CLUSTER

Trading Services

UNIT

Water and Sanitation

DEPARTMENT

Sanitation Operations

PROCUREMENT DOCUMENT

INFRASTRUCTURE

Documents are to be obtained, free of charge, in electronic format, from the National Treasury's eTenders website or the eThekwini Municipality's website.

Contract No: 30661-5W

Contract Title: Construction of the Southern Wastewater Treatment Works Multidisciplinary Upgrades

Est. CIDB Grade/ Class: 9 9EP and 9ME

CLARIFICATION MEETING AND QUERIES

Clarification Meeting: Compulsory Clarification Meeting

Meeting Location, Date, Time: Southern Wastewater Treatment Works (@ co-ordinates - 29.955135360820552, 30.97299685576011) on 13 June 2025 at 11h00

Queries can be addressed to:
The Employer's Agent's Representative:
Name: Shanir Ramjathan
Tel: +27 (0)31 254 5700
eMail: Shanir.r@ixengineers.co.za.co.za

TENDER SUBMISSION

Delivery Location: The Tender Box in the foyer of the Municipal Building 166 KE Masinga Road, Durban

Closing Date/ Time: Friday, 04 July 2025 at 11h00

FACSIMILE, eMAIL, or POSTED TENDERS WILL NOT BE ACCEPTED

Issued by:

ETHEKWINI MUNICIPALITY

Deputy Head: Water and Sanitation

Date of Issue: 30/05/2025

Document Version 01/03/2024

VOLUME 4 OF 9

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Tenderer Name:			VAT Registered: Yes No
	Price (excl)	VAT	Price (incl)
Submitted:	R	R	R
Corrected:	R	R	R

INDEX to TENDER DOCUMENT - VOLUMES

This Tender Document consists of 9 (Nine) Volumes as indicated in the table below.

Volume	Description	Contents
1 of 9	Tender Document	Tendering Procedures Returnable Documents Agreement and Contract Data Scope of Work Site Information
2 of 9	Pricing Data	Pricing Assumptions / Instructions Bill of Quantities
3 of 9	Standard Specifications	Standard Specifications Amendments to standard Specifications
4 of 9	**Electrical (This Document)**	**Standard Specifications Particular Specifications - MV Particular Specifications - OHS Data Sheets**
5 of 9	Mechanical	Standard Specifications Project Specifications - Mechanical Particular Specifications – Lifting Equipment Mechanical Data Sheets
6 of 9	Building Work	Particular Specifications
7 of 9	HVAC Services	Project Specifications - HVAC Particular Specifications - HVAC Pricing Instructions - HVAC Returnable Schedule - HVAC Inspection Sheet - HVAC
8 of 9	Annexures	Quality Assurance, Transport, Installation, Testing and Commissioning Environmental Management Plan Employer's Health and Safety Specification Employers Standard Electrical Standard Specifications Employers Standard Mechanical Specifications Employer Control Instrumentation Project Specification
9 of 9	Drawings	General Drawings Electrical Drawings Mechanical Drawings Building Work Drawings Structural Drawings HVAC Drawings Civil Drawings

Declaration by Tenderer

I, the undersigned, hereby declare and confirm that I have obtained all 9 (Nine) of the Tender Document Volumes as indicated in the table above.

NAME (Block Capitals): _____ **Date**

SIGNATURE: ---------- ----------

This Tender Document (Volume 4 of 9: Electrical) consists of the following Documents.

STANDARD SPECIFICATIONS- MEDIUM VOLTAGE
PARTICULAR SPECIFICATION – MEDIUM VOLTAGE
PARTICULAR SPECIFICATION – LOW VOLTAGE
PARTICULAR SPECIFICATION –OCCUPATIONAL HEALTH AND SAFETY
ANNEXURES – TECHNICAL DATA SHEETS

STANDARD SPECIFICATIONS- MEDIUM VOLTAGE

1 Contents

STANDARD SPECIFICATIONS: MEDIUM VOLTAGE

1. OVERVIEW

1.1 This section of the specification deals with the general requirements of electric equipment and the installation thereof. It is to be read in conjunction with the various Electrical Technical Specifications which have precedence in the event of conflict.

2. COMPLIANCE WITH STANDARDS

2.1 Equipment and methods of installation shall comply with the latest edition and/or amendment of:

STANDARD	DESCRIPTION
SANS 156 & VC8036	Moulded case circuit breakers
SANS 555	Unused and reclaimed mineral insulating oils for transformers and switchgear
SANS 780	Distribution Transformers
SANS 950	Unplasticised polyvinyl chloride rigid conduit and fittings for use in electrical installations
SANS 1029	Miniature substations
SANS 1063	Earth rods, couplers and connections
SANS 1091	National colour standards for paint
SANS 1195	Busbars
SANS 1339	Cross-linked polyethylene (XLPE)-insulated electric cables (3,8/6,6 kV to 19/33 kV)
SANS 1973	Low voltage switchgear and control gear assemblies
SANS 1507	Electrical cables with extruded solid dielectric insulation for fixed installation
SANS 1874	Switchgear – Mental Enclosed Ring Main Units for rated A.C. voltages above 1 kV and up to and including 24 kV
SANS 1885	AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
SANS 10111-1	Engineering Drawing – General Principles
SANS 10142-1	The wiring of premises Part 1: Low-voltage installations
SANS 10142-2	The wiring of premises Part 2: Medium-voltage installations above 1 kV A.C. not exceeding 22 kV A.C. and up to and including 3 000 kW installed capacity
SANS 10199	The Design and Installation of an Earth Electrode
SANS 10198 Parts 1 – 13	The selection, handling and installation of electric power cables of rating not exceeding 33 kV

SANS 10200	Neutral Earthing in Medium Voltage Industrial Power Systems
SANS 10222	Electrical security installations
SANS 10292	Earthing of low-voltage (LV) distribution systems
SANS 10313	Protection against lightning – Physical damage to structures and life hazard
SANS 60044-1	Instrument transformers Part 1: Current transformers
SANS 60044-2	Instrument transformers Part 2: Inductive voltage transformers
SANS 60044-5	Instrument transformers Part 5: Capacitor voltage transformers
SANS 60947	Low-voltage switchgear and control gear
SANS 60502-4	XLPE Joints and Terminations
SANS 61280	Fibre optic communication subsystem test procedures
SANS 61281	Fibre optic communication subsystems
SANS 61282	Fibre optic communication system design guides
SANS 62305	Protection against lightning
NRS 003-1 (Int)	Metal Clad Switchgear
NRS 003-2	Metal-clad switchgear - For rated A.C. voltages above 1 kV and up to and including 24 kV Part 2: Standardized panels
NRS 013	Medium Voltage Cables
IEC 137	Insulated bushings for alternating voltages above 1 kV
IEC 60269	Low-voltage fuses
IEC 60439	Low voltage switchgear and control gear assemblies
IEC 60529	Degrees of protection provided by enclosures (IP codes)
IEC 60695-11-10	Fire hazard testing – Test flames – 50W horizontal and vertical test methods
IEC 60947-1 and 3	Low-voltage switchgear and control gear
IEC 62227-200	AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
OHS Act	Occupational Health and Safety Act and Regulations – Act 85/1993 Local Fire Regulations The Regulations of the Local Supply Authority

