction, a designation of the cable feeder name. A "J" shall indicate a cable joint location.
f) Reference can be made to drawing D-DT-8012 for details

4.7 Arrangement of cables within trenches

a) Single core cables will be laid in trefoil groups.
b) Where specified, fibre optic cable shall be laid alongside MV or LV cables as shown in applicable project drawings
c) The minimum spacing between the fibre optic cable (FOC) and an electrical cable shall be 150mm and the FOC shall be bedded in soft sand.
d) The existence of buried fibre shall be noted on all cable route markers.
e) The manufacturer's minimum cable bending radii shall be strictly adhered to.
f) Power, control and instrumentation analogue signal cables shall be grouped separately throughout their length. MV cables shall not be mixed with LV cables but grouped separately.
g) The clearance between instrumentation signal cables and electrical control and power cables shall not be less than 300mm.

4.8 Cable Support Systems (Buildings)

Where necessary eg. building entry or on wood poles (MV overhead line to cable terminations) cable support systems shall be provided as below;

a) The cable support system for a building or other (not power line pole) structure will comprise ladder racks bolted to the building structure (horizontal / vertical as required) with, 20% spare capacity for future modifications. Conduit systems shall not be used. All cable racking shall be pre-manufactured standard heavy duty (Powerspan) ladder type

b) Outdoor cable ladder systems including covers shall be capable of withstanding the conditions outlined in the Project environmental data. Cables shall be provided with mechanical protection where they leave the cable racks.
c) Cable ladder racks and tray for external, outdoor or other potentially damp locations shall be manufactured from grade 316L stainless steel. Cable ladder rack and tray for air-conditioned locations shall be manufactured from heavy-duty hot-dipped galvanised steel.
d) Cable ladder racks shall be installed in accordance with manufacturer's recommendations and installation drawings developed for the Project.
e) In the case of vertical trays, the cables shall be secured by means of stainless steel cable straps or hot galvanised clamps.
f) Single core cables will be laid in trefoil groups. All cable trays/ladders will be electrically bonded to the earth system.
g) The manufacturer's minimum cable bending radii shall be strictly adhered to.
h) Cable saddles or clamps will have smooth and rounded edges to prevent damage to the cable sheath or serving.
i) MV and low voltage cables shall be secured to racks by means of nylon cable straps in areas not exposed to direct sunlight and 12 mm stainless steel cable straps with plastic protection in-between strap and cables for exterior installations and installations exposed to direct sunlight

4.9 Tests

a) Each cable shall be tested after installation in accordance with SANS 1507, SANS10142-1, SANS10142-2 as well as any other applicable statutory standards and/or SKAO requirements
b) The insulation resistance of the cable shall be tested using a suitable Megger. The results must be recorded and certified as being adequate.
c) Phase and continuity tests shall also be carried out for each cable.
d) The contractor shall submit copies of the relevant tests to the SKAO.
e) All Medium Voltage cables shall be subjected to a VLF pressure test as per SANS 10198 Part 13

5 Cable

5.1 Cable Rating

The rating of MV cables shall be carried out in conformance with SANS 10198-4 " The selection, handling and installation of power cables of rating not exceeding 33kV – Part 4 Current ratings" and IEC6053-1 "Calculation of the cyclic and emergency current rating of cables. Part 1: Cyclic rating factor for cables up to and including 18/30 (36) kV"

The rating of LV cables will take note of the extremely long LV cable runs required in some instances. Suitable mitigation shall be put in place to cater for situations where the earth loop impedance is excessive and has the potential to cause a safety risk.

The contractor shall appoint a competent and experience supervisor on a full-time basis to oversee the cable installation.

The nominal rated voltage of the medium voltage cables shall be:

a) 12.7/22 kV
b) 1.9/3.3 kV
c) others to be specified based on choice of any other intermediate voltage

The nominal current ratings will be based on:

a) Voltage Drop
b) load current rating
c) Fault current capability
d) Cables shall have a fault clearing rating of 1 second

De-rating shall be considered for

a) Ambient air temperature
b) Soil temperature for buried cables.
c) Depth of Burial
d) Soil thermal resistivity
e) Cable grouping
f) Solar radiation

5.2 Medium Voltage Cables

a) All MV cables shall be XLPE insulated, PVC bedded and sheathed, to SANS 1339 and the relevant A/B schedules annexed hereto.

b) Three (3) single cores power cables with separate earth conductor shall be used where the calculated cable size exceeds 240mm^2
c) The preferred cable sizes are listed in the A/B schedules annexed in Appendix A hereto
d) The cores of 3-core cables shall be individually screened.
e) The cores of 3-core cables shall be identified by the numbers 1, 2 and 3 printed at frequent intervals on the extruded semi-conducting core screen or on the semi-conducting bedding tapes of each core, or by other acceptable means
f) The bedding under the armouring shall comprise an extruded layer of PVC Type B in accordance with SANS 1411-2.
g) Cables shall be used on wooden drums with a metal flanged spindle hole that is suitable for a spindle having a diameter of 80mm.
h) Unless otherwise specified at the time of order, standard drum lengths shall be 300m for 3-core cables and 500m for 1-core cables.
i) Cables shall be legibly marked in accordance with the requirements of SANS 97 or SANS 1339 as applicable, but the marking shall include the specification number to which the cable has been manufactured, the conductor size in ……2 and material i.e. copper (Cu). A typical legend would be :

XXXXXXXXX CABLES 2000 22 kV 50 ……^{2} Cu SANS 97

j) The cable shall also bear the SABS mark.
k) Cables shall be sequentially marked at one metre intervals with the legend 000 m, 001 m, etc. starting with 000 m at the barrel of a drum and finishing with the number indicating the length of cable on the drum at the outer end of the cable. Length marking shall be to an accuracy of better than 1%.

5.2.1 MV cable termination

a) MV Cables will be terminated in general accordance with the requirements, as applicable, of the Eskom Distribution Standard DSP 34-209 part 22 “Cable Systems – Section 6: Cabling in Medium Voltage Substations”, DSP 34-1175 “ General Information and Requirements for Medium Voltage Cable Systems” and 240-56030619 “Accessories for Medium Voltage Power Cables for Systems with Nominal Voltages of 11kV to 33kV Standard”.
b) MV XLPE insulated cable terminations, indoor and outdoor depending on the application, shall be carried out in accordance with the relevant XLPE cable manufacturers’ recommendations and specifications.
c) The contractor shall notify SKA timeously as to the day on which jointing is to be carried out in order to allow the SKAO to inspect the joint/termination if required. The SKAO may request that a particular joint be opened for inspection and/or redone at the cost of the contractor if insufficient notice for inspection was given
d) The crossing of cores in joints shall not be permitted under any circumstances

5.2.2 Connection of 22kV cable circuits to existing switchgear

a) Cables emanating from the 22kV busbars at the Site Complex will be terminated and connected in general accordance with the requirements of the Eskom Distribution Standard 34-209 part 22 “Cable Systems – Section 6: Cabling in Medium Voltage Substations” with particular reference to paragraph 4.4.
b) The earthing of the cable termination shall conform to D-DT-5240 sheet 20.
c) It will be the responsibility of the contractor to supply all compatible termination materials, arrange outages, disconnect existing redundant circuits, terminate and connect new cables, adjust protection settings and commission new circuits.

5.2.3 Termination of 22kV Cable to Overhead Line Structures

a) Cable termination onto overhead line poles shall be made in accordance with the applicable sheet of Eskom Drawing D-DT-0850 “Cable termination from Substation onto overhead Line – General Arrangement”
b) The above arrangement is applicable irrespective of whether or not the cable emanates from a substation or is a feed off located close to a Dish Antenna.

5.2.4 Medium Voltage Cable Tests

a) Each cable shall be tested after installation in accordance with SANS 1507, SANS10142-1, SANS10142-2 as well as any other applicable statutory standards and/or SKA requirements
b) The insulation resistance of the cable shall be tested using a suitable Megger. The results must be recorded and certified as being adequate.
c) Phase and continuity tests shall also be carried out for each cable.
d) The contractor shall submit copies of the relevant tests to the SKAO.
e) All Medium Voltage cables shall be subjected to a VLF pressure test as per SANS 10198 Part 13

5.3 Low-Voltage Cables up to 1,000 V

This portion covers the supply and installation of the 600/1000V PVC insulated power cables. All cables shall be rated 600/1000V.

The following standards are applicable to the low-voltage cable installation:

a) SANS 1507-3: Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3 300V) Part 3: PVC Distribution Cables;
b) SANS 10142-1: Code of Practice for the wiring of premises Part 1: Low Voltage Installations;
c) SANS 1411-2: Materials of insulated electric cables and flexible cords Part 2: Polyvinyl Chloride (PVC);
d) SANS 1186-1: Symbolic Safety Signs Part 1: Standard Signs and General Requirements
e) The Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended;

The following particular requirements are shall also be complied with as part of the low-voltage cable installation:

a) Copper conductors shall be used for power, lighting, measuring and control cables.
b) The overall derating factor will be determined according to SANS 10142-1 considering the method used for laying, bunching and ambient temperatures.
c) The minimum cross-sectional area of power cables shall be 2.5 mm².

The following shall be applicable for the selection and design of LV Cables:

d) Each cable is to be sized using manufacturer's cable selection charts, and applying the necessary de-rating factors, for the selected application.
e) All LV cabling will be PVC insulated, SWA armoured, PVC bedded, 600/1000V grade, PVC sheathed construction as per SANS 1507
f) The colour of the phase insulation in cables shall be red, white (or yellow) and blue (Neutral shall be in black)
g) The colour of the phase insulation in cables shall be red, white (or yellow) and blue (Neutral shall be in black)
h) The cable shall have a fault clearing rating of 3 seconds
i) Long, lightly loaded cable runs present particular problems in respect of voltage drop and protection. Such the phase conductors of such cables shall be oversized to maintain the voltage drop within SANS 10142 limits and the neutral and earth conductors shall be oversized to ensure that short circuit faults at the end of the cable remote from the source present at least 2 X the overcurrent trip current rating of the source protection device. Where this is not economical, alternative measures such as earth leakage relays may be employed. All solutions shall be in compliance with SANS10142-1
j) All cables shall be secured with cable glands and terminated with wire lugs as detailed below

5.3.1 LV Cable terminations

a) LV cables shall always be terminated at gland plates / cubicles with the correct type and size SWA captive cone gland and all cores shall be terminated with correctly sized preinsulated wire grip type compression lugs.
b) Crimping tools shall be of the double die, ratchet controlled type to ensure full crimping pressure is achieved.
c) Preinsulated lugs shall be sized and applied in accordance with the table below.
d) Crimping tools shall be calibrated and the contractor shall supply unique valid calibration certificates for each tool.
e) Spare cores shall be terminated and earthed permanently at one end, the other end shall be capped with an insulating material and secured within the enclosure. The end to be earthed shall be agreed with the SKAO engineer on an application by application basis.

Table 1: Pre-insulated Lugs vs Wire Size

Pre-Insulated Wire Grip Lugs	Wire Size
Red	0,5mm^2 - 1,5mm^2
Blue	1,5mm^2 - 2,5mm^2
Yellow	4,0mm^2 - 6,0mm^2

Table 2: –Termination Type vs Pre-insulated Lug Type

Termination type	Pre-insulated Lug type
Bolt / stud	Ring tongue (Open spade lugs not allowed)
Lamp fitting direct screw pressure	Pin type (only one per connection)
Rail mounted terminals	Hook blade (note cage clamp terminals are not permitted)

5.3.2 Cable Jointing

The jointing or splicing of cables and cable cores / panel wires shall be avoided as a design or installation requirement unless circumstances determine such an arrangement provides an overall benefit to the project, and is approved by the SKAO.

a) All cable joints shall be carried out by competent personnel in accordance with the joint manufacturer's instructions.
b) The number of joints shall be kept to an absolute minimum. Joints will only be acceptable when a cable run exceeds the maximum allowable drum lengths.
c) All low voltage armoured cables shall be terminated by means of mechanical glands, fitted with earth rings and shrouds
d) Bi-metallic lugs shall be used when terminating aluminium conductors onto copper busbars

5.3.3 Cable Glands

a) In general all cables (SWA) will be fitted with captive cone type cable glands with correctly sized PVC shrouds over the cable sheath and gland.
b) In the event that an unarmoured cable application is approved by the SKAO, as an exception, such cable will be fitted with a captive component type compression gland with elastomeric seals and with correctly sized PVC shrouds over the cable sheath and gland.
c) All cable glands and adapters will be made of nickel plated brass or stainless steel and will be fitted with soft sealing nylon washers. Fibre washers will not be used.

5.3.4 Low Voltage Cable Tests

a) Each cable shall be tested after installation in accordance with SANS 1507, SANS10142-1 as well as any other applicable statutory standards
b) The insulation resistance of the cable shall be tested using a suitable Megger. The results must be recorded and certified as being adequate.
c) Phase and continuity tests shall also be carried out for each cable.

d) The contractor shall submit copies of the relevant tests to the SKAO.

6 Miniature Substations

A Miniature Substation is described as a factory-assembled and tested free-standing unit which is accessible to the public. The miniature substations used on the SKA Project will comprise of 3 compartments, namely a transformer, medium voltage switchgear and low voltage compartment. The medium voltage switchgear and low voltage compartments must be suitable for connection to underground cables.

Particular requirements for the minisub on the SKA site must comply with the requirements below as well as the relevant technical schedule appended to this document:

a) Miniature substations will be supplied in strict conformance with Eskom Specification **240-56062752**
b) The pollution level for the SKA Project as defined in Eskom Specification 240-56062752 shall be "Medium"
c) **No electronic devices for SCADA or Metering purposes will be allowed in miniature substations.** Items such as Earth Fault Indicators, Earth Leakage Relays and Protection Relays shall be permitted.
d) **Factory Testing and Approvals to be done by the SKAO (for RFI compliance) shall be done prior to site deployment**
e) All miniature substations to be supplied to the SKAO shall be "Type B" mini subs with an integral MV Ring Main Unit
f) All mini subs shall be mounted on a pre-constructed concrete plinth in compliance with drawing D-DT0859 sheets 5 /6 for cast on site plinths or sheet 7 pre-cast plinths.
g) All miniature substations shall be tested in accordance with SANS 1029:2016, SANS780 and Eskom Specification 240-560062752. The following tests shall be carried out on-site for each installed unit. The contractor shall provide the SKAO with the proposed test procedure for acceptance/approval before these tests are conducted
h) Minisubs must be supplied with a CT installed between the transformer star point and earth (on the earth side of the PEN link) in order to monitor small magnitude earth fault currents. This CT must be wired to the MV protection relay located in the RMU compartment and shall cause the relay to trip the MV transformer breaker should an earth fault current on the 400V side of the transformer be detected.

7 Medium Voltage Ring Main Units

A Ring Main Unit (RMU) is described as a factory-assembled and tested free-standing unit which is accessible to the public. The Ring Main Units associated with the SKA 22kV reticulation network will comprise of 2 variations, namely Type 3R and Type 2R-1B. The Ring Main Unit must be suitable for connection to underground cables.

MV Ring Main Units shall be supplied in conformance with Eskom Distribution Standard 240-56030406.
The number, configurations and ratings are given in schedule A hereto.

a) All ring main units shall be mounted on a pre-constructed concrete plinth in compliance with drawing D-DT-0863 sheets 1/2 cast on site plinths/pre-cast plinths - 2way RMU, 3/4 - 3way RMUs or 5/6 - 4 way RMUs.

b) Standard configurations of the RMUs to be supplied are listed in drawing D-DT-8060. Reference will be made to these standard configurations in the relevant technical datasheets.

8 Protection & Control Equipment

a) All protection and control equipment shall comply with the relevant sections / provisions of IEC 60255 and Eskom Specification 240-61266445.
b) A suitably qualified protection design / commissioning engineer or engineers (or persons with an acceptable relevant similar qualification) whom shall be registered with ECSA, shall be appointed under this contract.
c) The Contractor shall submit details of the person(s) and their qualifications and references to SKAO for review within 4 weeks of appointment.
d) The Contractor may utilize separate persons or parties for the study and implementation activities. The ultimate requirement is the inclusion of a signed protection study report and a signed protection commissioning report in the operating and maintenance manuals.
e) The ultimate requirement for the study portion is for the Contractor to develop a protection scheme for the SKA installation system, taking into consideration all possible system parameters (including generation, conditioning and bypass modes for 1 to 5 DRUPS) as well as optimal grading and co-ordination with the mains supply as well as the UPS system's protection characteristics. The study shall encompass the entire power system and not just the 22kV reticulation sub-element
f) The costs for this protection study will be captured as part of the "Losberg Power Facility" sub-element

Works required for the study:

a) Verify the existing and planned fault levels and trip settings of the upstream network through discussions with Eskom and SKA site personnel and if needed inspection on site
b) Evaluate the new and existing 22 kV, 33 kV and 400 V SKA installations and determine appropriate protection settings for the network at commissioning time and for it at completion. i.e. include settings for the spiral arm installations (auto-reclosers etc.) which may only be installed after LPF completion.
c) Liaise with Eskom and agree on setting adjustments for the feeder breakers at Karoo substation, if needed

Study deliverables to include:

a) Settings for the SKA network upstream of the LPF e.g. the SKA auto-recloser at Karoo Substation.
b) Settings for the new 33 kV RMU circuit breaker.
c) Settings for the new 22 kV Dummy Load RMU transformer breaker.
d) Settings for the new 22 kV Reactor RMUs
e) Settings for the existing 22 kV RMUs in the Core Rings (if no changes needed still capture in the report, such that a single report covers the installation at completion).
f) Settings for the new 22 kV Spiral Arm RMUs and auto-reclosers
g) Settings for 33 kV and 22 kV circuit breakers inside the LPF, including DRUPS 22 kV gear.

h) Settings for the adjustable circuit breakers in the LPF Main LV DB.
i) Assist by clearing up any protection grading queries the STATCOM protection lead and other parties may have.
j) The deliverable shall be a report: signed hard copy and electronic format (pdf).

Commissioning activities under the responsibility of the commissioning specialist include:

a) Protection relay and DRUPS programming – create logic diagrams & files based on grading study results and conduct physical implementation (provide own programming equipment and dongles as needed).
b) Check and confirm the integrity of control, instrumentation, power and earthing wiring and terminations (visual inspection, insulation tests, etc.).
c) Witness and approve the on-site cold commissioning process (functional, secondary relay injection, pressure testing, phasing and insulation tests of incomer and feeder cables etc.) of the modified and new LPF equipment.
d) Oversee hot commissioning of the LPF (functional testing of all breakers and interlocks after mains energization), simulating all possible modes of operation.
e) Compile a safety report based on the checklists from Annex B of SANS 10142-2 but modified for 33 kV and above 3 MVA and as applicable to the installation.
f) Redline all changes made to the MV installation on the existing as-built schematics. The final submission to be signed hard copy and electronic formats (CAD and PDF).

The SKAO Commissioning Engineer shall be required to liaise with and ultimately oversee commissioning teams of the other work packages (Grid, Losberg Power Facility and Buildings) to ensure a coordinated commissioning process.

9 Transformers

9.1 Transformers for 22kV/3,3kV, 22kV/400V and 3.3kV/400V

Transformers for stepdown from 22kV to intermediate (1.1kV to 11kV) for distribution of power over distances greater than 2km from the 22kV backbone to a dish stepdown transformer shall be supplied in accordance with provisions of the relevant parts of IEC 60076 and Eskom distribution standard 240-45395762 (Note the dual 11kV/22kV primary voltages envisaged in the latter standard are not required for this project – all transformers will have a primary voltage rating of 22/24kV Ur/Um).

a) The voltage ratio and short circuit impedance of intermediate step down transformers shall be specified in the relevant Technical Schedules
b) The vector group configuration of intermediate step down transformers shall be Dyn11 unless otherwise specified in the relevant Technical Schedules
c) The specific quantities, ratings and sizes are given in the relevant technical schedules.

The following routine tests shall be performed in accordance with IEC/SANS 60076-1 and SANS 780 on each transformer:

a) Measurement of winding resistance.
b) Measurement of voltage ratio and phase displacement.
c) Measurement of short-circuit impedance and load loss.
d) Measurement of no-load loss and current
e) Separate source voltage test.
f) Induced overvoltage test.
g) Measurement of paint thickness
h) Test for effectiveness of sealing.
i) Measurement of insulation resistance test.

10 MV Shunt Reactors

MV shunt reactors as may be required shall be constructed in accordance with IEC 60076-6 and Eskom Specification for Air Core Reactors 240-42587021.

Specific quantities, sizes and parameters are found in the associated technical schedules

11 400V Standby Generators

Standby generators when required will be operated in island mode only and it shall not be possible for them to be paralleled (deliberately or inadvertently) with the alternate (grid) supply.

a) Chop-over from grid supply to standby supply and return to grid shall be initiated automatically and effected by means of a break before make contact arrangement with both mechanical and electrical interlocking to prevent paralleling of the two supplies.
b) Fast start engine capability shall ensure the load supply break is limited to 30 s maximum for loss of grid and return to grid should be effected with less than 1s interruption in supply.
c) Return to grid shall be delayed by 3 minutes from the time that a healthy grid is first detected.
d) Standby generators shall be fuelled by diesel with an autonomous 7 day diesel supply.
e) The ability to safely replenish the fuel supply during extended outages with the generators remaining onload throughout the refuelling activity is required.
f) Standby generators shall be delivered complete with all control and switching facilities in a factory assembled and tested sound proof enclosure.
g) Standby generators shall be placed on a suitable purpose built concrete pad.
h) The installation is to be designed to avoid any environmental impact of fuel or lubricating oil loss or spillage
i) Fire protection for the diesel generator and fuel supply shall be designed to minimise deleterious environmental impacts and to prevent the spread of fire to any other co located equipment.
j) Standby generators shall be sized such that they are capable of picking up 1.2x the full cold load of the facility to be powered.
k) AVR and governor settings shall be optimised to ensure that the voltage and frequency transients experienced on full load pick up and full load rejection are within the requisite power quality parameters.

12 Surge Arresters

a) Where 24kV rated equipment is connected to an overhead line(s) by means of a cable that is longer than 50m, screened surge arresters shall be installed at the equipment terminals as well as at the cable to OHL termination.
b) All surge arresters used within the core area network shall be station class arresters and those situated at the transformers and cable circuits located on the spiral arms shall be distribution class arresters.
c) Distribution class arresters shall conform with IEC/SANS 60099-4 Surge arresters Part 4: Metal-oxide surge arresters without gaps for AC systems as well as Eskom Standard 240-56062768. Station class arresters shall conform with the provisions of Eskom Standard DSP_34-419
d) All arresters of both classes shall be gapless metal-oxide type arresters. Specific parameters are given in the relevant technical schedules
e) The guarantees of all electrical performance stated in Schedule B shall be supported by evidence in the form of type-test certificates or by tests witnessed by an Employer's Representative.

12.1 Electrical Requirements

The major electrical performance requirements are set out in Schedule A. In addition to these requirements the following electrical and mechanical characteristics are required;

12.2 Airborne contamination

Arresters shall be immune to the effects of airborne contamination on the external surfaces of the arrester housing. Pollution levels will be specified in the relevant technical schedule.

12.3 Short-circuit capability

Arresters shall withstand short-circuit currents without violent shattering and shall have the ability to self–extinguish any fire caused by the arc.

12.4 Arrester housing

12.4.1 Material

Arrester shall be polymer housed. Arresters with ceramic housing are not acceptable.
The housings of arresters intended for Coastal/Industrial applications shall be manufactured from silicone rubber.

12.4.2 Distribution Type Arresters

A disconnecting device shall be provided to disconnect the earth lead in order to isolate the arrester electrically from the overhead line and to give a positive identification of the failed unit.

12.4.3 Mounting

The 6.6kV to 44kV arresters shall be arranged for base mounting. The mounting bracket is 70 mm wide and has a single 14 mm diameter mounting hole. A threaded stud (M12 x 50mm) a nut, spring washer and two flat washers are required to mount the arresters.
This bracket must allow for direct attachment onto the arrester mounting bracket provided on the distribution transformer, of which detail are shown in the attached drawings.

12.4.4 Terminals

12.4.4.1 Line terminals

The line terminal of the 6.6kV to 44kV arresters shall comprise of a threaded stud (M12 x 50 mm), a nut, flat washer and spring washer (for application of a crimpled lug, M12 hole).

12.4.4.2 Earth terminals

No additional earth terminal is required on the 6.6kV to 44kV arresters.

13 Junction Boxes

a) Junction boxes shall be rated IP66, made of fibre reinforced plastic or stainless steel, each with a canopy installed.
b) The terminal blocks in the terminal boxes shall be mounted on mounting rails. Interconnection of several terminals shall be made by means of terminal links. Partition plates shall be installed between adjoining jumpered terminals.
c) End plates shall be provided at the end of each terminal block. If earthing connections are required, these shall be via earthing terminals or an earthing bar.
d) Junction boxes shall be equipped with an adequate number of cable glands and plugs for unused cable gland openings.
e) Junction boxes will be fitted with a stainless steel nameplate.
f) When plastic terminal boxes are used and in the case of large metal glands, internal metal plates shall be used to reinforce the terminal box wall. These metal plates shall be connected to the earthing terminals. Smaller metal glands that do not require reinforcing plates shall likewise be connected to earthing terminals.

14 Distribution Kiosks

This specification covers the manufacture of distribution kiosks for three-phase, four-wire, 400/230V, 50 Hz systems.

14.1 Applicable Standards

a) SANS 556: Low Voltage switchgear Part 1: Circuit Breakers;
b) SANS 60439: Low Voltage Switchgear and Control Gear Assemblies Parts 1-5;
c) SANS 60947: Low-voltage switchgear and control gear – Parts 1-8;
d) SANS 1973: Low Voltage Switchgear and Control Gear Assemblies Part 1-8;
e) SANS 1091: National Colour Standards for Paint;
f) SANS 1186-1: Symbolic Safety Signs Part 1: Standard signs and General Requirements;
g) SANS 60529: Degrees of Protection for Enclosures (IP Code)

14.2 Size

The kiosk shall be suitably sized to accommodate the number of outgoing circuits and equipment specified.

14.3 Moisture, Dust and Vermin

a) The kiosk shall have an ingress protection (IP) rating of 54.
a) The kiosk shall be weatherproof, vermin and insect proof and tamper proof.
b) The door surrounds shall incorporate a splash proof sill around the inner border of the door opening.
c) A neoprene strip shall be fitted along the edges of each door to seal the kiosk against dust and water

14.4 Ventilation

a) Two ventilation grills or slots, approximately 150mm x 125mm, vermin proofed by means of 1.5mm brass mesh or perforated steel plate spot-welded on the inside, shall be provided on the top and bottom of both side panels.
b) The construction of the grills shall prevent the ingress of rain, water and vermin.

14.5 Canopy

a) The entire kiosk shall be manufactured from 2.5mm (minimum thickness) 3CR12 steel.
b) Cable terminations shall be facilitated by means of mechanical glands with shrouds on the cable glad plate. K-Clamps mounted on a unistrut rail shall be provided to support the cables.
c) The kiosk shall be plinth mounted with the use of a concrete base
d) All set screws, nuts and spring washers used for the fitment of parts or equipment in the kiosk shall be of stainless steel.
e) All set screws and nuts shall be fitted with spring washers
f) The roof of the canopy shall form part of the box and shall not be a separate item.

g) The roof shall be pitched and slope downwards toward the front and the back of the kiosk.

14.6 Doors

a) The kiosk will be fitted with two doors, one at the front and one at the back.
b) The doors shall be fitted with stainless steel internal hinges on the left side of the kiosk (both doors hinge on the same side)
c) Doors shall swivel through 135 degrees
d) The locking mechanism shall be a three lever system or three pin system at the top, side and bottom of the doors.
e) The locking mechanism shall be lockable by padlocks.
f) The doors shall be bonded to the frame by means of a copper braided straps, tooth washers, bolts and nuts.

14.7 Equipment Mounting Plate/Support Frame

a) The inner plate shall be installed to mount the electrical equipment in the kiosk. The inner plate shall be manufactured from 3mm 3CR12 steel and shall be powder-coated white in colour.
b) The plate shall have a 10mm lip bent at 90° to the plate, on the top and bottom sides.
c) The DIN-rails shall be fitted onto the inner plate using stainless steel bolts, nuts and spring washers; or screws and spring washers; or rivets, as shown on the drawing. The DIN-rail may also be spot-welded onto the back of the panel.
d) The inner plate shall be fitted onto the box by means of at least eight stainless steel set screws, spring washers and nuts.

14.8 Busbars

a) The busbars shall be fitted onto the back of the kiosk for the red, white, blue and neutral phases.
b) The busbars shall be of tinned copper
c) The insulators shall have a cylindrical shape (without sheds)
d) The insulators shall have M10 inserts on either end
e) The minimum diameter of the flat circular surface where the insulator makes contact with the frame and busbar shall be 25mm.
f) The busbars shall be coloured to indicate the phase of each busbar
g) The order of the busbars from left to right shall be neutral, red, white and blue (as seen from the back)
h) The busbars shall come fitted with stainless steel 35mm M8 and M12 set screws, nuts and spring washers.

14.9 Wiring

a) All wiring shall be done using stranded copper Polyvinyl Chloride (PVC) insulated conductor, which shall comply with SANS 1507 and SANS 1411-2.
b) The supply cables shall be connected onto the busbars at the back of the inner plate.

c) The neutral from the supply side will be hard wired, by way of a 25mm square cable onto the earth stud inside the kiosk.
d) There shall be no joints or splices in the wiring.
e) The wiring shall be colour coded to represent the relevant phase busbar to which it is connected. The neutral wire shall be black and the Earth wire shall be green and yellow.
f) A 16mm^2 stranded copper colour-coded PVC insulated conductor shall be used to connect each Miniature Circuit-breaker (MCB) to the phase busbar that supplies it.
g) The side of each conductor that is connected to the Phase busbar shall be fitted with a tinned copper lug.
h) No bare wiring shall be exposed at termination points on the MCB's and terminals
i) The gland plates and the internal frame/assembly structure shall be bonded to the kiosk enclosure to ensure maximum electrical continuity between the gland plate, the internal frame/assembly structure and the rest of the distribution kiosk enclosure.