	The Regulations of the Department of Posts and Telecommunications
ISO 272	Fasteners – hexagonal products – width across flats
ISO 1461	Hot dip galvanised coatings on fabricated iron and steel articles
ISO 2859 -1	Sampling schemes indexed by acceptable quality limit (AQL) for lot-by-lot inspection
ISO 4759	Tolerances for fasteners
ISO 8501-1	Preparation of steel substrates before application of paints and related products
BS EN 22063	Metallic and other inorganic coatings
Various	Electrical General Specifications of the eThekwini Municipality Water and Sanitation
IEC 60051	Direct acting analogue electrical measuring instruments and their accessories
SANS 60137	Insulated bushings for alternating voltages above 1 000 V
IEC 60255	Electrical relays
SANS 60269-1	Low-voltage fuses, Part 1: General requirements
SANS 60269-2	Low-voltage fuses, Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial applications)
SANS 62271-1	High-Voltage switchgear and control gear, Part 1: Common specifications
SANS 61850-3	Communication Networks and Systems in Substations
Ethernet Switch Applicable Environmental and EMI Tests	
Compliance with SANS 61850-3 with the following tests:	
IEC 61000-4-2	ESD
IEC 61000-4-3	Radiated RFI
IEC 61000-4-4	Burst (Fast Transient)
IEC 61000-4-5	Surge
IEC 61000-4-6	Induced (Conducted) RFI
IEC 61000-4-8	Magnetic Field Enclosure ports
IEC 61000-4-29	Voltage Dips and Interrupts DC
IEC 61000-4-11	Voltage Dips and Interrupts AC
IEC 61000-4-12	Damped Oscillatory
IEC 61000-4-16	Mains Frequency Voltage

IEC 61000-4-17	Ripple on DC Power Supply
IEC 60255-5	Dielectric Strength
IEC 60255-5	HV Impulse
Compliance with IEEE 1613 with the following tests:	
IEEE C37.90.3	ESD
IEEE C37.90.2	Radiated RFI Enclosure ports 35 V/m
IEEE C37.90.1	Fast Transient
IEEE C37.90.1	Oscillatory
IEEE C37.90	HV Impulse
IEEE C37.90	Dielectric Strength
Environmental	
IEC 60068-2-1	Cold Temperature Test
IEC 60068-2-2	Dry Heat Test
IEC 60068-2-30	Humidity (Damp Heat, Cyclic)
IEC 60255-21-1	Vibration
IEC 60255-21-2	Shock
Standards	
IEEE 802.3	for 10 BaseT
IEEE 802.3u	for 100 BaseT(X) and 100Base FX
IEEE 802.3ab	for 1000 BaseT(X)
IEEE 802.3z	for 1000 BaseX
IEEE 802.3x	for Flow Control
IEEE 802.1D-2004	for Spanning Tree Protocol
IEEE 802.1Q-2005	for Multiple Spanning Tree Protocol
IEEE 802.1w	for Rapid STP
IEEE 802.1Q	for VLAN Tagging
IEEE 802.1p	for Class of Service (QOS)

NRS 012	Cable terminations and live conductors within air insulated enclosures (insulation co-ordination) for rated A.C. voltages of 7,2 kV and up to and including 36 kV
SANS 1091	National colour standards
SANS 1274	Coating applied by the powder coating process
SANS 279	Paints and varnishes – Scratch test
SANS SM 155	Resistance to salt fog on paint films
SANS ISO 1461	Hot dip galvanised coatings on fabricated iron and steel articles
SANS 1019	Standard voltages, currents and insulation levels for electricity supply
SANS 1574	Electric cables - Flexible cords and flexible cables
SANS 2409	Paints and varnishes – Cross cut test
SANS 60265-1	High Voltage Switches-Part 1, High voltage switches for rated voltage above 1 kV and less than 52 kV
SANS 62271-100	High-voltage switchgear and control gear, Part 100: Alternating-current circuit breakers
SANS 62271-200	High-voltage switchgear and control gear, Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
SANS IEC 62271102	High-voltage switchgear and control gear, Part 102: Alternating current disconnectors and earthing switches
EN 50181	Plug-in type bushings above 1 kV up to 36 kV and from 250 A to 1,25 kA for equipment other than liquid filled transformers
NRS 012/SANS 876	Cable terminations and live conductors within air-filled enclosures (insulation co-ordination) for rated A.C voltages from 7,2 kV up to and including 36 kV
NRS 053/ SANS 1332	Accessories for Medium-Voltage Power Cables (3,8/6,6 kV to 19/33 kV)
NRS 075	Mechanical Torque Shear Connectors
SANS 97	Electric Cables: Impregnated paper insulated metal sheathed cables for rated voltages from 3,3/3,3 kV up to 19/33 kV
SANS 1339	Electric cables - Cross-linked polyethylene (XLPE) - insulated cables for voltages from 3,8/6,6 kV to 19/33 kV
SANS 10198	The selection, handling and installation of rating not exceeding 33 kV - Part 10: Jointing and termination of paper insulated cables

SANS/IEC 61238-1	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) - Part 1: Test methods and requirements
IEC 60055-1	Paper insulated metal sheathed cables for rated voltages up to 18/30 kV (with copper or aluminium conductors and excluding gas pressure and oil filled cables) - Part 1 Test on cables and their accessories.
IEC 61442	Electrical Cables - Test methods for accessories for power with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)
SANS 9227	Corrosion tests in artificial atmospheres – Salt spray tests
ISO 8501-1: 2007	Preparation of steel substrates before application of paints and related products
ISO 9223: 2012	Corrosion of metals and alloys - Corrosivity of atmospheres: Classification, determination and estimation
NRS 068: 2014	Cable earth fault indicator
SANS 121: 2011	Hot dip galvanized coatings on fabricated iron and steel articles
SANS 164-1: 2018	Plug and socket-outlet systems for household and similar purposes for use in South Africa: Two-pole and earth, 16 A 250 V AC system
SANS 876: 2016	Cable terminations and live conductors within air-filled enclosures (insulation coordination) for rated AC voltages from 7,2 kV up to and including 36 kV
SANS 780: 2009	Distribution transformers
SANS 1029: 2016	Miniature substations for rated AC voltages up to and including 24 kV
SANS 1091: 2012	National colour standards for paint
SANS 60269-2: 2016	Low voltage fuses: Supplementary requirements for fuses for use by authorised persons
SANS 60439-1: 2004	Low voltage switchgear and control gear assemblies: Type tested and partially type tested assemblies
SANS 60529: 2013	Degrees of protection provided by enclosures (IP code)
SANS 60695-11-10: 2004	Fire hazard testing: Test flames - 50 W horizontal and vertical test methods
SANS 61243-5: 1997	Live working - Voltage detectors: Voltage detecting systems (VDS)
SANS 780	Distribution Transformers
Eskom Standard 24075661431	Specification for mineral insulating oils (Uninhibited and Inhibited): Purchase, Management, Maintenance and Testing
Eskom Standard 24045395762	Specific requirements for distribution pole and ground-mounted transformers up to 33 kV and 1 MVA

Eskom Standard: 24056030674	Corrosion protection and maintenance of new and in service transformers and reactors
Eskom Standard DPC 341473	Procedure for the handling and transportation of power distribution transformers up to 500 KVA and 33 kV
SANS 60317-0-1	Specifications for particular types of winding wires Part 0-1: General requirements - Enamelled round copper wire
SANS 60137	Insulated bushings for alternating voltages above 1 000 V
SANS 1037	Standard transformer bushings
SANS 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions
BS EN 50180-1	Bushings above 1 kV up to 36 kV and from 250 A to 3,15 kA for liquid filled transformers – Part 1: General requirements for bushings
BS EN 50180-2	Bushings above 1 kV up to 36 kV and from 250 A to 3,15 kA for liquid filled transformers – Part 2: Requirements for bushing components
BS EN 50180-3	Bushings above 1 kV up to 36 kV and from 250 A to 3,15 kA for liquid filled transformers – Part 3: Requirements for bushing fixation
SANS 876	Cable terminations and live conductors within air-filled enclosures (insulation co-ordination) for rated AC voltages from 7,2 kV up to and including 36 kV
SANS 60076-5	Power Transformers – Part 5: Ability to withstand short circuit
SANS 1091	National Colour Standard
SANS 60947-1	Low Voltage switchgear and controlgear – Part 1: General rules
SANS 60947-2	Low Voltage switchgear and controlgear – Part 2: Circuit breakers
SANS 10142-1	The wiring of premises – Part 1: Low voltage installations
Eskom Distribution IARC – Distribution Technology	Technical Bulletin – Load and No-Load Loss Factors for Large Power Transformers (1.25 To 160 MVA)
NRS 039	Guide for the application of gapless metal-oxide surge arresters in distribution systems
SANS 121 ISO 1461	Hot-dip galvanised coatings on fabricated iron and steel articles - Specifications and test methods
SANS 4998	Continuous hot-dip zinc coated and zinc-iron alloy-coated carbon steel sheet of structural quality
SANS 60099-1	Surge arresters-Part 1: Non-linear type gapped arresters for a.c. systems

SANS 60099-4	Surge arresters-Part 4: Metal oxide surge arresters without gaps for a.c. systems
SANS 3575	Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities

The contractor's attention is drawn to the following requirements:

2.2 The submission of the Health and Safety Plan in accordance with the OHS Act 85;

2.3 Submission of a letter stating that: The contractor has ensured that a person deemed competent in terms of paragraph (b), (c) and (d) of the definition of a competent person in regulation 1 of the General Machinery Regulations, GMR 1521 of 5 August 1988, or a person registered in a professional category in terms of the Engineering Profession Act, 2000, has approved the design, construction and witnessed testing of that part of the installation;

2.4 Any person who erects or installs any article for use at work on or in any premises shall ensure as far as reasonably practical, that nothing about the manner in which it is erected or installed makes it unsafe or creates a risk to health when properly used.

3. SYSTEMS AND OPERATING/ENVIRONMENTAL CONDITIONS

3.1 The relevant items detailed in Annexure A are for use in indoor enclosures which form part of eThekwini Water and Sanitation medium voltage (11 kV) system and shall be designed to operate satisfactorily when subjected to the following operating conditions:

Description	Detail
Climate	humid and sub-tropical
Altitude	from sea-level to 1 000 m
Ambient temperature	from 0°C to 50°C
Maximum relative humidity	99 %
Highest system phase-to-phase voltage	12 kV
System frequency	50 Hz
System neutral earthing	Solid
Rated normal current	630 A
Fault level	25 kA
Service configuration of switchboard	In-line extendable to form a continuous bank
Highest fault level at 11 kV source	350 MVA
Mean annual value of solar radiation	1.0 kW/m^2
Average total annual rainfall figure	1 000 mm
Lightning level/lightning ground flash density	High/up to 5 flashes per km^2 per year
Line configuration	Triangular, horizontal and vertical
Number of phases	3

Minimum specific creepage	31mm/kV

4. CABLE INSTALLATION

4.1 EXCAVATIONS AND TRENCHING

4.1.1 General

4.1.1.1 The purpose of this specification is to ensure standards are maintained for the installation and backfilling of electrical cables on this project, it is essential to ensure that any possible subsidence of cable trench backfilling is eliminated.

4.1.1.2 The electrical contractor may be required to excavate, in all kinds of ground and to an appropriate depth and width, trenches for the installation of cables and/or the installation of cable ducts. All excavations shall comply with the requirements of the OHS Act as well as local bylaws and regulations.

4.1.1.3 The electrical contractor shall take all the necessary precautions and provide the necessary warning signs, red and white plastic chevron tape (danger tape) and/or lights to ensure that the public and/or employees on site are not endangered.

4.1.1.4 The electrical contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other site construction, or other property.

4.1.1.5 The electrical contractor shall be responsible for the provision of all planking, shoring, strutting, temporary bridging, roping, warning lamps and notices well as other precautions to prevent danger to persons.

4.1.1.6 The engineer may instruct the electrical contractor to install additional safeguards, at his own expense, but this shall in no way relieve the electrical contractor of his responsibility to ensure safety of the excavations.