14.10 Kiosk Plinth

a) The kiosk plinth shall be of the precast concrete type.
b) All surfaces and edges of the plinths shall be free from imperfections, cracks and chips.
c) The plinth shall be dimensioned to suit the dimensions of the distribution kiosk and relevant loads acting on the plinth.
d) Holding down bolts shall comprise a minimum of 4 x bolts with transverse reinforcing to secure the bolts in the plinth concrete

14.11 Access

e) The kiosk shall have back to back access.
f) The rear of the kiosk will house the incoming isolator, busbars and surge arrestors only.

14.12 Notices and Labelling

a) Notices shall be provided as required by the Occupational Health and Safety Act. All notices shall be fastened to the kiosks with rivets
b) Standard "DANGER" notices in accordance with SANS 1186-1 shall be provided by the manufacturer and placed outside on both doors of the kiosk.
c) A label showing the name of the manufacturer, the date of manufacture and the various quality checks shall be placed on the inside of the kiosk door.
d) All circuit/equipment labels shall have black lettering on a white background, with 6mm high lettering.
e) The 6mm labels shall be mounted inside an aluminium label holder below the relevant item of equipment.

14.13 Inspection

a) The SKAO shall be notified at least two weeks in advance of the anticipated completion date of the equipment manufacturing process. This will be to allow the SKAO to make arrangements to visit the

suppliers' premises for the purposes of carrying quality inspections and witnessing of tests prior to the equipment being dispatched to site.

14.14 **Drawings**

Shop drawing submittals shall include, but not be limited to the following:

a) An outline drawing showing all relevant dimensions
b) A drawing showing the equipment layout which shall include all busbar/equipment ratings, capacities and accessories.
c) Before manufacturing of any kiosk starts, the contractor shall submit the final drawings to the SKAO for approval.

15 22kV Pole Mounted Auto-Recloser

An Auto Recloser (ARC) is described as a factory-assembled and tested free-standing circuit breaker which makes use of a mechanical switching device that, after opening, closes automatically after a predetermined time.

An auto-recloser is considered to consist of two main subcomponents, i.e. a circuit-breaker and a control cabinet. In order to distinguish between the two main subcomponents and the combined product, the following terminology will be utilised:

- Circuit-breaker – the mechanical switching device, including the bushings and mounting bracket
- Recloser control – the control cubicle and its entire contents, including the control cable
- Auto-recloser – the combination of the circuit-breaker and the recloser control

Auto-reclosers shall be supplied in conformance with Eskom Distribution Standard 240-71084644.
The number, configurations and ratings are given in schedule A hereto.

a) All auto-reclosers shall be pole/platform mounted;
b) All units shall be tested in term of the project requirements for RFI (including control box, protections relays etc.) prior of deployment to site.

16 22kV RC Filter

The installation of suitably rated and sized RC Filters/Zorc units are required to protect the 22kV reticulation network against switching surges.

The new RC filters are to be installed outdoor and must be supplied complete with their own plinth, steelwork supports and fencing.

Reference can be made to the applicable technical schedule found in Appendix A of this document for additional requirements.

17 Marking and Labels

a) The Contractor shall provide notices, labelling, signage and operating instructions as described on the drawings and specifications included in the project pack and as required by statute.

b) All items forming part of the installation that present a potential hazard shall be identified as such.

c) Marking of Machinery shall be in accordance with ISO 61310-2. Machinery shall bear all markings which are necessary:
   i. For its unambiguous identification
   ii. For its safe use

   And supplementary information shall be given, as appropriate:

   i. Permanently on the machinery
   ii. In accompanying documents such as instruction handbooks
   iii. On the packaging

d) All electrical equipment shall be identified with engraved nameplates.
e) Equipment labels shall remain legible and affixed after use in the intended environment, including maintenance activities, for at least 50 years or for the lifespan of the intended equipment, whichever is longer.
f) Equipment labels should be clearly visible on the top or adjacent, in plain sight.
g) INSA equipment packaging shall be marked with the part number of the contents.
h) Where practical, all line replaceable units should be marked with an Electronically readable or scannable ID.

17.1 Labels

a) Outdoor labels shall be engraved aluminium or stainless steel
b) Indoor labels shall be of the engraved type "Traffolyte" or equivalent with black characters on a white background, matching the style already installed on site.
c) Nameplates shall be screwed to the fixed part of metalwork or structure with aluminium rails, or to the equipment housing by means of stainless steel screws (Ensure that the integrity of the equipment is not compromised).
d) Self-tapping screws shall not be accepted.
e) Labels on existing equipment shall be updated to match new and modified installations
f) Under no circumstances shall labels be attached to functional, removable equipment.

17.2 Identification

Each item in a motor control centre, distribution and control panels as well as any remotely installed equipment shall be tagged with the identical numbering as shown on the drawing

17.3 Warning Signs

Warning signs shall be erected wherever required by the OHS Act and shall comply to SANS (SANS 10142, SANS 1186, SANS 10140, etc.). Where signage for specific potential hazards is not covered by SANS this shall be provided in accordance with BS EN ISO 7010.

17.4 Cables Tags

a) Each cable shall carry a unique identifier
b) All cables shall be fitted at both ends with markers of durable, non-deteriorating material bearing the appropriate cable reference number.
c) The markers shall be located in a suitable position (as close as possible to the cable glands) to permit easy reference by Maintenance personnel.
d) Cable markers shall be laser engraved stainless steel 316 tags with a minimum letter size of 6mm.

17.5 Wires and cable cores

a) All wires and cable cores shall be fitted with identification markers of the interlocking ferrule type or the shrink on type.
b) Split or clip-on markers will not be acceptable.
c) All terminations on both ends of a break (terminal block) and both outer ends shall be clearly and indelibly marked

18 Deviation schedule

Any deviations offered to this specification shall be listed below with reasons for deviation. In addition, evidence shall be provided that the proposed deviation will at least be more cost-effective that that specified by SKA.		
Item	**Clause**	**Proposed deviation**

19 Appendix A – Technical Schedules

Technical Schedules – MV Cables

A- Employer's requirements

B- Supplier's Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
	Cable Characteristics			
1.01	Rated voltage (Ur)	kV	22	
1.02	Number of cores (1- Core or 3- Cores)	No.	3	
1.03	Conductor Type	Cu/Al	Cu	
1.04	Insulation	PILC/ XLPE	XLPE	
1.05	Screening of cables	Y/N	Yes	
1.06	Semiconducting core screen	Y/N	Yes	
1.07	Core identification	Y/N	Yes	
1.08	Metal sheath	Y/N	Yes	
1.09	Bedding under armouring	Y/N	Yes	
1.10	Armouring / copper wire screened	Y/N	Yes	
1.11	Conductor Size	mm^2	50	
1.12	Rated frequency (fr)	Hz	50	
1.13	Bear SABS Mark	Y/N	Y	
1.14	Applicable Product Standard		SANS 1339	
1.15	Applicable Eskom Standard for XLPE Cable		240-56063792	
1.16	Type of outer sheath		MDPE	
1.17	Ultraviolet (UV) radiation stabilized outer sheath		required	
1.18	Reduced halogen emission properties if PVC used for armour bedding and outer sheath		required	
1.19	Longitudinal water blocking for conductor and cable		required	
1.20	Method used to achieve water blocking		specify	
1.21	Instructions for conductor water blocking removal for jointing & termination		required	
1.22	Hole for wooden drums for a spindle in mm if not 80mm (minimum).	mm	Specify	
1.23	Drum length	m	300	
1.24	Cable outer sheath marking to SANS 97 or 1339		required	
1.25	Type tests report and applicable certificates to be provided		required	
1.26	Marking of cable identification system		required	

	Description	Units	Schedule A	Schedule B
1.27	Cable identification system location		As per Spec	
1.28	Dimensions of cable offered		provide	
1.29	Maximum sustained current rating in Ground	A	provide	
1.30	Maximum sustained current rating in Air	A	provide	
1.31	Maximum sustained current rating in Ducts	A	provide	
1.32	Short circuit rating	kA	provide	
1.33	Cable mass	Kg/m	provide	
1.34	Gross mass per standard drum length	kg	provide	
1.35	Resistance at max conductor temperature	Ω	provide	
1.36	Reactance per phase?	Ω/m	provide	
1.37	Capacitance per phase?	nF/m	provide	
1.38	Zero sequence impedance per phase?	Ω/m	provide	
1.39	Zero sequence capacitance per phase?	nF/m	provide	
1.40	Cable thermal time constant?	s	provide	
1.41	Cable Terminations to comply with Eskom Specification 240-56030619	Y/N	yes	

Technical Schedules – LV Cables

A- Employer's requirements

B- Supplier's Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
	Cable Characteristics			
1.01	Rated voltage (Ur)	V	400	
1.02	Number of cores	No.	2/3/4	
1.03	Conductor Type	Cu/Al	Cu/Al	
1.04	Insulation	PVC/ XLPE	PVC	
1.05	Core identification	Y/N	Yes	
1.06	PVC Bedding under armouring	Y/N	Yes	
1.07	Galvanised steel wire armoured	Y/N	Yes	
1.08	Conductor Size	mm^2	2.5-185	
1.09	Rated frequency (fr)	Hz	50	
1.10	Bear SABS Mark	Y/N	Y	
1.11	Applicable Product Standard		SANS 1507	
1.12	Applicable Eskom Standard for LV Cable		240-56063805	
1.13	Outer sheath material		PVC	
1.14	Ultraviolet (UV) radiation stabilized outer sheath		required	
1.15	Reduced halogen emission properties of PVC used for armour bedding and outer sheath		required	
1.16	Hole for wooden drums for a spindle in mm if not 80mm (minimum).	mm	Specify	
1.17	Drum length	m	500	
1.18	Cable outer sheath marking to 1507		required	
1.19	Type tests report and applicable certificates to be provided		required	
1.20	Marking of cable identification system		required	
1.21	Cable identification system location		As per Spec	
1.22	Dimensions of cable offered		provide	
1.23	Maximum sustained current rating in Ground	A	provide	
1.24	Maximum sustained current rating in Air	A	provide	
1.25	Maximum sustained current rating in Ducts	A	provide	

Item	Description	Units	Schedule A	Schedule B
1.26	Maximum sustained current rating in Ducts	A	provide	
1.27	Short circuit rating	kA	provide	
1.28	Cable mass	Kg/m	provide	
1.29	Gross mass per standard drum length	kg	provide	
1.30	Resistance at max conductor temperature	Ω	provide	
1.31	Reactance per phase?	Ω/m	provide	
1.32	Capacitance per phase?	nF/m	provide	
1.33	Zero sequence impedance per phase?	Ω/m	provide	
1.34	Zero sequence capacitance per phase?	nF/m	provide	
1.35	Cable thermal time constant?	s	provide	

Technical Schedules – 3.3kV Cables

A- Employer's requirements

B- Supplier's Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
	Cable Characteristics			
1.01	Rated voltage (Ur)	V	3300	
1.02	Number of cores	No.	3	
1.03	Conductor Type	Cu/Al	Cu	
1.04	Insulation	PVC/ XLPE	PVC	
1.05	Core identification	Y/N	Yes	
1.06	PVC Bedding under armouring	Y/N	Yes	
1.07	Galvanised steel wire armoured	Y/N	Yes	
1.08	Conductor Size	mm^2	16	
1.09	Rated frequency (fr)	Hz	50	
1.10	Bear SABS Mark	Y/N	Y	
1.11	Applicable Product Standard		SANS 1507	
1.12	Outer sheath material		PVC	
1.13	Ultraviolet (UV) radiation stabilized outer sheath		required	
1.14	Reduced halogen emission properties of PVC used for armour bedding and outer sheath		required	
1.15	Hole for wooden drums for a spindle in mm if not 80mm (minimum).	mm	Specify	
1.16	Drum length	m	500	
1.17	Cable outer sheath marking to 1507		required	
1.18	Type tests report and applicable certificates to be provided		required	
1.19	Marking of cable identification system		required	
1.20	Cable identification system location		required	
1.21	Dimensions of cable offered		provide	
1.22	Maximum sustained current rating in Ground	A	provide	
1.23	Maximum sustained current rating in Air	A	provide	
1.24	Maximum sustained current rating in Ducts	A	provide	
1.25	Maximum sustained current rating in Ducts	A	provide	
1.26	Short circuit rating	kA	provide	

Item	**Description**	**Units**	**Schedule A**	**Schedule B**
1.27	Cable mass	Kg/m	provide	
1.28	Gross mass per standard drum length	kg	provide	
1.29	Resistance at max conductor temperature	Ω	provide	
1.30	Reactance per phase?	Ω/m	provide	
1.31	Capacitance per phase?	nF/m	provide	
1.32	Zero sequence impedance per phase?	Ω/m	provide	
1.33	Zero sequence capacitance per phase?	nF/m	provide	
1.34	Cable thermal time constant?	s	provide	
1.41	Cable Terminations to comply with Eskom Specification 240-56030619	Y/N	yes	