4.1.1.7 Although not bound in or issued with this document (specification), the following Standard Specifications shall form part of the contract documents. The Contractor shall be in possession of these Standard Specifications and their related Codes of Practice which apply equally and shall keep copies thereof on site for reference by himself or the Engineer for the duration of the Contract:

- SANS 1200 DB-1989: Earthworks (Pipe Trenches);
- SANS 0198 Selection, Handling & Installation of Electric Power Cables.

4.1.2 Liaison

4.1.2.1 The electrical contractor will be required to liaise with the Engineer in Charge to co-ordinate the installation of all services, it is a requirement of this contract that close liaison be maintained at all times in order to eliminate or at least minimise any misunderstandings;

4.1.3 Routes

4.1.3.1 The electrical contractor shall familiarise himself with the routes and site conditions and shall then plan the procedure and order of doing the work in conjunction with the general construction programme for other services and construction requirements. All cable routes have been carefully planned and must be marked out on site, measured and pegged by a competent person appointed by the electrical contractor.

4.1.3.2 Should planned cable routes indicated on the construction drawings, clash with existing services the Contractor is to engage with the Engineer to determine a suitable solution or alternate routing if necessary;

4.1.3.3 Electrical cable trenches are to be co-ordinated with other known underground services. Cables shall be run parallel or at right angles to roads and building structures. Diagonal routes shall be avoided.

The Engineer shall approve any major route deviations due to obstructions of existing services before the excavation being undertaken;

4.1.3.4 The Engineer reserves the right to alter any cable route or portion thereof in advance of installation of cable. Payment in respect of any additional or wasted work involved shall be at the documented rates. The electrical contractor shall allow for the removal of obstructions along the cable routes including all tree roots and similar obstructions;

4.1.4 Existing Services

4.1.4.1 The electrical contractor shall obtain from the employer, engineer or the relevant Local Authority full details of existing buried services along the route and shall ensure that this information is passed to the individual directly responsible for the excavation. The electrical contractor shall be responsible for ensuring that all due care is taken when excavating near such existing services. Only labourers with experience of these conditions may be utilised.

4.1.4.2 The electrical contractor will be required to prove any existing or new services in the vicinity of his trenches by careful hand excavations to avoid unnecessary disruption of supply to consumers or avoid damage to new services. All services must be successfully proved prior to excavation of trenches commencing in an area. Under no circumstances will the use of mechanical equipment/excavator be permitted to locate any of the services. Mechanical excavators shall not be used within one metre of any known existing services nor shall they be used in other open ground without the prior written permission of the engineer;

4.1.4.3 The Contractor shall take cognisance of the fact that the installation of the new MV cable, fibre optic cables, pilot wire and earth cables shall run parallel with and intersect the following existing underground services:

- Pressure Pipelines;
- Gravity Pipelines;
- Telkom Cables;
- 11kV Underground Cables;
- LV Underground Cables;
- Abandoned foundations;

4.1.4.4 If required, the position of all existing services being MV, LV, Electronic Services and Civil Services shall be identified and marked on surface;

4.1.4.5 The Contractor shall ensure that the excavations do not endanger any persons, structures, roads, services or property. The Contractor shall take the necessary precautions and provide the required warning signs in this regard. Trenches crossing roads, pathways and entrances shall be backfilled as soon as practically possible

4.1.4.6 If any damage is caused by the electrical contractor’s staff to existing buried services, the electrical Contractor shall immediately notify the engineer to that effect and shall take such temporary or permanent remedial measures as the engineer may direct. All such measures shall be affected at the electrical contractor's expense;

4.1.5 Mechanical Excavators

4.1.5.1 Power-driven mechanical excavators may be used for trenching operations if they are not used in close proximity to other plant, services, or other installations likely to be damaged by the use of such machinery. The electrical contractor is advised that a major portion of the excavation shall be undertaken in the roadways with a major vehicular traffic and the mechanical excavator shall not cause

any traffic congestion. The use of power-driven mechanical excavators shall be subject to the approval of the engineer.

4.1.6 Blasting

4.1.6.1 No guarantee is given or implied that blasting will not be required. Should blasting be necessary and approved by the engineer, the electrical contractor shall obtain the necessary authority from the relevant government department and local authorities. The electrical contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

4.1.7 Shoring & Water Pumping

4.1.7.1 The Electrical contractor shall provide shoring for use in locations where there is a danger of the sides of the trench collapsing due to water logging or other ground conditions, to the full requirements of the OHS Act.

4.1.7.2 The strength of shoring must be adequate for site conditions prevailing and the shoring must be braced across the trench. The Electrical contractor shall provide all pump and equipment required to remove accumulated water from trenches. Water or any other liquid removed shall be disposed of without any nuisance or hazard. High water tables may be encountered.

4.1.8 Trenching

4.1.8.1 Trenching shall be programmed in advance and the approved programme shall not be departed from except with the consent of the engineer. Trenches shall be as straight as possible and shall be excavated to the dimensions indicated in this specification. The bottom of the trench shall be of smooth contour and shall have no sharp dips or rises that may cause tensile forces in the cable during back filling. The excavated material shall be placed adjacent to each trench in such a manner as to prevent nuisance, interference, or damage to adjacent drains, gateways, trenches, water furrows, other works, properties, or traffic. Where this is not possible the excavated materials shall be removed from site and returned for back filling on completion of the cable installation. Surplus material shall be removed from site and disposed of at the cost of the electrical contractor. Trenches across roads access ways or footpaths shall not be left open. If cables cannot be laid immediately the electrical contractor shall install temporary "bridges" or cover plates of sufficient strength to accommodate the traffic concerned.

4.1.8.2 Before cable installation the trench shall be inspected thoroughly and all objects likely to cause damage to the cables during or after cable installation shall be removed. Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subjected to chemical or other damage or electrolytic action, the Engineer shall be notified before installing the cables. The engineer will advise on the course of action to be taken.

4.1.8.3 Extreme care shall be taken not to disturb surveyor's pegs. These pegs shall not be covered with excavated material. If the surveyor's pegs are disturbed, a person qualified to do so shall replace them.

4.1.9 Dimension of Trenches

4.1.9.1 All cable trenches are to be sized to suit specific cable requirements in accordance SANS 10198. The engineer will determine any other combinations of cable installation on site and site instructions issued to the electrical contractor accordingly. The final ground levels must be confirmed with the engineer in charge by the Contractor.

4.1.9.2 Cable trenches for one or two cables shall not be less than 400 mm wide and need not be more than 700 mm wide. This dimension shall be valid for the total trench depth. The width shall be increased where more cables are installed to allow for the spacing stipulated. Where trenches change direction or when cable slack is to be accommodated, the electrical Contractor shall ensure that the requirements of the relevant SANS specification regarding the bending radii of cables are met when determining trench widths.

4.1.9.3 Trench depths shall be determined in accordance with cable installation depths and bedding thickness. Where the bottom of the trench has been loosened during excavation, it shall be compacted at OMC to 95 % MASSHTO density prior to laying of cable/s and bedding. Where the bottom of the trench has been excavated to a depth greater than that specified or ordered, the electrical contractor shall at his own expense replace the excess material so removed with fine granular material compacted to 95 % MAASHTO density or with 10 MPa concrete, as directed by the engineer.

4.1.9.4 For MV cables only, trenches shall be 1100 mm deep with bedding of 100 mm deep below the cable (cable 1000mm deep) and 150mm bedding above the cable. The MV cable protection slab shall be placed 200mm above the MV cable.

4.1.9.5 For armoured fibre optic cables laid in the ground, cables may be laid in the same trench as the power cables but must be spaced apart from the power cables encased with bedding as described below. A plastic danger tape “fibre-optic cable” shall be placed above the cable 350mm below normal ground line.

4.1.9.6 Where trenches change direction or when cable slack is to be accommodated, the Electrical Contractor shall ensure that the requirements of the relevant SANS Specification regarding the bending radii of cables are met when determining trench widths.

4.1.10 Bedding

4.1.10.1 Before installing the cables, all injurious items shall be removed from the bottom of the trench. The engineer shall inspect the floor of the trench before it is evenly covered with a layer of compacted sifted backfill or fine soil to a level that is at least 100 mm above the highest unevenness of the trench. Only sandy clay or loam soil with a satisfactory thermal resistivity (not exceeding 1,5°Cm/W) may be used for this purpose. The soil shall not contain any stones or lumps larger than 13.2 mm. Sea or river sand, ash, chalk, peat, clinker or clayey soil shall not be used. The use of crusher sand is acceptable. Where no suitable soil is available on site, the electrical contractor shall import fill from elsewhere and make all the necessary arrangements to do so. The cost of importing soil for bedding purposes shall be included in the unit rates for excavations. After cable installation a further layer of bedding shall be provided to extend to 150 mm above the cables. The bedding under joints shall be fully consolidated to prevent subsequent settling;

4.1.11 Cable Protection

4.1.11.1 The cables in the MV and Fiber Optic cables within the MV trench are to be protected by concrete slabs to be added as per the levels indicated on the drawings. Standard reinforced precast panels (500mm long and 250mm wide 50mm thick) shall be installed to cover the width of the 600mm wide trench (i.e. two slabs 250 wide side by side for the full length of the trench) to ensure protection to the cables below;

4.1.11.2 Danger Tape 150 mm wide approximately 300mm above cable as per the trench detail on the appropriate drawings;

4.1.12 Back Filling

4.1.12.1 The Electrical contractor shall not commence with the back filling of trenches without prior notification to the Engineer so that the cable installation may be inspected. Should the Electrical contractor fail to give a timeous notification, the trenches shall be re-opened at the Electrical contractor's cost. Such an inspection/survey will not be unreasonably delayed. Back filling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material is 26 mm and all large or sharp stones or other debris shall be removed from the fill material;

4.1.12.2 The electrical contractor shall have allowed in his tender for the removal of surplus material and the importation of suitable backfill material if required. Back filling of trenches may commence after the trenches have been approved and the position of all cables recorded and dimensioned on the as-built construction drawings. All trenches shall be backfilled in layers of thickness (after compaction) not exceeding 150 mm and the material shall be compacted to 93 % of modified AASHTO maximum density in the case of cohesive soil or 98 % in the case of non-cohesive soil. Care shall be taken to ensure newly laid cable is not damaged during compaction of trenches. Mechanical compactors shall be used, hand compaction will not be accepted.

4.1.12.3 The electrical contractor shall appoint independent experts to perform compaction tests for the compaction and provide a report to confirm that the compaction complies with the above specification. Where trenches are in grassed or open areas sufficient allowance must be made for final settlement.

4.1.12.4 For the first layer of 150 mm, sifted soil of which 75 mm must be below and 150 mm must be above the cable, must be used. Where no suitable soil is available on site, the Electrical contractor shall import fill from elsewhere and make all the necessary arrangements to do so;

4.1.12.5 Upon completion of backfilling, the final surfaces shall be worked to match the surrounding area and any surplus material shall be suitably disposed of. After backfilling the Contractor shall maintain the cable trenches for the duration of the contract;

4.1.12.6 For payment purposed, excavations shall be classified as follows:

- Soft excavation as classified in SABS 1200 Section D-1988;
- Intermediate excavation as classified in SABS 1200 Section D-1988;
- Hard excavation as classified in SABS 1200 Section D-1988;

4.1.12.7 The scheduled rates for excavations shall cover all costs to comply with safety requirements, protection measures, excavations and removal of excess material from site;

4.1.12.8 The scheduled rates for the import of selected fill material shall cover the supply, transport to site, delivery, and off-loading along cable trenches of fill material as specified;

4.1.12.9 The scheduled rates for backfilling shall cover the backfilling of cable trenches in layer with fill material as specified (measured elsewhere) and the compaction of the backfilled material as specified herein;

4.1.12.10 The scheduled rated for compaction tests shall cover the supply of all equipment and labour. The execution of tests by an approved laboratory and the submission of test reports to the Engineer

4.1.13 Surplus Ground

4.1.13.1 All surplus ground and rocks shall be removed from the works and dumped at a site to be approved by the Engineer. The cost of this work shall be included in the Electrical contractor's price for excavation of trenches etc.

4.1.14 Cable Work

4.1.14.1 All MV and LV cables must be installed in accordance with SANS 10198 and the Electrical contractor must adhere to the minimum bending radii specified. The storage, transportation, handling and installation of all underground cables shall be according to first class practice, and the electrical

contractor shall have adequate equipment and labour to ensure that no damage is done to the cables during such operations. The final ground levels must be confirmed with the engineer or employer before cables are installed.