Technical Schedules –Type B Miniature Substations

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
1.1			**315 kVA, 22kV/415V &33kV/400V Type B Miniature Substation**			
1.2	SANS 1029	4.2.1.3 a)	Altitude	m	1000	
1.3			Nominal HV system voltage	kV	33kV / 22kV	
1.4	SANS 1029	4.2.1.3 b)	Relative humidity	(%)	98	
1.5	SANS 1029 & SANS 62271-1	4.2.1.3 d) and 2.1.2 a)	Ambient air temperature	ºC	-10 to +40	
1.6	SANS 62271-1	2.1.2 b)	Maximum solar radiation	W/m2	1000	
1.7	SANS 62271-1	2.1.2 f)	Wind pressure	Pa	1050	
			Ultra-violet radiation		High	
1.8	240-56062752	3.1.1 a) ii)	Pollution conditions inside mini-sub		Degree 3	
1.9	240-56062752	2.1	Mini sub application(Inland/ Coastal)		Inland	
Minisub Transformer Ratings						
2.1	SANS 876	List 3 of Table 1	Rated lightning impulse withstand kV peak	kV	Item specific	
2.2	240-56062752	3.1.2.2 a)	Transformer power rating	kVA	315	
2.3	240-56062752	3.1.2.2 b)	Nominal voltage of system (Un) (kVrms)	kV	22 & 33	
2.4	SANS 780	8.26	Transformer rated no-load secondary voltage	kV	420	
2.5	SANS 780	Table 2	Rated short duration power frequency withstand voltage (50Hz)	kVrms	Item specific	
2.6	SANS 780	Table 1	Number of phases		3	
	SANS 780	6.1.3	Vector group		Dyn11	
2.7	SANS 1029	4.1.4.1	System frequency (Hz)		50	
2.8	240-56062752	3.1.2.2 d)	Transformer unit with welded cover		Yes	
2.10			MV system earthing (Effective/Non-effective)		Non-effective	
2.11	240-56062752		MV system fault level kA		20	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
2.12	240-56062752	3.1.2.3 h)	LV transformer neutral earthing		Solid connection to insulated LV neutral/earth bar	
2.13	240-56062752	3.7.1	a) Temperature rise limits: Top oil temperature rise	K	55	
			b) Temperature rise limits: Average winding temperature rise	K	60	
2.14	SANS 780	5.8.2 c)	**Tap changer**			
			a) Type of Tap		Switch	
			b) Secondary voltage regulation (Off-load): Tapping	%	5, -2.5, 0, +2.5, +5	
			c) Tap Changer: Manufacturer		provide	
			d) Model Number		provide	
			e) Precise electrical location of tapings		provide	
2.15	SANS 780	5.6.1	No-Load losses	kW	Item specific	
2.16	SANS 780	5.6.1	Load losses	kW	Item specific	
2.17	SANS 780	8.27	Impedance voltage (see table 9 of SANS 780)	%	Item specific	
2.18	240-56062752	3.5 e)	X/R ratio		provide	
2.19	240-56062752	3.5	Cost /kW of no-load losses	R/kW	provide	
2.20	240-56062752	3.5	Cost /kW of load losses	R/kW	provide	
2.21	SANS 780	8.5.3	Audio sound level -Maximum (see table 6 of SANS 780)	dB	Item specific	
2.22	SANS 1029	6.4.7	Transformer MV bushings (NB internal screen to be earthed)		EN 50180 Type C with M16X2 thread	
2.23	240-56062752	3.2.1.1 a)	a) The transformer bushing-centre spacing shall be	mm	Item specific	
2.24	240-56062752	3.2.1.1 b)	b) The distance between the outer bushing-centres and the mini-sub metal enclosure	mm	Item specific	
2.25	240-56062752	3.2.1.2	Transformer overload protection facility (LV main circuit breaker)		Yes	
2.26	240-56062752	3.2.1.2	Make (product) of circuit breaker		SANS 556-1	
2.27	240-56062752	3.2.1.2	Minimum fault current interrupting capacity	kA	provide	
2.28	SANS 780		a) Transformer winding material (Al/ Cu): MV		provide	
			b) Transformer winding material (Al/ Cu): LV		provide	
2.29	240-56062752	3.2.1.2 c)	Top-oil thermoelectric temp-sensing element		provide	
2.30	ESP 32-406		Transformer oil type	Must comply with Eskom Standard DSP 32-406	provide	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
Minisub Earthing						
3.1	240-56062752	3.1.2.3	LV neutral-earth busbar earthing arrangement		Item specific	
3.3	240-56062752	3.1.2.3 c)	LV neutral-earth bar / LV earth bar to be earthed (via a 70mm2 Cu electrical bridge to the mini-sub earth bar)		Yes	
3.4	240-56062752	3.1.2.3 d)	i) Neutral surge arrester Class		Class 1	
	240-56062752	3.1.2.3 d)	ii) Neutral surge arrester Discharge current rating	kA	10	
	240-56062752	3.1.2.3 d)	iii) Neutral surge arrester MCOV	kV	5	
	240-56062752	3.1.2.3 d)	iv) Neutral surge arrester Max residual voltage	kV	19.5	
	240-56062752	3.1.2.3 d)	v) Neutral surge arrester Min creepage	mm	140	
	240-56062752	3.1.2.3 d)	vi) Neutral surge arrester OEM	Name	provide	
3.5	240-56062752	3.1.2.3	Number of insulated electrolytic copper conductors of cross-sectional area	mm^2	Item specific	
3.6	SANS 1029	6.3.3.2.6	a) Clearance to earthed metallic framework	mm	20	
			b) Spacing between phase centres shall be	mm	185	
			c) The spacing between the lowest (blue) phase busbar and	mm	300	
Minisub Metering Requirements						
4.1	SKA RFI Policy		No Metering Equipment to be installed for RFI Reasons		Comply	
Minisub LV Assembly						
5.1	SANS 1029	6.3.3	Does LV assembly comply with SANS 1973-1?		Yes	
5.2	240-56062752	3.1.2.5 c)	Minimum number of outgoing LV cable feeder bays.		Item specific	
5.3	240-56062752 & SANS 1029	3.1.2.5 & Fig C.9	Number of gland plates to be provided (see fig C. 9 of SANS 1059)		1 per LV feeder bay	
5.4	SANS 1029	6.3.3.3.10	Number of gland holes per LV feeder bay		2	
5.5	SANS 1029	6.3.3.3.10	Size of hole per LV feeder bay (diameter)	mm	1 x 65 & 1 x 52	
5.7	SANS 1029	6.3.3.3.10	Clearance for each hole per feeder bay	mm	98 (for the 65mm hole) & 65 (for the 52mm hole)	
5.8	SANS 1029	6.3.3.3.10	Distance between adjacent feeder bay centre lines (see fig	mm	110	
5.10	240-56062752	3.1.2.5 g) & 3.1.2.5 h)	LV feeder protection offered: MCCB or vertical fuse holders?		MCCB	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
5.11	240-56062752	3.1.2.6 a)	LV busbar rating (see table 2 of 240-56062752) (A). Rated at 1.2 transformer rated secondary current.	A	Item specific	
5.12	SANS 1029	6.3.3.2.6	Clearance between phase to phase centres (see figure C.10).	mm	185 (min)	
5.13	SANS 1029	6.3.3.2.6	Clearance between the lowest (blue) phase busbar and neutral busbar centres (see figure C.10).	mm	300 (min)	
5.14	SANS 1029	6.3.3.2.6	Clearance between lowest LV neutral and gland plates (see figure C.10)	mm	200 (min)	
5.15	240-56062752	3.1.2.6	a) Busbar insulation		Air insulated	
			b) Busbars		3 + one identical neutral-earth busbar (insulated from frame)	
5.16	SANS 1029 & SANS 1973-1	6.3.3.1	Does current density of busbars meet requirements?	A/mm2	Yes	
5.17	SANS 1029 & SANS 1973-1	4.1.2.5	Does the rated short-time withstand current of main circuit (1s) meet Eskom's requirements?	kArms	provide	
5.18	240-56062752	3.1.2.6 b)	Stainless Steel M12 set screws provided		Yes	
Minisub LV Auxilliary Equipment						
6.1	240-56062752	3.1.2.8 a)	LV maximum demand ammeters to be provided for all three phases		Yes	
6.2	SANS 1029	6.3.3.5.1	Ammeter type		Thermal integrating over 15 min period	
6.4	240-56062752	3.1.2.8 b)	One voltmeter with a selector switch provided?		Yes	
6.6	SANS 1029	6.3.3.5.3	Ammeter and voltmeter size and display (mm)		96 X 96	
6.7	SANS 1029	6.3.3.5.3	Ammeter and voltmeter position		LV compartment (as high as possible)	
6.8	240-56062752	3.1.2.8 c)	Provision for three point socket outlet in LV compartment (with instantaneous-trip earth leakage unit [20A, 5kA rapturing capacity, 30 mA sensitivity] and 20 A HRC fuse with neutral fuse link		Yes	
6.9	240-56062752	3.1.2.8 d)	Provision of tamperproof compartment for the installation of a photocell.		No	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
6.10	240-56062752	3.1.2.8 d)	300 mm X 300 mm blank plate for PECU		No	
6.11	240-56062752	3.1.2.8 d)	Numbering of ferrules for auxiliary wiring		Yes	
Minisub General Electrical Requirements						
7.1	240-56062752	3.1.2.9 a)	Is the wiring of the mini sub as per D-DT -0868		Yes	
7.2	240-56062752	3.1.2.9 b)	Do LV auxiliary fuses comply with the requirements of fuse		Yes	
7.3	240-56062752	3.1.2.9 b)	LV auxiliary fuses shall be of size E1.		Yes	
7.4	240-56062752	3.1.2.9 d)	Are terminal blocks in accordance with DSP 34-253?		Yes	
7.5	240-56062752	3.1.2.9 d)	Do terminal blocks have spring loaded screw terminals?		Yes	
Minisub Type B Specific Requirements						
9.1	240-56062752 & 240-97690165	3.3 a)	a) Medium voltage compartment shall be fitted with a non-extensible 2R-1B RMU.		Yes	
			b) Medium voltage compartment shall be fitted with a non-extensible 2R-1B RMU and IRTU.		No (IRTU not permitted)	
9.2			RMU manufacturer	Name	Provide	
9.3	240-56062752	3.3.1.1 b)	a) Integral cable test facilities that do not require access to the cable termination enclosure.		Yes	
			b) Cable test facility with interlocking capability		Yes	
			c) Working instructions for the RMU for the correct reinstatement procedure of the earth connection on the cable test facilities		Yes	
9.4	240-56062752	3.3.1.1 c)	Remote tripping (hand-held push-button remote control unit) provided		Yes	
9.5	240-56062752	3.3.1.1 d) 3.3.1.1 c) vi	a) RMU incoming/ outgoing MV cable requirement:		3 core	
			b) Cable support (clamping) required SANS 876 and D-DT 8019 all three core cables. Outer diameter (mm)	mm	Item specific	
			c) Cable support (clamping) required SANS 876 and D-DT 8019 all single core cables. Outer diameter (mm)	mm	Item specific	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
9.6	240-56062752	3.3.1.1 c) II 3.3.1.1 c) V	a) The cable termination enclosure for 3-core cable terminations shall have a 800 mm minimum bushing centre line spacing distance to the bottom cable entry or bottom entry plate.	mm	Yes	
			b) For 22 kV ring main units, the minimum spacing between bushing centres and between the outer bushing centres and earthed metal enclosure shall be 90 mm and 50 mm respectively	mm	Yes	
9.7	240-56062752	3.3.1.1 e) 3.3.1.2 a)	Is an "integrated" voltage detection system (VDS) with fixed voltage indicators and test points provided?		Yes	
			Type (make and product) for interconnection cable (SANS 1029) offered? SANS 1339 or IEC 60502-2.	SANS 1339 or IEC 60502-4	Provide	
9.8	240-56062752; SANS 1332 and D-DT 8017	3.3.1.2 a) and 3.3.1.2 b)	a) Type of connection (SANS 1332) to RMU		Provide	
			b) Make (product) connector used on transformer bushing (SSC)		Provide	
			c) Make (product) connector used on RMU T-Off (SSC)		Provide	
9.9	240-56062752	3.3.1.2 c)	Interconnection arrangement between RMU and transformer MV bushings.		Provide	
9.10	240-56062752	3.3.1.3	a) The transformer bushing-centre spacing. (mm)	mm	Provide	
			b) The distance between the outer bushing centres and the mini-sub metal enclosure. (mm)	mm	Provide	
9.11	240-56062752	3.3.1.4	a) The transformer unit shall be fitted with a top-oil thermoelectric temperature-sensing element		Item specific	
			b) For IRTU fitted mini subs: A proposal for digital gauges for temperature sensing element for the transformers submitted?		N/A – No IRTU allowed	
9.12	240-56062752	3.3.1.5 a)	a) Main LV switch dis-connector provided?		Yes	
			b) The type (product make) of switch dis-connector offered?		Provide	
9.14	240-56062752 Table 4	3.3.1.5 c)	The standard size of switch dis-connector or circuit breaker offered:	A	450A	
9.15	240-56062752	3.3.1.6	a) For IRTU fitted mini subs: Does the IRTU meet requirements ?		No IRTU allowed for RFI reasons	
			b) All drawings, technical schedules and type test reports in accordance with 240-97690165 and SANS 1874 to be submitted?		No IRTU allowed for RFI reasons	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
9.16	240-56062752	3.3.2 a)	For mini-subs designed for the fitting of LV circuit breakers: does the mini sub meet the following requirements?			
			a) The LV assembly shall be at least 1000 mm	mm	1000	
			b) Does the LV assembly accommodate a minimum of 6 LV circuit?		Yes	
			c) Are LV circuit breakers up to 150 mm wide?		Yes	
			d) Is the clearance between the LV circuit breakers 20 mm between circuit breakers?		Yes	
9.17	240-56062752	3.3.2 b)	Are LV busbars and gland plate support structure pre-drilled to allow for up to 9 feeder bay, and are six gland plates provided?		Yes	
9.18	240-56062752	3.3.2 c)	Does the mini-sub base have four 24 mm Ø round mounting holes?		Yes	
9.19	240-56062752	3.3.3	Does the protection relay meet minimum requirements?		Yes	
9.20	240-56062752 & SANS 1029	3.7.2 3.7.2 a) 3.7.2 b) 3.7.2 c) 3.7.2 d)	a) Does internal arc classification test for Type B mini-subs meet requirements?		yes	
			b) Are all type test performed on the enclosure offered?		yes	
			c) Are all type tests performed on each RMU offered? (test for each RMU supplier type if not using one supplier)		yes	
			d) Are all RMU compartments tested in according to SANS 62271-200 for both the IAC-A and IAC-B tests of the mini-sub enclosure?		yes	
			e) Are all applicable type test videos for all applicable IAC AB test supplied?		yes	
9.21	-	-	Does the minisub have a facility to detect small magnitude Earth Fault currents on the 400V side (0-5A). These LV earth faults may be due to a LV phase to tank fault for example.		Required / include method statement on how this feature/facility will function	
Minisub Construction Requirements						
11.1	240-56062752	3.1.3.1.d)	Does the base channel and sills of the doors comply		Yes	
11.2	240-56062752	3.1.3.1.e)	Does the three-point locking mechanism on each compartment door have an additional, captive, 10 mm Allen cap screw?		Yes	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
11.3	240-56062752	3.1.3.1.f)	Are all door handles manufactured from stainless steel and classified as heavy duty?		Yes	
11.4	240-56062752	3.1.3.1.g)	Is a pad lock protection provided?		Yes	
		3.1.3.1.j)	a) For IRTU fitted mini subs: Is a proposal for additional fitting of remote controlled door locking devices provided?		No IRTU allowed for RFI reasons	
		3.1.3.1.k)	b) For Type B mini subs: Proposal for alternative mechanical door locking devices and padlock protection facilities provided?		No IRTU allowed for RFI reasons	
Minisub Materials and Corrossion Protection						
12.1	240-56062752 & SANS 60815-1	3.1.3.2 b)	For mini-subs classified as “inland”, the class of pollution		yes	
12.2	240-56062752 & SANS 60815-1	3.1.3.2 c)	For mini-subs classified as “coastal”, the class of pollution		N/A	
12.3	240-56062752	3.1.3.2 d)	For inland applications, the mini-sub enclosure, LV ASSEMBLY		yes	
12.4	240-56062752 & 240-75655504	3.1.3.2 i) & 3.9.2	Corrosion protection offered for Inland application		yes	
12.5	240-56062752	3.1.3.2 e)	For coastal applications, the mini-sub enclosure, LV ASSEMBLY		N/A	
12.7	240-56062752	3.1.3.2 f)	Inland application: The transformer-cooling radiator shall be		yes	
12.9	240-56062752 & 240-75655504	3.1.3.2 i) & 3.9.2	Inland application: Corrosion protection for transformer		yes	
12.11	240-56062752	3.1.3.2 g)	The mini-sub base shall be hot-dipped galvanized mild steel		Yes	
12.12	240-56062752	3.1.3.2 h)	The gland plate support structure and gland plates shall be		Yes	
12.13	240-56062752	3.1.3.2 k)	Is a 5 mm thick cork packing (i.e. cork gasket) applied in all		Yes	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
12.14	240-56062752 & SANS 1091	3.1.3.2 l)	Is the colour of the mini sub Light Admiralty Grey (G29)?		Yes	
Minisub Marking, labelling, packaging and transport						
13.1	240-56062752	3.8.1.1	Does the mini-sub rating plate meet requirements?		Yes	
13.2	240-56062752	3.8.1.2 a)	Is treatment and Full First Aid Instructions in accordance		Yes	
13.3	240-56062752	3.8.1.2 b)	Are the MV and warning signs in accordance with D-DT		Yes	
13.4	SANS 1029	8.4.11	Are transformer phase label provided below the bushings?		Yes	
13.5	SANS 1029	6.3.3.2.5	Colour coded LV bus bar provided?		Yes	
13.6	240-56062752	3.8.1.3 a)	Primary voltage, secondary voltage and kVA rating stencilled		Yes	
13.7	SANS 1029	8.4.4	Mini sub mass and stock number stencilled on the side or		Yes	
13.8	SANS 1029	4.2.2.3.9	Provision for the safe keeping of documents?		Yes	
13.9	240-56062752	3.8.1.3 e) i & ii	For Type B units: Short operating procedure written in black		Item specific	
13.10	240-56062752	3.8.1.3 e) iii	Is a drawing depicting the wording of the operating		Yes	
Minisub Documentation						
14.1	240-56062752	3.8.2.3	Type test report and certificates provided?		Yes	
14.2	240-56062752	3.8.2.3	Are routine test certificates submitted?		Yes	
14.3	240-56062752	3.8.2.2 a)	Are the following drawing submitted?		Yes	
			a) Mini sub GA drawing		Yes	
			b) LV assembly drawing		Yes	
			c) Operating procedure label for RMU tee off		yes	
			d) For Type B mini subs: Relay settings drawing		yes	
			e) Mini sub schematic drawing		Yes	
			f) Wiring diagram		Yes	
			g) Rating plate drawing		Yes	
		3.8.2.2 b)	h) For Type B mini sub: drawing for the operating procedure		Item specific	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
Minisub Accessories						
15.1	240-56062752	3.10 a)	Hand-held push-button remote control unit with a portable		Item specific	
15.2	240-56062752	3.10 b)	Type of sealant provided?		Poly-urethane or equivalent	
15.3	240-56062752	3.10 c)	Holding down set screws supplied?		Yes	