4.1.14.2 Regarding the installation of low voltage cable, the following requirements shall be complied with:

- Under no circumstances should a drum or reel of cable be dropped during unloading or transport to or on a site. When rolled, drums and reels must always be rolled in the direction of the arrow marked upon the flange. The protective cover and securing tie of the inner end must be removed before the cable is unwound. It is essential that cables should be installed only when both the cable and the ambient temperature are above 10°C;
- The cable shall be removed from the drum in the direction indicated in such a way that no twisting, tension or other mechanical damage is caused, and must be adequately supported at short intervals during the whole operation;
- Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation, or distortion of any kind. Multiple cables may be drawn through a single sleeve pipe provided sufficient air space is allowed and the heat and current capacity of the cables are not adversely affected;
- Suitable approved cable rollers onto which the cable shall be drawn must be placed in or alongside the cable trench. The rollers must preferably be spaced two metres apart, but the spacing must under no circumstances exceed three metres;
- The maximum speed at which cables shall be drawn must not exceed 10 metres per minute;
- The cable must be bent slowly and carefully and the minimum radius of curvature must not be less than "12 d" where "d" is the overall diameter of the cable;
- Where cables are cut and not immediately made off, the ends are to be adequately sealed immediately;
- The electrical contractor is advised to measure actual lengths of cable required on site before ordering as he will not be compensated for redundant cable or in fact any other material over supplied. Optimum use shall be made of cable to avoid cable joints in cable;
- The separation between cables of the same voltage shall not less than 150mm;
- Cables installed within the inspection access in which the distribution board is installed shall be saddled to the concrete with stainless steel saddles and stainless-steel fixings.

4.1.15 Cable Slack

4.1.15.1 At every termination, sufficient slack shall be provided for future repairs to the cable end should this become necessary due to a fault or some unforeseen circumstances on site.

4.1.16 Cable Identification

4.1.16.1 Every power distribution cable, switchboard interconnecting cable, and any other cable, shall be provided at both ends of the run with an approved Bowthorpe Hellerman tag showing the size and details of the cable. All identifications shall correspond with the construction record drawings and single-line diagrams associated with the contract.

4.1.17 Cable Joints and Terminations

4.1.17.1 MV cable joints and terminations may only be carried out by an accredited cable jointer who has passed the MV paper cable or XLPE cable jointing course run by the eThekwini Municipality. All MV accessories shall comply with the requirements of NRS 053. MV cable joints will only be permitted in

cable drum lengths exceeding 300 metres or where a new length of cable needs to be spliced into an existing cable.

4.1.17.2 MV cable joints shall be of the heat shrink, filled type provided with a core separator and filler mastic of make approved by the eThekwini Municipality Electricity Department. Three phase cable joints shall be designed to permit the crossing of cores in the joint, however cables should be laid in a manner to avoid the cores from crossing each other. The use of “Tyco” mechanical connectors using shear head bolts for joining the copper conductors will be acceptable. Connectors shall incorporate an oil block. The heat shrink material used shall have a minimum wall thickness of at least 1.0 mm after application. The main earthing conductor of the joint shall be connected to the lead sheath of the cable by a constant force spring. A layer of tinned copper shall be provided for application under the constant force spring (CFS) and connected to the armouring of the cable with a CFS. The CFS shall have a minimum width of 20 mm and shall be suitable for the cable width. The MV cable joint shall be prepared on a concrete base to maintain the stability of the joint on a level plain and the slab above the joint shall indicate “Cable Joint”

4.1.17.3 Both the indoor (for mini-subs) and the outdoor (for the overhead line connection) MV cable terminations shall be of the type utilising heat shrink sleeving to the approval of the eThekwini Municipality. The mini-sub cable terminations shall be classified as indoor terminations for use in air filled enclosures. Clearances within the enclosure shall be in accordance with NRS 012. Right angle connections shall be fitted with an insulated right-angle boot. Unless otherwise specified indoor cable termination tails shall have a length of 650mm and outdoor termination tails a length of 1600mm for 11kV cables. The specific creepage for both indoor and outdoor terminations shall be at least 31mm/kV. A semi-conductive tube shall be provided that covers the metallic-paper core screen from the break-out boot to the end of the core screen. The purpose of the conductive tube is to prevent the metallic-paper core screen from moving during the termination process. Heat shrink sleeving must cover the barrel of the connecting lug. Outdoor terminations shall be provided with crutch support to prevent damage to the cable crutch and core insulation from over tri-furcating and shall be fitted with rain skirts.

4.1.17.4 Joints in LV cable runs shall not be allowed unless specified or authorised in writing by the engineer. All joints in LV cables shall be made either by means of compound filled boxes according to the best established practice by competent cable jointers using first class materials or by means of approved epoxy-resin pressure type jointing kits such as "Scotchcast". Epoxy resin joints must be made entirely in accordance with the manufacturer's instructions and with materials stipulated in such instructions. The electrical contractor will issue the engineer with a copy of the jointing instructions associated with each type of termination or straight through joint, being installed on site. Low voltage PVC cables are to be made off with sealing glands and materials designed for this purpose which must be of an approved make. Where cables are cut and not immediately made off, the ends are to be sealed immediately.

4.1.18 LV Cable Glands

4.1.18.1 All cable glands shall be rated at IP 65 with corrosion guard and shall conform to SANS 1213. Type: Pratley, CCG or equal and approved.

4.1.19 Cable Tests

4.1.19.1 All equipment required to carry out MV and LV tests on cables and switchgear shall be provided by the contractor. All MV cable and switchgear tests must be witnessed by the engineer and recorded by the contractor. Where cabling has been installed in the form a ring main, the contractor shall ensure by testing that there is no cross-over of phases which would result in a phase to phase fault in the event of the ring being operated in the closed position. Phase to phase sticks will be required for this test. Phase to phase tests shall be proved by the contractor before closing the 11kv ring. All MV paper

cable and accessories shall be tested in accordance with IEC 6005-1 table 3. AC pressure test equipment will be required for this purpose.

4.1.19.2 Each section of laid and jointed LV cable shall be tested in accordance with SANS 1507. The insulation resistance shall be measured with a 1000-volt insulation tester and the readings shall be tabulated and certified. Similarly, the earth continuity resistance of each section of cable shall be measured and recorded. All low voltage cables must be tested on site before final terminations after installation of cable glands, in the presence of engineer. All test results must be submitted to the engineer.

4.1.19.3 Tests on completion of the installation and jointing of the various cables shall be carried out on site in the presence of the engineer and the test results properly recorded and submitted in triplicate.