Technical Schedules – Freestanding Ring Main Unit

A- Employer's requirements

B- Supplier's Technical offering and Guarantees

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
			RMU 22kV 630A/200A 2R1B			
1.1			Nominal voltage	kV_{rms}	22	
1.2	SANS 1874 4.2.1		Rated power-frequency voltage	kV_{rms}	24	
1.3	SANS 1874 4.2.2		System frequency	Hz	50	
1.4			Number of phases		3	
1.5			System voltage range	pu	0.9 to 1.1	
1.6	240-56030406		Rated lightning impulse withstand voltage	kV_{peak}	150	
1.7	SANS 1874		Rated short-duration power frequency withstand voltage	kV_{rms}	50	
1.8	SANS 1874		Rated normal current of busbars	A	630	
1.9	SANS 1874	4.4.1.3	Rated normal current of switch dis-connector	A	630	
1.10	SANS 1874	4.6.1.3	Rated current of circuit breaker	A	630 or 200	
1.11	SANS 1874	4.2.4.1	Rated short-time withstand r.m.s. current (3 seconds)	kA_{rms}	20	
1.12	SANS 1874	4.2.4.3	Rated short-time withstand r.m.s. current (3 seconds) of earthing switches	kA_{rms}	20	
1.13	SANS 1874	4.2.4.1	Rated peak withstand current	kA_{peak}	50	
1.14	SANS 1874	4.2.6	Rated short circuit breaking current of the circuit breaker	kA_{rms}	20	
1.15	SANS 1874	4.2.7	Rated short circuit making current	kA_{peak}	50	
Design						
2.2	SANS 1874 4.18		Irrespective of the inland or coastal rating the RMU enclosure shall be suitable for coastal applications		All RMUs shall be suitable for Coastal applications	
2.3	SANS 1874	4.3.2	Extensible unit required?		No	
2.4	SANS 1874	4.3.3.3	Degree of protection offered (RMU):			
	SANS 62271-200		a) moving parts		IP 2X	
	SANS 62271-200		b) live parts		IP 2X	
	SANS 876		c) cable boxes		IP 3X	
2.5	SANS 1874	4.3.5	Type of cable test facilities offered?		Yes	
	SANS 1874	4.3.5.4	Cable test facilities interlocked?		Yes	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
2.6	SANS 1874	4.3.9.1	Interlock with remote equipment required? If yes, state	Y/N	No	
			a) type of interlock required		N/A	
			b) auxiliary supply details		20 or 16	
			c) interfacing details of remote equipment		N/A	
2.8	SANS 1874	4.3.9.2	Interlocking facilities offered		N/A	
2.9	SANS 1874	4.3.10.2	Insulating medium		provide	
2.10	SANS 1874	4.3.10.2	Minimum maintenance free period	yrs.	30	
2.11	SANS 1874	4.3.10.3	Interrupting technology (switch dis-connectors)		provide	
2.12	SANS 1874	4.3.10.3	Interrupting technology (circuit breaker)		provide	
2.13	SANS 1874	4.3.14.1 a)	IAC required for RMUs -AFLR in accordance with SANS 62271-200?		Yes	
2.14	SANS 1874	4.3.14.1	IAC required for the RMUs (AB - FLR in accordance with SANS 62271-200 & SANS 62271-202)?		Yes	
Switch-disconnectors						
3.1	SANS 1874	4.4.1.1	Class of switch dis-connector (min)		E2-M1	
3.2	SANS 1874 & 240-56062752	4.3.5.1 & 3.1.1 a)	Cable test facility to be independent of cable termination enclosure?		Yes	
3.3	SANS 1874	4.3.5.4	Cable test facilities interlocked?		Yes	
3.4	SANS 1874	4.4.2.2 / 4.9.2	Provision for remote tripping and closing required (i.e. remote control via RTU)?	Y / N	N	
3.5	SANS 1874	4.4.2.2 / 4.9.2	Details of remote opening and closing offered		N/A	
3.6	SANS 1874	4.4.2.2 / 4.9.2	Provision for remote indications and alarms required (i.e. via RTU)?	Y / N	N	
3.7	SANS 1874	4.6.2.18	Provision for hand-held remote control unit (open, close and earth) required?		Yes	
3.8	240-56030406	3.4b) and 3.25a)	Type of plug-in connector to be supplied			
3.9	240-56030406		Pins for trip control function		C and D	
3.10	240-56030406		Pins for close control function		A and B	
3.11	240-56030406	3.25	Details of provisions offered for hand-held remote control unit	24V/110V	Yes	
3.12	SANS 1874	4.9.1.4	Accuracy class and burden (VA) of CT offered (if applicable)		N/A	
3.13	SANS 1874	4.9.1.6 / 4.9.2	Provision for communication with an RTU (i.e. remote analogue indication)?		No	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
3.14	SANS 1874	4.9.1.7	Type of ammeter/multi-meter offered		provide	
Cable termination enclosure of the switch dis-connector functional units						
4.1	240-56030406	3.13	Spacing between bushing centres (min)	mm	105 mm or 90 mm	
4.2	240-56030406	3.13	Spacing between outer bushing centres and enclosure side wall	mm	55 mm or 50 mm	
4.3	SANS 1874	4.8	Distance from bushing centre line to cable support clamp (min). The cable support clamp shall be mounted above any bottom enclosure mounted plates for 3 core cable termination applications. For 1 core cable termination applications where bottom plates are required to be mounted above the cable clamps for Internal Arc venting compliance, the plate shall be positioned to meet the SANS 876 requirement for a 22 kV voltage rating single core cable termination to be fitted.	mm	800	
4.4	SANS 1874	4.8	Bushings horizontally positioned?	Y/N	YES	
4.5	SANS 1874	4.8.4	Type of bushing		EN 50181 C-type interface	
4.6	SANS 1874	4.11.4	Cross sectional area of earthing bar (min)	mm^2	120	
4.7	SANS 1874	4.8.6	Type of cable support clamp		SANS 876 / D-DT-8019 / 240-56062752	
4.8	240-56030406	3.13 g)	Size (range) of cable support clamp (3 Core Cable	mm	50-100	
4.9	240-56030406	3.13 g)	Size (range) of cable support clamps (3 * 1	mm	25-55	
Circuit-breakers for tee-offs						
5.1	SANS 1874	4.6.1.1	Class of circuit-breaker (min)		E2-M1	
5.2	SANS 1874	4.6.1.3	Rated normal current of the circuit-breaker (200A/630A).	A	200A / 630A	
5.3	SANS 1874	4.3.5.1	Cable test facility to be independent of cable termination enclosure?	Y/N	Not mandatory (if available to be supplied)	
5.4	SANS 1874	4.6.3.3 / 4.9.2	Provision for remote tripping and closing, and the opening for the inline dis-connector required (i.e. remote control via	Y/N	No	
5.5	SANS 1874	4.6.3.4	Details of remote tripping and closing, and the opening for the inline dis-connector where applicable offered.		provide	
5.6	SANS 1874	4.9.2	Provision for remote indications and alarms required (i.e. via RTU)?	Y/N	No	
5.7	240-56030406	3.4	Provision for hand-held remote control unit (trip and close) required?	Y/N	Yes	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
5.8	240-56030406	3.4 b)	Type of plug-in connector to be supplied		ITT Cannon type CA 3102 A 14S-2 or equivalent	
5.9			Pins for trip control function		C and D	
5.10			Pins for close control function		A and B	
5.11	240-56030406	3.4	Details of provisions offered for hand-held remote control unit	24V/110V	provide	
5.12	240-56030406	3.10 b)	Second Trip Coil required and Voltage	Y	No	
Protection relay Requirements						
5.12	240-56030406	3.6.1	Self-Powered Protection Relay (SPR) required.	Y/ N	Y	
5.12.1	240-56030406	3.6	Protection functional requirements satisfied, i.e. functions, setting ranges, characteristic curves etc. (provide technical manual).		provide	
5.12.2	240-56030406	3.6.1.1 c)	Details of provisions made to ensure minimum earth fault pick-up current of 40 A.		provide	
5.12.3	240-56030406	3.6	CT ratio required if different to that specified (SPR).	A		
5.14	240-56030406	3.6.1.3	Protection CT: type, class and ratio	T_ C_ R	provide	
5.15	240-56030406	3.6 3.6.1.2 a)	Detail the supply requirements to power up SPR for single and Three Phase conditions	A	provide	
5.16	240-56030406	3.6.2	SPR to include additional functionality for communication of Analogues to IRTU	Y/N	N	
5.17			Protection IED required for IRTU application.	Y/N	N	
5.18	240-56030406	3.6, 3.6.3.1-3.6.3.12	Protection functional requirements satisfied, i.e. functions, setting ranges, characteristic curves etc. (provide technical manual).		provide	
5.19	240-56030406	3.7	Current sensors- type, class and ratio	T_ C_ R_	provide	
5.20	240-56030406	3.8	Voltage sensors- type, class	T_ C_	provide	
Cable termination enclosure of the circuit breaker functional units						
6.1	240-56030406	3.13d)/ ,e)/ & f)	Spacing between bushing centres (min)	mm	90	
6.2	240-56030406	3.13d)/ ,e)/ & f)	Spacing between outer bushing centres and enclosure side wall (min)	mm	55	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
6.3	SANS 1874 4.8	SANS 1874 4.8	Distance from bushing centre line to cable support clamp (min). The cable support clamp shall be mounted above any bottom enclosure mounted plates for 3 core cable termination applications. For 1 core cable termination applications where bottom plates are required to be mounted above the cable clamps for Internal Arc venting compliance, the plate shall be positioned to meet the SANS 876 requirement for a 22 kV voltage rating single core cable termination to be fitted.	mm	800	
6.4	SANS 1874	4.8	Bushings horizontally positioned?	Y/N	YES	
6.5	SANS 1874	4.8.4	Type of bushing		EN 50181 C-type interface	
6.6	SANS 1874	4.11.4	Cross sectional area of earthing bar (min)	mm^2	120	
6.7	SANS 1874	4.8.6	Type of cable support clamp		SANS 876 /D-DT-8019 / 240-56062752	
6.8	240-56030406	3.13g)	Size (range) of cable support clamp (3 Core Cable	mm	50-100	
Busbars						
7.1	SANS 1874	4.7.2	Current rating of Busbars	A	630	
7.2	SANS 1874	4.7.2	Busbars to be extensible left or right?	L / R /NA	N/A	
IRTU						
8.1	SANS 1874	4.9.2	RTU to be provided?	Y/N	No	
Gas requirements						
9.1	SANS 1874	4.10.2	Expected life before replenishment of gas (minimum)	Years	30	
9.2	SANS 1874	4.10.3 & 3.13	Type of gas indication device		Density meter	
9.3	SANS 1874	4.10.5	Mass of gas:			
9.3	SANS 1874	4.10.5 4.10.6	a) Busbar chamber	kg	provide	
			b) Other	kg	provide	
Earthing						
10.1	SANS 1874	4.11.1	Earth fault level and duration	kA-s	2 kA – 3 s	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
Live Circuit Indication						
11.1	SANS 1874 240-56030406	4.12.4 3.14	Type of live circuit indication required		VDS	
Earth Fault Indication						
12.1	SANS 1874	4.13.1	Type of earth fault indicator		Self- Powered via internal CT	
			Earth fault indicator details:			
12.2	SANS 1874	4.13.6	a) Cable box location for CT		LHS 'R'	
12.3	SANS 1874	4.13.7	b) Position of 'remote' indicator		Visible from outside, front of RMU	
12.4	SANS 1874	4.13.7	c) Method of protecting indicator against vandalism		Welded steel tube	
			Make of earth fault indicator			
12.6	SANS 1874	4.13	Type (model) of earth fault indicator		provide	
Testing						
15.4	SANS 1874	5.2.3	RMU Internal arc type test details		yes	
15.5	SANS 1874	5.2	RMU type test reports		Yes	
15.6	240-56030406	3.21 and 3.22	RMU type test reports and videos		Yes	
15.7	240-56030406	3.6.4 e)	CT type test reports		Yes	
15.8	240-56030406	3.6.5 f)	VT type test reports		Yes	
15.9	240-64685228	4.	SPR Type test report		Yes	
15.10	240-64685228	4.	Protection IED Type test report		Yes	
15.11	CISPR-11/A, IEC 60255-25, EN 55011		Type Test for RFI Compliance		Yes	
Documentation						
17.1	SANS 1874	7.2	General assembly drawing(s)		provide	
17.2	SANS 1874	7.2	Drawing(s) showing mimic indication system, tee-off operating procedure, other labels & signs		provide	
17.3	SANS 1874	7.2	Wiring diagram(s)		provide	
17.4	SANS 1874	7.2	Rating plate drawing		provide	

Item	Document	Sub-clause	Description	Units	Schedule A	Schedule B
17.6	SANS 1874	7.2	Tabulated summary of completed type tests required?	Y/N	Yes	
17.7	SANS 1874	7.2	Full set of type test reports required?	Y/N	Yes	
17.8	SANS 1874	7.2	Proof of type test laboratory accreditation?	Y/N	Yes	
17.9	SANS 1874	7.2	Copy of RMU factory routine test certificate?		Yes	
17.10	SANS 1874	7.2	Copy of CT and VT factory routine test certificate?	Y/N	Yes	
17.11	SANS 1874	7.2	Copies of the latest technical catalogue(s) including SPR and	Y/N	Yes	
17.12	SANS 1874	7.2	Number of installation, operation and maintenance manuals		1	