4.1.19.4 On each completed section of laid and jointed cable, the insulation resistance shall be tested in accordance with specification for testing included elsewhere in this document. The cables must be adequately supported at intervals during the whole operation. Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after drawing in of the cables;

4.1.20 Cable Route Markers

4.1.20.1 The contractor shall install cable markers to mark the MV cable route. These markers shall be of the concrete type with an aluminium plate as per the detail on the MV layout drawing. The following characteristics of the MV cable route shall be marked:

- Bends;
- Cable diversions;
- Joints (Joints shall only be allowed when the cable run is longer than the drum length approx. 300M);
- Road Crossings;
- Straight run every 50m

4.1.21 Cable Sleeves

4.1.21.1 Sleeves which are not currently installed will be installed by the electrical contractor. It shall be the responsibility of the electrical contractor to ensure that all the sleeves are correctly installed. All electrical sleeves across roads and paved areas will be uPVC150mm nom. Diameter;

4.1.21.2 Before backfilling each end of all sleeves entering buildings or substations shall be sealed with “Pratliperl” to prevent ingress of vermin and prevent the cable sleeve from acting as a storm water or ground water drainage system.

5. STANDARD TECHNICAL SPECIFICATION FOR: 11 kV FIXED PATTERN SWITCHGEAR PANELS AND RING MAIN UNITS

5.1 SCOPE

5.1.1 To manufacture, supply, delivery, off-loading, assembly and commissioning for fixed pattern (non-withdrawable), assembled metal-enclosed switchgear for rated voltages of 12 kV for indoor installation together with the installation of the medium voltage cable terminations at the Southern Wastewater Treatment Works in Durban, KZN.

5.2 SPECIFICATION

5.2.1 This specification details the manufacture, supply, delivery, off-loading, assembly and commissioning for fixed pattern (non-withdrawable), assembled metal-enclosed switchgear for rated voltages of 12 kV for indoor installation. This includes the supply, delivery and installation of cable terminations onto the switchgear as well as automation functionality. Enclosures may include fixed and/or removable components.

5.3 REQUIREMENTS

5.3.1 General

The switchgear is a-maintenance free, factory-assembled and type-tested medium-voltage switchgear.

It is three-pole metal-enclosed and SF_6-insulated.

Following variants are available.

- Circuit breaker feeder
- Cable feeder
- Bus metering and Bus Earth feeder, and
- Bus coupler feeder (with Bus PT and without Bus PT)

Depth and the height of all these panel types are identical. Circuit breaker, cable connection & bus metering panels have a width of 500 mm and bus coupler panel has width of 1000 mm.

The centre piece of the switchgear consists of hermetically welded containers made of corrosion-resistant stainless steel, accommodating the primary devices (circuit-breaker and three-position disconnector).

The switchgear is sealed for life. The individual panels are interconnected by solid insulated busbars outside the gas compartments; hence gas work is not required, neither for installation at site nor for extension of the switchgear.

The operating mechanisms of the vacuum circuit-breaker and the three-position disconnector are located outside the gas compartment and are therefore accessible at any time. The operating mechanisms are maintenance-free.

Current transformers and voltage transformers are located outside the gas compartment.

Cables entry is from bottom and is accessible from front as well as rear. They are arranged at one level back-to-back and at a user-friendly mounting height.

Service life of switchgear is 25 years.

5.3.2 Panel Design

A switch panel consists of the following functional components:

- Busbar compartment with solid insulated busbar connections.

- Switchgear vessel with vacuum circuit-breaker and three-position disconnector
- Cable compartment
- Low-voltage compartment
- Panel enclosure

The switchgear vessel made of high grade non-magnetic stainless steel is welded and meets the requirements of a sealed pressure system.

Panels are interconnected by the bolted busbar.

Cables are connected with outside-cone system. A floor cover closes the panel at the bottom.

Switchgear is tested for internal arc classification IAC AFLR for 1sec as specified in IEC 62271-200.

In case of internal faults, pressure is released from the top through a rear duct. The top cover contains expanded metallic sheet to cool down the hot gases.

Switchgear is provided for wall-standing or free-standing arrangement.

The degree of protection is IP67 for live parts of the primary circuit, and IP4X for the switchgear enclosure.

The switchgear enclosure is powder-coated with highly resistant epoxy resin in the colour "RAL 7032"

5.3.3 Switchgear Vessel

The switchgear vessel made of hermetically welded stainless steel accommodates the active, live parts of the switchgear:

- Vacuum interrupters
- Three-position disconnector
- Bushings of outside cone

The rated pressure of the SF_6 gas in the vessel is 150 kPa (absolute).

Gas density is monitored with manometer / Ready for Service Indicator.

Gas leakage rate is < 0.1% per year.

5.3.4 Switching Devices

5.3.4.1 Circuit-Breaker

The vacuum interrupters are operated linearly from the outside mechanism. They are operated by the outside mechanism through hermetically sealed rotary bushings which are welded to the tank.

The operating mechanism is available in the following versions:

- Manual operating stored-energy spring mechanism
- Motor operating stored-energy spring mechanism

The maintenance-free operating mechanism has the following equipment features:

- ''Trip-free'' according to IEC 62271-100
- Auxiliary switch contacts for control and signalling
- Operations counter
- Circuit-breaker tripping signal through Relay
- Closing solenoid

- Releases equipped according to typical
- 'Spring charged' indication
- Mechanical position indicator
- Mechanical OFF pushbutton
- Mechanical ON pushbutton (option depending on the type of operating mechanism)

In all circuit-breaker panels, the feeder is make-proof earthed by closing the circuit-breaker additionally.

Endurance class of circuit-breaker:

Function	Class	Standard	Property of Switchgear
BREAKING	M2	IEC 62271-100	10,000 x mechanically without maintenance
	E2 (With Non Auto-reclosive) E1 (With Auto-reclosive)	IEC 62271-100 IEC 62271-100	10,000 x. rated normal current without maintenance 2,000 x rated normal current without maintenance 20 x rated short-circuit breaking current without maintenance
	C2	IEC 62271-100	Very low probability of restrikes

5.3.4.2 Three-Position Disconnector

In circuit-breaker, the three-position disconnector fulfils the functions DISCONNECTING and, in combination with the circuit-breaker, make-proof EARTHING.

The primary part is welded in the switchgear vessel.

The operating mechanism is located outside the switchgear vessel.

Endurance class of three-position disconnector:

Function	Class	Standard	Property of Switchgear
DISCONNECTING	M1	IEC 62271-102	2,000 x mechanically without maintenance
READY-TO-GROUND			2,000 x mechanically without maintenance
EARTHING	E2	IEC 62271-102 & IEC 62271-200	5 x rated short-circuit making current Ima through CB without maintenance

The operating mechanism of the three-position disconnector is available in the following versions:

- Manual operating mechanism for DISCONNECTING and EARTHING functions
- Motor operating mechanism for DISCONNECTING function, manual operating mechanism for EARTHING function

The operating mechanism of the three-position disconnector has the following equipment features:

- Auxiliary switch contacts, disconnector: 2 changeover, 1 NO, 1 NC for free use
- Auxiliary switch contacts, earthing switch: 2 changeover, 1 NO, 1 NC for free use

5.3.5 Interlocks

In switchgear, the circuit-breakers and three-position disconnectors are mechanically interlocked between each other.