Technical Schedules – LV Distribution Kiosks

A- Employer's requirements

B- Supplier's Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1.01	Rated voltage (Ur)	V	400	
1.02	Kiosk Cladding Material	No.	3CR12	
1.03	Corrosion Protection	Y/N	yes	
1.04	Exterior Colour		white	
1.05	Cable Entry/Exit		Bottom	
1.06	Non Conductive Barriers	Y/N	Yes	
1.07	Additional UV Protection required for glands, supply cables, shrouds	Y/N	Yes	
1.08	Exterior Dimension (mm) Length	mm	provide	
1.09	Exterior Dimension (mm) Width	mm	provide	
1.10	Exterior Dimension (mm) Height	mm	provide	
1.11	Clearance between Neutral and live bars (mm)	mm	provide	
1.12	Creepage distances (mm)	mm	provide	
1.13	Lockable door – 3 Pin Locking System	Y/N	Yes	
1.14	No. of supply cable holes to suit glands for 185mm cables (4 core AL SWA)	No.	2	
1.15	No. of consumer cable holes to suit glands for 10 -25mm cables (4 core- SWA)	No.	6	
1.16	Blanking plugs for all cable holes	Y/N	yes	
1.17	Glands for SWA cables with neoprene shrouds required for % of holes.		50%	
1.18	Standard to which glands must comply		DSP 34-623	
1.19	3 Phase MCBs Required for outgoing circuits	Y/N	Yes	
1.20	Fault rating (kA)	kA	20	
1.21	Rated current (A) – Outgoing feeds	A	63	
1.22	Busbars required	Y/N	Yes	
1.23	Busbar current rating (A)	A	250	
1.24	Busbar Fault Current rating (kA)	kA	20	
1.25	Earth bar (Yes/No- % of phase busbar rating)_		Yes - 100%	
1.26	Submission of Shop drawing for Approval prior to manufacture	Y/N	Yes	
1.27	Busbars and terminals to be shrouded	Y/N	Yes	
1.28	Marking and labelling, Customer allocated unique location number / designation	Y/N	Yes	
1.29	Marking and labelling, Electric shock hazard sign (SANS1186)	Y/N	Yes	
1.30	Freestanding – back to back access	Y/N	Yes	
1.31	Ingress Protection		IP54	

Technical Schedules – Transformers 22kV/3.3kV – Pole Mount

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Identification				
1.1	Name of manufacturer		provide	
1.2	Name of supplier		provide	
1.3	Manufacturer's Type Designation		provide	
1.4	SABS certification mark?		yes	
1.5	State SABS 780 permit number		provide	
2 Ratings				
2.1	Power rating	kVA	50	
2.2	Rated primary voltage	kV	22	
2.3	Rated no-load secondary voltage	kV	3.3	
2.4	Frequency	Hz	50	
2.5	Number of phases		3ph	
2.6	Vector Group		Dyn11	
3. Insulation levels				
3.1	BIL - Primary	kV	150	
3.2	BIL - Secondary	kV	45	
3.3	Power frequency withstand voltage - Primary	kV	50	
3.4	Power frequency withstand voltage – Secondary	kV	16	
4. Inter-turn winding insulation				
4.1	Type (Enamel or Paper)		provide	
4.2	Enamel grade (if applicable)		Grade 3	
4.3	Paper thickness (if applicable)	mm	> 0.125	
4.4	Paper type (if applicable)		provide	
4.5	Paper make (if applicable)		provide	
5. Interlayer insulation				
5.1	Highest interlayer stress in non- tap part of winding.	kV/mm	< 5	
5.2	Highest interlayer stress in tap part of winding.	kV/mm	< 5	
5.3	Paper type.		provide	
5.4	Paper make.		provide	
6. Tap changer				
6.1	Type		Switch	
6.2	Tap range	%	0, ±2.5, ±5	
7. MV Cable Termination Enclosures and Bushings				
7.1	Make		provide	
7.2	Product Code		provide	
7.3	Material (e.g. porcelain)		provide	
7.4	Specific creepage distance	mm/kV	≥31	

7.5	Clamping		Base	
7.6	Type		Draw Lead	
7.7	Stem Diameter		M12	
8. LV Bushings				
8.1	Make		provide	
8.2	Product code		provide	
8.3	Material (e.g. Porcelain)		provide	
8.4	Stem diameter		M12	
8.5	Detail of LV cable connection shown on a drawing		Yes	
8.6	Air filled enclosure on side of the tank		NO	
8.7	Stainless steel fasteners		Yes	
8.8	Clearance between ph-ph and ph-earth		60mm	
8.9	Current density of Copper flags for LV Connections		2.0 A/mm² max	
8.10	Two Earthing terminals welded to centres of side walls		Required	
8.11	Surge arrester mounted on earthing terminal in LV termination enclosure		N	
8.12	Electrolytic copper conductor		70mm²	
9. Losses				
9.1	Loss factor base (Cost of Dx or Gx)		Distribution (Dx)	
9.2	No-load Loss Factor, NLLF	R/kW	TBC	
9.3	Load Loss Factor, LLF	R/kW	TBC	
9.4	Guaranteed no-load losses, PNL	W	≤ 130	
9.5	Guaranteed load losses, PLL	W	≤ 630	
10. Impedance voltage & X/R ratio				
10.1	Impedance at principle tapping	%	≤ 4,5	
10.2	X/R ratio		provide	
11. Audio-sound level (clause 8.5.3 of SANS 780)				
11.1	Maximum limit of transformer audio-sound level	db(A)	≤ 48	
12. MV winding wire				
12.1	Material (e.g. Cu or Al)		provide	
12.2	Type (e.g. Round, Strip or Foil)		provide	
13. LV winding wire				
13.1	Material (e.g. Cu or Al)		provide	
13.2	Type (e.g. Round, Strip or Foil)		provide	
14. Core material				
14.1	Core material		Steel/Amorphous	
14.2	Type/code		provide	
14.3	Maximum Flux Density of Core Material		provide	
14.4	Supplier		provide	

15. Tank and tank cover				
15.1	Tank type: Sealed		Sealed	
15.2	Plain, radiators or corrugated		provide	
16. Transformer dimensions - not exceeding underbase				
16.1	Width	mm	≤ 3 000	
16.2	Length	mm	≤ 4 000	
16.3	Height	mm	provide	
16.4	Mass	kg	provide	
16.5	Oil capacity	l	provide	
16.5	Transformer Mounting		Steel Pole	
17. Pole Mounting Bracket				
17.1	Single pole mounting bracket required? (Yes or No)		Yes	
17.2	Dimension		To suite steelpole	
18. Transformer under base				
18.1	Under base		Required	
19. Lifting lugs				
19.1	Lifting lugs		Required	
19.2	Hole diameter	mm	≥ 30	
20. Earthing terminals				
20.1	Boss material		Stainless steel	
20.2	Boss depth	mm	≥ 30	
20.3	Set screw material		provide	
20.4	Set screw dimensions	mm	M12 x 25	
20.5	Supplied with washer and spring washer		Yes	
21. Surge arrester brackets				
21.1	Surge arrester bracket		Required	
21.2	Mounting hole diameter	mm	14	
21.3	Dimension D (worst case)	mm	≥ 200	
21.4	Dimension E (worst case)	mm	≥ 190	
21.5	Dimension F (worst case)	mm	≥ 150	
22. Corrosion protection Inland transformers				
22.1	Indicate the coating system (i.e.DS numbers according to DSP 34-1658) that is offered. (e.g.DS7 for mild steel)		required	
22.2	Tank		provide	
22.3	Radiators		provide	
22.4	Threaded rods and accessories		provide	
22.5	Paint colour SANS 1091		G29 Light Admiralty Grey	

23. All Type Tests in Accordance				
23.1	All Type Tests in Accordance with SANS 780 incl. Short Circuit Withstand Tests		Required	
24. Routine Tests				
24.1	All Routine Tests in accordance with SANS 780		Required	

Technical Schedules – Transformers 3.3kV/400V – Pad Mount

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Identification				
1.1	Name of Manufacturer		provide	
1.2	Name of Supplier		provide	
1.3	Manufacturer's Type Designation		provide	
1.4	SABS certification mark?		yes	
1.5	State SABS 780 permit number		provide	
2. Ratings				
2.1	Power rating	kVA	50	
2.2	Rated primary voltage	kV	3.3	
2.3	Rated no-load secondary voltage	V	420	
2.4	Frequency	Hz	50	
2.5	Number of phases		3ph	
2.6	Vector Group		Dyn11	
3. Insulation levels				
3.1	BIL - Primary	kV	45	
3.2	BIL - Secondary	kV	10	
3.3	Power frequency withstand voltage - Primary	kV	16	
3.4	Power frequency withstand voltage – Secondary	kV	3	
4. Inter-turn winding insulation				
4.1	Type (Enamel or Paper)		provide	
4.2	Enamel grade (if applicable)		Grade 3	
4.3	Paper thickness (if applicable)	mm	> 0.125	
4.4	Paper type (if applicable)		provide	
4.5	Paper make (if applicable)		provide	
5. Interlayer insulation				
5.1	Highest interlayer stress in non- tap part of winding.	kV/mm	<5	
5.2	Highest interlayer stress in tap part of winding.	kV/mm	<5	
5.3	Paper type.		provide	
5.4	Paper make.		provide	
6. Tap changer				
6.1	Type		Switch	
6.2	Tap range	%	0, ±2.5, ±5	
7. MV Cable Termination Enclosures and Bushings				
7.1	Air filled enclosure on side of the tank		Y/N	
7.2	Stainless steel fasteners		Y/N	
7.3	Cable termination type		Type 3	
7.4	Earthing terminal height from the gland plate	mm	100mm	
7.5	Gland plate entry hole	mm	110mm	
7.6	Dimensions between bushings	mm	Min 135mm	
7.7	Clearances within the MV cable termination enclosure	mm	90mm	

Item	Description	Units	Schedule A	Schedule B
7.8	Cable support clamp diameter	mm	50-75mm	
7.9	Depth of cable box	mm	>= 350mm	
7.10	MV warning sign with aircraft pop rivets		Y/N	
7.11	Distance from gland plate to MV bushing centre line	mm	NRS 012	
7.12	Method of sealing the the cable entry into the MV cable termination enclosure		provide	
8. LV Bushings				
8.1	Make		provide	
8.2	Product code		provide	
8.3	Material (e.g. Porcelain)		provide	
8.4	Stem diameter		M12	
8.5	Detail of LV cable connection shown on drawing		Yes	
8.6	Air filled enclosure on side of the tank		NO	
8.7	Stainless steel fasteners		Yes	
8.8	Clearance between ph-ph and ph-earth		60mm	
8.9	Current density of Copper flags for LV Connections		2.0 A/mm² max	
8.10	Two Earthing terminals welded to centres of side walls		Required	
8.11	Surge arrester mounted on earthing terminal in LV termination enclosure		Y/N	
8.12	Electrolytic copper conductor		70mm²	
8.13	Number of cable gland holes	Table 4	1	
8.14	Size of gland hole	Table 4	50mm	
8.15	Clearance around gland hole	Table 4	85mm	
8.16	Cable gland type Adjustable mechanical	Table 4	No. 5	
9. Losses				
9.1	Loss factor base (Cost of Dx or Gx)		Distribution (Dx)	
9.2	No-load Loss Factor, NLLF	R/kW	TBC	
9.3	Load Loss Factor, LLF	R/kW	TBC	
9.4	Guaranteed no-load losses, PNL	W	≤ 130	
9.5	Guaranteed load losses, PLL	W	≤ 630	
10. Impedance voltage & X/R ratio				
10.1	Impedance at principle tapping	%	≤ 4,5	
10.2	X/R ratio		provide	
11. Audio-sound level (clause 8.5.3 of SANS 780)				
11.1	Maximum limit of transformer audio-sound level	db(A)	≤ 48	
12. MV winding wire				
12.1	Material (e.g. Cu or Al)		provide	
12.2	Type (e.g. Round, Strip or Foil)		provide	
13. LV winding wire				

Item	Description	Units	Schedule A	Schedule B
13.1	Material (e.g. Cu or Al)		provide	
13.2	Type (e.g. Round, Strip or Foil)		provide	
14. Core material				
14.1	Core material		Steel/Amorphous	
14.2	Type/code		provide	
14.3	Maximum Flux Density of Core Material		provide	
14.4	Supplier		provide	
15. Tank and tank cover				
15.1	Tank type: Sealed		Sealed	
15.2	Plain, radiators or corrugated		provide	
16. Transformer dimensions - not exceeding underbase				
16.1	Width	mm	≤ 3 000	
16.2	Length	mm	≤ 4 000	
16.3	Height	mm	provide	
16.4	Mass	kg	provide	
16.5	Oil capacity	l	provide	
17. Transformer under base				
17.1	Under base		Required	
18. Lifting lugs				
18.1	Lifting lugs		Required	
18.2	Hole diameter	mm	≥ 30	
19. Earthing terminals				
19.1	Boss material		Stainless steel	
19.2	Boss depth	mm	≥ 30	
19.3	Set screw material		provide	
19.4	Set screw dimensions	mm	M12 x 25	
19.5	Supplied with washer and spring washer		Yes	
20. Surge arrester brackets				
20.1	Surge arrester bracket		Required	
20.2	Mounting hole diameter	mm	14	
20.3	Dimension D (worst case)	mm	≥ 200	
20.4	Dimension E (worst case)	mm	≥ 190	
20.5	Dimension F (worst case)	mm	≥ 150	
21. Corrosion protection Inland transformers				
21.1	Indicate the coating system (i.e.DS numbers according to DSP 34-1658) that is offered. (e.g.DS-7 for mild steel)		provide	

Item	Description	Units	Schedule A	Schedule B
21.2	Tank		provide	
21.3	Radiators		provide	
21.4	Threaded rods and accessories		provide	
21.5	Paint colour SANS 1091		G29 Light Admiralty Grey	
22. All Type Tests in Accordance				
22.1	All Type Tests in Accordance with SANS 780 inc Short Circuit Withstand Tests		Required	
23. Routine Tests				
23.1	All Routine Tests in accordance with SANS 780		Required	

Technical Schedules – MV Shunt Reactors

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Environmental				
1.1	Altitude above sea level	m	1800	
1.2	Ambient temperature			
	Maximum	C	45	
	Minimum	C	-10	
	Daily average	C	35	
	Yearly average	C	30	
	Maximum average daily temperature variation	C	20	
1.3	Relative humidity			
	Minimum	%	50	
	Maximum	%	96	
	Average	%	68-83	
1.4	Solar radiation			
	Maximum	W/m2	2.6 x 103	
1.5	Wind loading	Pascals/ ms-1	1200/40	
1.6	Pollution		Inland	
1.7	Type		Industrial	
1.8	Classification (IEC 60815)	mm/kV	31	
1.9	Climatic conditions		Rain/dry/ hail/high UV radiation	
1.10	Seismic level	g	0.3	
2. System Details				
2.1	Maximum system voltage (Um)	kV	22	
2.2	Temporary overvoltages			
	For 10 min	kV	1.05 Um	
	For 1 min	kV	1.25 Um	
	For 5 s	kV	1.5 Um	
	For 1 s	kV	1.75 Um	
2.3	Nominal system frequency	Hz	50	
2.4	Number of phases		3	
2.5	Three-phase system fault levels (design value)	kA	provide	
2.6	Single-phase system fault levels (design value)	kA	provide	
3. Type				
3.1	Phases	1Ø/3Ø	3Ø	
3.2	Model		provide	
3.3	Winding Connections		delta	
3.4	Application		Shunt Reactor – capacitive current compensation	
4. Reactor Rating				
4.1	Rated power	MVAr	Refer enquiry document	
4.2	Rated voltage	kV	24	

Item	Description	Units	Schedule A	Schedule B
4.3	System Frequency	Hz	50	
4.4	Reactor Duty		Continuous	
4.5	Rated continuous / power frequency current (IN)	A	Provide	
4.6	Current density of windings at rated current	A/mm2	provide	
4.7	Root sum square current (Irss)	A	provide	
4.8	Current spectrum	A	provide	
4.9	Rated thermal short-time / circuit current (IKN)	kA	provide	
4.10	Rated short-time / circuit current duration	s	provide	
4.11	Rated mechanical short-time / circuit current		provide	
4.12	Rated mechanical short-time duration	s	provide	
4.13	Rated linear impedance	Ω	provide	
4.14	Rated inductance	mH	provide	
4.15	Tolerance on inductance	%	provide	
4.16	Rated resistance	Ω	provide	
5. Reactor Details				
5.1	Type of cooling	AN	AN	
5.2	Line terminals		Bushings	
5.3	Mounting		Platform/Pole	
5.4	Minimum clearance between base of insulators and ground level	mm	Provide	
5.5	Single-phase switching	Yes/No	No	
5.6	Winding material		provide	
5.7	Insulation material		provide	
5.8	Mass of one coil	kg	provide	
5.9	Coil dimensions			
	Diameter	mm	provide	
	Height	mm	provide	
5.10	Dimensions of unit including pedestals			
	Diameter	mm	provide	
	Height	mm	provide	
5.11	Maximum audible noise level of individual reactor	dB	provide	
5.12	Distance at which noise level is to be measured	mm	provide	
5.13	Pollution mitigation			
5.14	Life expectancy	yrs	40-50	
5.15	Manufacturer		provide	
5.16	Country of manufacture		provide	
6. Reactor Insulation				
6.1	Insulation level (BIL)	kV peak	150	
6.2	60s power frequency withstand voltage	kV rms	50	
6.3	Interturn voltage withstand	kV	Provide	
6.4	External voltage grading	kV/mm	31	
6.5	Reference temperature	°C	provide	
6.6	Temperature rise test voltage	kV	Umax	
6.7	Temperature rise test duration	hr	provide	

Item	Description	Units	Schedule A	Schedule B
6.8	Short circuit test current	A	provide	
6.9	Short circuit shot duration	s	provide	
6.10	Number of short circuit shots		provide	
6.11	Q factor test frequencies	Hz	provide	
7. Bushings				
7.1	Material (eg. Porcelain)		provide	
7.2	Minimum creepage distance	mm/kV	31	
7.3	Power frequency wet withstand voltage at sea level	kV rms	50	
7.4	Lightning impulse withstand test voltage at sea level (1.2/50µs full wave)	kV peak	150	
8. Tests				
8.1	Temperature rise		Yes	
8.2	Measurement of magnetic characteristics		Yes	
8.3	Acoustic noise level measurements		Yes	
8.4	Test for electrostatic charging tendency		YES	
9. Spares				
9.1	One complete set of bushings of each type used		Yes	

Technical Schedules – Diesel Generators for Construction Camps

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Rating				
1.01	Standby Rating (kW/kVA)		Refer to Enquiry Document	
1.02	Prime Rating (kW/kVA)		Refer to Enquiry Document	
1.03	Frequency (Hz)		50	
1.04	Nominal Voltage (V)		400	
2. System Details				
2.01	Fuel		Low sulphur diesel	
2.02	Naturally aspirated / Turbocharged		provide	
2.03	Water cooled		Yes	
2.04	Jacket water heater		Yes	
2.05	Maximum ambient temp for full rated output (°C)		40	
2.06	Altitude for full rated output (m)		1000	
2.07	Displacement Capacity (l)		provide	
2.08	#cylinders / configuration		provide	
2.09	Bore (mm)		provide	
2.10	Stroke (mm)		provide	
2.11	Block / cylinder head material		provide	
2.12	Starting battery voltage 12V or 24V		provide	
2.13	Starting battery capacity		provide	
2.14	Battery charging alternator rating (A)		provide	
2.15	Standby charger (230V 1øinput) Float voltage(V)/Current limit(A)		provide	
2.16	Lubrication Oil Specification			
3. Alternator				
3.01	Design		Brushless	
3.02	# poles		4	
3.03	# phases		3	
3.04	Configuration		3P-4W	
3.05	Earthing		Solid	
3.06	Minimum Insulation class		H	
3.07	Phase rotation		A,B,C (positive)	
3.08	Cooling		Air	
3.09	Temperature rise		<150°C	
3.10	Single harmonic distortion from no load to full load		<3%	
3.11	Total harmonic distortion from no load to full load		<5%	
4. AVR and Governer Performance				
4.01	Genset regulation class to ISO 8528-1		G3	

Item	Description	Units	Schedule A	Schedule B
4.02	Voltage regulation (no load to full load)		±1% max	
4.03	Random voltage variation		±1% max	
4.04	Load pick-up capability		75% rating	
4.05	Voltage perturbation at load pick-up (%Vr)		<3%	
4.06	Frequency variation (no load to full load)		±1% max	
4.07	Random frequency variation		±0.3% max	
4.08	Speed perturbation at load pick-up (% rated speed)		<5%	
4.09	Governor control modes		Isochronous	
5. Transfer Switch				
5.01	Transfer mode		Dark chop-over	
5.02	Paralleling with grid		Not possible	
5.03	Break before make contacts both directions		required	
5.04	Interlocking		Electrical & Mechanical	
5.05	Parallel operation with other generators		Not permitted	
6. Start & Stop				
6.01	Automatic start, chop over from grid to generator		Required	
6.02	Automatic return to grid on restoration		Required	
6.03	Mains fail detection		loss of one or more phases	
6.04	Phase failure detection voltage (Settable in 1% steps ±20% of setting given)		80% Vr	
6.05	Phase return voltage detection ((Settable in 1% steps +5=-20% of setting given)		95% Vr	
6.06	Incorrect grid phase rotation detection		Required	
6.07	Grid loss detection time range settable in 0.5s steps		1-10s	
6.08	Grid return detection time range settable in 0.5s steps		10-120s	
6.09	Cooling time after return to grid		180s	
6.10	Chop back to grid after loss of grid during cooling time		3s	
6.11	Start-up, warm up and load pickup time in event of grid failure		30s max	
6.12	Number of start attempts before lock out		3 at 60s rest intervals	
7. Protection Requirements				
7.01	Overvoltage	Y/N	yes	
7.02	Undervoltage	Y/N	yes	
7.03	Negative sequence / phase unbalance	Y/N	yes	
7.04	Overload	Y/N	yes	
7.05	Short circuit	Y/N	yes	
7.06	Earth Fault	Y/N	yes	
7.07	Underfrequency	Y/N	yes	
7.08	Over frequency	Y/N	yes	
7.09	Field failure	Y/N	yes	
7.10	reverse power	Y/N	yes	
7.11	engine low oil pressure	Y/N	yes	

Item	Description	Units	Schedule A	Schedule B
7.12	engine overtemperature (oil and coolant)	Y/N	yes	
7.13	starting battery failure	Y/N	yes	
7.14	engine under / overspeed	Y/N	yes	
7.15	failure to start	Y/N	yes	
8. Controls				
8.01	Auto / manual operation	Y/N	yes	
8.02	Manual speed control	Y/N	yes	
8.03	Manual voltage control	Y/N	yes	
8.04	In service / out of service	Y/N	yes	
8.05	Emergency stop switch	Y/N	yes	
9. Indications				
9.01	Voltages - L-N, L-L all 3 phases	Y/N	yes	
9.02	Current - on grid, on generator - all three phases	Y/N	yes	
9.03	Operation mode	Y/N	yes	
9.04	Total and individual phase real & reactive power	Y/N	yes	
9.05	Cumulative Sent out energy in kWh	Y/N	yes	
9.06	Running hours	Y/N	yes	
9.07	Starting battery voltage	Y/N	yes	
9.08	Oil pressure and temperature	Y/N	yes	
9.09	Coolant temperature	Y/N	yes	
9.10	Start and stop operations with time and date	Y/N	yes	
9.11	Protection operations - identification, time and date.	Y/N	yes	

Technical Schedules – Surge Arresters – Distribution Class

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Identification				
1.01	Supplier		Provide	
1.02	Manufacturer		Provide	
1.03	MOV block manufacturer		Provide	
1.04	Product code: (For coastal Application)		provide	
2. Operating Conditions				
2.01	Altitude	m	up to 1800	
2.02	Average humidity	%	30 to 90	
2.03	Minimum ambient temperature	°C	-10	
2.04	Maximum ambient temperature	°C	40	
2.05	Maximum diurnal variation	°C	30	
2.06	Intensity of solar radiation	kW/m2	1,1	
2.07	IEC pollution level: Item 3 (Inland)	mm/kV	31	
2.08	Lightning activity		High	
2.09	System earthing		Non- effective	
2.10	System configuration		3-phase, 3-wire	
2.11	Nominal system voltage (Un)	kV	22	
2.12	Maximum system voltage (Um)	kV	24	
2.13	Supply frequency	Hz	50	
2.14	BIL of equipment to be protected	kV peak	150	
3. Arrester Characteristics				
3.01	Arrester classification		Distribution class	
3.02	IEC line discharge class		1	
3.03	Nominal lightning discharge current (8/20µs)	kA	10	
3.04	Energy in per unit of Ur, with two high current impulses (4/10, 100kA) as tested in the operating duty test	kJ/kV	provide	
3.05	Arrester rated voltage (Ur)	kV	provide	
3.06	MCOV (Uc)	kV	19.5	
3.07	Maximum residual voltage (Ures) at 10kA (8/20µs)	kV	80	
4. Housing				
4.01	Material		provide	
4.02	Colour		provide	
4.03	Minimum creepage distance	mm	744	
4.04	Power frequency withstand voltage	kV	50	
5. Arrester housing profile design				
	IEC 60815 parameters:			
5.01	c		≥ 20	

Item	Description	Units	Schedule A	Schedule B
5.02	s/p		≥ 0,65	
5.03	Ld/d		≤ 5	
5.04	P1 – P2		≥15	
5.05	CF		≤ 3,5	
5.06	PF		≥0,7	
6. Mounting Detail				
6.01	Orientation		Vertical	
6.02	Method of mounting		Insulated mounting arm	
6.03	Diameter of mounting hole in bracket	mm	14	
6.04	Minimum bracket length, i.e. dimension C	mm	>130	
6.05	Supplied M12 x 50 mounting bolt, nut, serrated washer and three flat washers		Yes	
7. Terminals				
7.01	Diameter of terminals	mm	provide	
7.02	Material: Line terminal		provide	
7.03	Earth terminal		provide	
	Bolted connector on line terminal shall be suitable for clamping the following conductors:			
7.04	Material		ACSR	
7.05	Type		Squirrel to Hare	
7.06	Diameter	mm	6 to 14	
8. Ground Leads				
8.01	Supply flexible ground leads		yes	
8.02	Minimum length of ground lead	mm	300	
8.03	Diameter of lug hole on loose end	mm	14	
8.04	Type of ground lead (flat strip, braided etc)		provide	
8.05	Ground lead material		provide	
8.06	Outline dimensions		provide	
9. Ground lead disconnector				
9.03	Product code		provide	
9.03	Resistance of internal resistor		provide	
10. Documents to be submitted				
10.01	Dimension drawings		Provide	
10.02	Mounting detail drawing		Provide	
10.03	Line terminal and ground terminal drawings		Provide	
10.04	Marking detail drawing		Provide	
10.05	Arrester characteristic V-I curve AC		Provide	
10.06	Arrester characteristic V-I curve DC		Provide	
10.07	TOV Capabilities with prior duty per IEC 60099-4		Provide	
10.08	MOV element dimension drawings / detail		Provide	

Item	Description	Units	Schedule A	Schedule B
10.09	Insulation withstand test report per IEC 60099-4		Provide	
10.10	Residual voltage test report per IEC 60099-4		Provide	
10.11	Long duration current impulse test report per IEC 60099-4		Provide	
10.12	Operating duty test report per IEC 60099-4		Provide	
10.13	Power frequency vs time characteristics per IEC 60099-4		Provide	
10.14	Short circuit test report per IEC 60099-4		Provide	
10.15	Natural ageing and pollution performance test report per IEC 60099-4		Provide	
10.16	Internal partial discharge test report per IEC 60099-4		Provide	
10.17	Water immersion test report per IEC 60099-4		Provide	
11. Miscellaneous				
11.01	Total mass of assembled unit	kg	provide	
11.02	Minimum expected life of arrester at 40 °C and MCOV	yrs	25	
11.03	Sample available for inspection		Yes	
12. Insulation withstand test				
12.01	Reference number of test report		provide	
12.02	Lightning impulse (1,2/50µs) withstand level [(1,3/0,82) Ures]	kV	127	
12.03	60 s wet power frequency withstand	r.m.s kV	50	
13. Insulation withstand test on insulated mounting bracket				
13.01	10 s wet withstand from earth terminal to earthed mounting bracket [1,5 x MCOV]	kV	29	
14. Residual voltage test				
14.01	Reference number of test report		provide	
14.02	Maximum residual voltage for a 10 kA steep current impulse (1/20µs) [4 x Ur]	kV	100	
14.03	Maximum residual voltage for a lightning current impulse (8/20µs) of magnitude:			
14.04	5 kA	kV	provide	
14.05	10 kA	kV	80	
14.06	20 kA	kV	provide	
15. Long duration current impulse withstand test				
15.01	Reference number of test report		provide	
15.02	Charging voltage	pu of Ur	3.2	
	or			
15.03	charging current	A	provide	
15.04	Virtual duration of peak	µs	2000	
15.05	Number of discharge operations		18	
15.06	Number of grouped operations		6	
15.07	Operations per group		3	
15.08	Maximum interval between operations	s	60	
15.09	Interval between groups		Cool to ambient	

Item	Description	Units	Schedule A	Schedule B
15.10	Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	

Technical Schedules – Surge Arresters – Station Class

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Identification				
1.01	Supplier		Provide	
1.02	Manufacturer		Provide	
1.03	MOV block manufacturer		Provide	
1.04	Product code: (For Inland Application)		provide	
2. Operating Conditions				
2.01	Altitude	m	up to 1800	
2.02	Average humidity	%	30 to 90	
2.03	Minimum ambient temperature	°C	-10	
2.04	Maximum ambient temperature	°C	40	
2.05	Maximum diurnal variation	°C	30	
2.06	Intensity of solar radiation	kW/m2	1,1	
2.07	IEC pollution level: Item 3 (Inland)	mm/kV	31	
2.08	Lightning activity		High	
2.09	System earthing		Non- effective	
2.10	System configuration		3-phase, 3-wire	
2.11	Nominal system voltage (Un)	kV	22	
2.12	Maximum system voltage (Um)	kV	24	
2.13	Supply frequency	Hz	50	
2.14	BIL of equipment to be protected	kV peak	150	
3. Arrester Characteristics				
3.01	Arrester classification		Station Class	
3.02	IEC line discharge class		2	
3.03	Nominal lightning discharge current (8/20µs)	kA	10	
3.04	Minimum Energy absorption capability for a single high current impulse (4/10, 100kA) in per unit of MCOV	kJ/kV	3.4	
3.05	Arrester rated voltage (Ur)	kV	provide	
3.06	MCOV (Uc)	kV	24	
3.07	Maximum residual voltage (Ures) at 10kA (8/20µs)	kV	85	
4. Housing				
4.01	Material		provide	
4.02	Colour		provide	
4.03	Minimum external creepage distance Um x 31mm/kV	mm	744	
5. Arrester housing profile design				
	IEC 60815 Annex D parameters:			
5.01	c		≥ 20	

Item	Description	Units	Schedule A	Schedule B
5.02	s/p		≥ 0,65	
5.03	Ld/d		≤ 5	
5.04	P1 – P2		≥15	
5.05	CF		≤ 3,5	
5.06	PF		≥0,7	
6. Mounting Detail				
6.01	Orientation		Vertical	
6.02	Method of mounting		base	
6.03	Diameter of mounting hole in bracket	mm	14	
6.04	Minimum bracket length, i.e. dimension C	mm	>130	
7. Arrester Line Terminals				
7.01	Diameter of terminals	mm	M12	
7.02	Type		Threaded	
7.03	Minimum Length		50mm	
7.04	Orientation		Verticle	
7.05	Supplied with: M12 nut, two flat washers and spring washer		yes	
7.06	Material		provide	
8. Arrester Earth Terminals				
8.01	Diameter of terminals	mm	M12	
8.02	Type		Threaded	
8.03	Minimum Length		50mm	
8.04	Orientation		Verticle	
8.05	Supplied with: M12 nut, two flat washers and spring washer		yes	
8.06	Material		provide	
9. Documents to be submitted				
9.01	Dimension drawings		Provide	
9.02	Mounting detail drawing		Provide	
9.03	Line terminal and ground terminal drawings		Provide	
9.04	Marking detail drawing		Provide	
9.05	Arrester characteristic V-I curve AC		Provide	
9.06	Arrester characteristic V-I curve DC		Provide	
9.07	TOV Capabilities with prior duty per IEC 60099-4		Provide	
9.08	MOV element dimension drawings / detail		Provide	
9.09	Insulation withstand test report per IEC 60099-4		Provide	
9.10	Residual voltage test report per IEC 60099-4		Provide	
9.11	Long duration current impulse test report per IEC 60099-4		Provide	
9.12	Operating duty test report per IEC 60099-4		Provide	
9.13	Power frequency vs time characteristics per IEC 60099-4		Provide	
9.14	Short circuit test report per IEC 60099-4		Provide	
9.15	Natural ageing and pollution performance test report per IEC 60099-4		Provide	
9.16	Internal partial discharge test report per IEC 60099-4		Provide	

Item	Description	Units	Schedule A	Schedule B
9.17	Water immersion test report per IEC 60099-4		Provide	
10. Miscellaneous				
1001	Total mass of assembled unit	kg	provide	
10.02	Minimum expected life of arrester at 40 °C and MCOV	yrs	25	
10.03	Sample available for inspection		Yes	
11. Insulation withstand test				
11.01	Reference number of test report		provide	
11.02	Lightning impulse (1,2/50µs) withstand level [(1,3/0,82) Ures]	kV	135	
11.03	60 s wet power frequency withstand	r.m.s kV	50	
12. Residual voltage test				
12.01	Reference number of test report		provide	
12.02	Maximum residual voltage for a 10 kA steep current impulse (1/20µs) [4 x Ur]	kV	97	
12.03	Maximum residual voltage for a lightning current impulse (8/20µs) of magnitude:			
12.04	5 kA	kV	provide	
12.05	10 kA	kV	85	
12.06	20 kA	kV	provide	
12.07	Maximum Residual Voltage for a 500A Switching Current Impulse	kV	provide	
13. Long duration current impulse withstand test				
13.01	Reference number of test report		provide	
13.02	Charging voltage	pu of Ur	3.2	
	or			
13.03	charging current	A	provide	
13.04	Virtual duration of peak	µs	2000	
13.05	Number of discharge operations		18	
13.06	Number of grouped operations		6	
13.07	Operations per group		3	
13.08	Maximum interval between operations	s	60	
13.09	Interval between groups		Cool to ambient	
13.10	Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	
14. Operating Duty test				
14.01	Reference number of test report		provide	
	Conditioning part 1:			
14.02	10 kA current impulse (8/20µs), energised at 1.2 x MCOV	kV	29	
14.03	Number of discharge operations		20	
14.04	Number of grouped operations		4	
14.05	Operations per group		5	

Item	Description	Units	Schedule A	Schedule B
14.06	Interval between operations	s	60	
14.07	Intervals between groups	min	30	
	Conditioning part 2:			
14.08	High Current Impulse (4/10µs)	kA	100	
14.09	Number of applications		2	
14.10	**Conditions for Switching Surge Test:**			
14.11	Charging voltage	pu of Ur	3.2	
14.12	or			
14.13	charging current	A	provide	
14.14	Virtual duration of peak	µs	2000	
14.15	Number of discharge operations		2	
14.16	Interval between operations	s	60	
14.17	Starting tempreture for first impulse	°C	60	
14.18	Energy dissipated during second impulse	kJ	Provide	
	Conditions for power frequency test at elevated levels as in IEC 60099-4; 7.5.2:			
14.19	Interval between last long duration current impulse ad power frequency test	ms	100	
14.20	Elevated rated voltage (Ur) applied for 10s	kV	provide	
14.21	Elevated continuous operating voltage (Uc*) applied for 30min	kV	provide	
14.22	Maximum permitted change in residual voltage after long duration current impulse withstand test	%	5	
15. Power frequency voltage versus time characteristic				
15.01	Reference number of test report		provide	
16. Short Circuit Test				
16.01	Reference number of test report		provide	
16.02	High Current	kA r.m.s.	40	
16.03	Low Current	kA r.m.s.	0.6 ±0.2	
17. Internal Partial Discharge Test				
17.01	Reference number of test report		provide	
17.02	Power Frequency Voltage Applied [1.05 x MCOV]	kV	25	
17.03	Maximum Partial Discharge	pC	10	

Technical Schedules – Pole Mounted Auto-recloser

A- Employer's requirements

B- Supplier's Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Identification				
1.01	Name of manufacturer		Provide	
1.02	Name of supplier		Provide	
1.03	Product code of circuit-breaker		Provide	
1.04	Product code of recloser control		Provide	
2. Rated Requirements				
2.01	Nominal voltage Un (phase to phase)	kV	22	
2.02	AC 60 s wet withstand	kV	50	
2.03	BIL (open contacts)	kV	125	
2.04	BIL (closed contacts)	kV	150	
2.05	Rated continuous current	A	400	
2.06	Rated short-time (3s) withstand current	kA	12.5	
2.07	Rated symmetrical interrupting current	kA	12.5	
2.08	Rated symmetrical making current	kA	12.5	
2.09	Frequency	Hz	50	
3. Contact Operations				
3.01	Min. guaranteed mechanical operations		provide	
3.02	Min. guaranteed operations at rated continuous current		provide	
3.03	Min. guaranteed operations at rated symmetrical interrupting current		provide	
4. Bushings				
4.01	Product Code of Bushing		provide	
4.02	Insulation Material		cyclo-aliphatic	
4.03	Creepage Distance	mm/kV	31	
5. Material and Coating				
5.01	Circuit Breaker Tank		provide	
5.02	Control Cubicle		provide	
6. Miscellaneous				
6.01	Total Mass	kg	≤ 500	
5.02	Warranty Period		Provide	
5.03	Break before make contacts both directions		required	
5.04	Type Test for RFI Compliance		CISPR-11/A, IEC 60255-25, EN 55011	

Technical Schedules – RC Filter

A- Employer‘s requirements

B- Supplier’s Technical offering and Guarantees

Item	Description	Units	Schedule A	Schedule B
1. Identification				
1.01	Name of manufacturer		Provide	
1.02	Name of supplier		Provide	
1.03	Product code of RC Filter		Provide	
2. Rated Requirements				
2.01	Type of Surge Protection		RC Filter/Zorc for the suppression of switching surges	
2.02	Installation Type		Outdoor	
2.03	Altitude	m	1800m asl	
2.04	Ambient Temperature	°C	-5 to 50	
2.05	Rated Voltage	kV_{L-L}	22	
2.06	Maximum Power System Voltage	kV_{L-N}	14 (22kV/√3*1.1)	
2.07	Power System Frequency	Hz	50	
2.08	Impulse Frequency Withstand (BIL)	kV	150	
3. Rating of Capacitor				
3.01	Rated Capacity	uF	0.2	
3.02	Frequency	Hz	50	
3.03	Phase	No.	1	
4. Rating of Resistor				
4.01	Non-inductive Resistor (must have Linear V-I characteristic)	Ω	30	
5. Tests				
5.01	Capacitance Tolerance	%	-5 to +10	
5.02	Withstand Voltage Test	kV DC	64.5	
5.03	Maximum Permissable Voltage	%	110	
5.04	Capacitor Loss	%	Below 1%	
5.05	Sealing Test		No Oil Leaks when heating a capacitor in a thermostatic batch of 70°C until a constant temp is reached	
6. Miscellaneous				
5.02	Warranty Period		Provide	
5.04	Type Test for RFI Compliance		CISPR-11/A, IEC 60255-25, EN 55011	

21 Appendix B – Informative References

National Rationalised Specifications (South African ESI agreed standards)	
NRS 003 (-2)	AC METAL-ENCLOSED SWITCHGEAR AND CONTROLGEAR FOR RATED VOLTAGES ABOVE 1kV AND UPTO AND INCLUDING 36kV
NRS 004 / SANS 1029	MINI-SUBSTATIONS FOR RATED AC VOLTAGES UP TO AND INCLUDING 24KV
NRS 006 / SANS 1784	SWITCHGEAR – METAL – ENCLOSED RING MAIN UNITS FOR RATED AC VOLTAGES ABOVE 1kV AND UP TO AND INCLUDING 24 kV –retained as SANS1874
NRS 013	MEDIUM VOLTAGE CABLES
NRS 028	CABLE LUGS AND FERRULES – FOR COPPER AND ALUMINIUM CONDUCTORS
NRS 031	ALTERNATING CURRENT DISCONNECTORS AND EARTHING SWITCHES (ABOVE 1000V)
NRS039-1	SURGE ARRESTERS FOR USE IN DISTRIBUTION SYSTEMS – PART 1:GUIDE FOR THE APPLICATION OF GAPLESS METAL-OXIDE SURGE ARRESTERS
NRS039-2	SURGE ARRESTERS FOR USE IN DISTRIBUTION SYSTEMS – PART 2:DISTRIBUTION CLASS, GAPLESS METAL-OXIDE SURGE ARRESTERS
NRS 054	POWER TRANSFORMERS
NRS 056-1	SERVICE DISTRIBUTION BOXES – METER KIOSKS AND DISTRIBUTION KIOSK – PART 1: LOW-VOLTAGE NON STEEL METER KIOSKS FOR USE IN UNDERGROUND NETWORKS
NRS 056-2	SERVICE DISTRIBUTION BOXES – METER KIOSKS AND DISTRIBUTION KIOSK – PART 2: SPECIFICATION FOR GROUND – MOUNTED, LOW-VOLTAGE DISTRIBUTION KIOSKS
NRS 056-3	SERVICE DISTRIBUTION BOXES – METER KIOSKS AND DISTRIBUTION KIOSK – PART 3: LOW-VOLTAGE NON STEEL METER KIOSKS FOR USE IN UNDERGROUND NETWORKS SPECIFICATION FOR LOW-VOLTAGE STEEL METER KIOSKS FOR USE IN UNDERGROUND NETWORKS
NRS 067	COMPACT CUBICLE, FIXED PATTERN, SWITCHGEAR FOR RATED A.C. VOLTAGES FROM 12kV UP TO AND INCLUDING 36kV
NRS 068``	ELECTRICITY DISTRIBUTION – CABLE EARTH FAULT INDICATOR
NRS 074-1	LOW – VOLTAGE (600/1000V) CABLE SYSTEMS FOR UNDERGROUND ELECTRICAL DISTRIBUTION – PART 1:CABLES
NRS 075	MECHANICAL TORQUE SHEAR CONNECTORS
NRS 076	EARTHING OF DISTRIBUTION SUBSTATIONS WITH NOMINAL VOLTAGES UP TO AND INCLUDING 132KV
NRS 077	XLPE-INSULATED CABLES AND ACCESSORIES FOR SYSTEMS WITH NOMINAL VOLTAGES OF 44kV, 66kV, 88kV AND 132kV
South African National Standards (IEC Equivalent)	

SANS 121	Hot dip galvanised coatings on fabricated iron and steel articles – Specifications and test methods.
SANS 475	Luminaires for interior lighting, street lighting and floodlighting - Performance requirements
SANS 10389-1	Exterior lighting Part 1: Artificial lighting of exterior areas for work and safety
SANS 1088	Luminaire entries and spigots
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
SANS 1874	Switchgear – metal enclosed ring main units- for rated voltages above 1kV anf upt up to and including 36kV
SANS 10225	The design and construction of lighting masts
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 10114-1	Interior lighting Part 1: Artificial lighting of interiors
SANS 10114-2	Interior lighting Part 2: Emergency lighting
SANS 60598-1	Luminaires Part 1: General requirements and tests
SANS 60598-2	Luminaires Part 1: Particular requirements (all sections)
SANS 1464-22	Safety of luminaires Part 22: Luminaires for emergency lighting
SANS 1091	National Color Standard
SANS 60079	Use of electrical apparatus in hazardous areas
SANS 10108	The classification of hazardous locations and the selection of equipment for use in such locations
SANS 10086	The installation, inspection and maintenance of equipment used in explosive atmospheres
SANS 10313	Protection against lightning – Physical damage to structures and life hazard
SANS 61643	Low voltage surge protection devices
SANS 62305	Protection against lightning
SANS 1339	Electric cables – Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3.8/6.6 kV to 19/33 kV
SANS 1489	Electrical connections in group I and II hazardous locations
SANS 10280	Overhead power lines for conditions prevailing in South Africa
SANS 10199	The design and installation of earth electrodes.
SANS 60439	Low voltage switchgear and control gear assemblies
SANS 60947	Low voltage switchgear and control gear
SANS 60076	Power transformers
SANS 780	Distribution transformers
SANS 1885	AC Metal-Enclosed Switchgear and Controlgear for Rated Voltages above 1kV and up to and including 36kV

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