Interlocking conditions:

- Operation of the three-position disconnector cannot be selected as long as the circuit-breaker is closed.
- When "operation of three-position disconnector" is selected, the circuit-breaker is blocked against closing.
- Selecting "disconnector function" or "earthing switch function", the operating shaft entry will be restricted for the associated switching operation.
- The operating lever cannot be removed until the switching operation has been completed.
- The circuit-breaker cannot be operated until the operating lever of the three-position disconnector has been removed and the control gate is moved to the center position.
- Feeder earthing (three-position disconnector to EARTH and circuit-breaker CLOSED) is secured against "de-earthing" (by a padlock).
- Electrical connections to releases are disabled when the three-position disconnector is switched to EARTHED.
- The cable compartment cover can only be removed if the panel is earthed.

5.3.6 Cable Connection

The cable compartment is accessible from the front & tool-based rear for cable connections.

In the circuit-breaker panel, the three phases are arranged back-to-back with termination height of 630 mm and 785mm for cable connection panel

It is possible to connect up to 3R x 1C x 630 Sq. Mm cable per phase to bushing type.

The bushings are designed as outside-cone system according to DIN EN 50181 Type C.

5.3.7 Instrument Transformers

5.3.7.1 Current Transformers

Current transformers are designed as ring-core transformers. They are fitted outside the vessels at earth potential, i.e. without dielectric stress.

In the cable connection area, the current transformers are fitted around the bushings above cable termination point.

Their burden must be adjusted to the measuring instruments and digital protection equipment available.

Ratio, rating and accuracy can be adjusted to the respective requirements.

5.3.7.2 Voltage Transformers

In circuit-breaker panels, it shall be possible to connect voltage transformers at cable compartment. It is a single pole design. Line VT can be accommodated in cable compartment and bus VT can be accommodated in sectionalizer panel or separate panel.

5.3.8 Busbar

The busbar is located outside the SF_6 compartment in a metal enclosure. It is plugged onto the switchgear vessels from above and screwed tight.

The busbar itself is made of round-bar copper, the length of which depends on the panel width. Due to the solid insulating sleeve on the busbar system, the arrangement is independent of environmental influences such as condensation and pollution. Also the busbar joints are covered with high quality EPDM shroud.

The busbars are flat at ends, making it easy for extension in future for any switchgears.

5.3.9 Switchgear Enclosure

The internal arc classified switchgear enclosure consists of the following assemblies:

- Three-part panel front
- Floor cover in cable compartment
- Rear wall with gas flow path and top explosion provision
- Busbar cover with integrated expanded metallic sheet to reduce the pressure and cool down the hot gases

5.3.10 Earthing

5.3.10.1 Feeder earthing

- Circuit-breaker panels

Feeders are make-proof earthed by switching in two steps:

1. Switch the three-position disconnector to the READY-TO-EARTH position
2. Close the associated circuit-breaker.

5.3.10.2 Busbar earthing through Bus Coupler Panel

- Section 1 earthing

1. Switch the Section 2 three-position disconnector to the READY-TO-EARTH position
2. Close the circuit-breaker of bus coupler panel / sectionalizer.

- Section 2 earthing

1. Switch the Section 1 three-position disconnector to the READY-TO-EARTH position
2. Close the circuit-breaker of bus coupler panel / sectionalizer.

5.3.11 Capacitive Voltage Detecting System

Capacitive layers are integrated in the bushings.

Capacitive voltage detection is performed with an LRM socket module (LRM = low resistance modified). In this LRM socket module, fixed voltage indicators are mounted to verify safe isolation from supply phase by phase.

5.3.12 Low-Voltage Compartment

Low-voltage compartments are located at the front and are removable.

The secondary devices (associated protection, measuring and control devices) are mounted in the low-voltage compartment on a rear mounting plate or a DIN-rail system. Signalling devices can be integrated in the door of the low-voltage compartment.

The electrical connections to the primary part and from panel to panel are made via flexible wire harnesses with plug connectors.

General bus wires are laid in a separate connection duct located at the top.

Internal panel wires are laid in metal-clad wiring ducts. These are located on the left and right side in the front part of the switchgear enclosure and are accessible from the cable compartment resp.

The right-side wiring duct accommodates the internal panel wiring. Customer-specific control cables can be routed to the low-voltage compartment through the left-side wiring duct. External control cables are inserted from below on the left side of the panel through a cut out in the panel base.

Rating plate of the panel, fixed on the inside of the LV door, in English language.

5.3.13 Operational Reliability

Consistent hermetically welded enclosure excludes any external influence on the primary part.

Due to the welded stainless-steel enclosures, loss of SF_6 gas is impossible.

Long-time proven components like welded-in ROTARY bushings and the Siemens vacuum switching technology are integrated in this innovative global concept.

5.3.14 Personal Safety

Internal enclosure of components, internal arc resistant design and a complete interlocking concept – to provide the maximum degree of personnel safety.

5.3.15 Climatic and Environmental Independence

Hermetically welded stainless-steel enclosure make the switchgear insensitive to any environmental influences. The primary part is therefore consistently protected against external influences such as humidity, pollution, dust, aggressive gas, small animals, etc.

5.3.16 Compactness

SF_6 insulation enables very compact dimensions, offering at the same time a high switchgear performance. This provides an economical utilization of surface and space, especially in cities and conurbation, both for existing set up and for new buildings.

5.3.17 Maintenance-Free Design

The offered switchgear is maintenance-free for life due to the following features:

- Hermetically welded stainless-steel enclosure, with maintenance-free vacuum switching technology and maintenance-free three-position switches,
- Maintenance-free operating mechanisms for circuit-breakers and three-position switches,
- No need to check the gas quantity and quality due to the welded stainless-steel enclosures.
- Under high pollution and extreme climates, a visual check of air insulated area (outside the vessel) is suggested.

5.3.18 Ergonomic Design

The switchgear stands out for a user-friendly and functional industrial design. All switching devices are operated from the switchgear front. Control elements and indicators are located at an ergonomic height and are optimally integrated in the overall design.

5.3.19 Installation Friendliness

Switchgear installation and extension as well as panel replacement is done without SF6 gas work.

The switchgear can be installed without special tools and instruments.

Busbar interconnection from panel to panel is made through bolted busbar units.

5.3.20 Documentation

The medium-voltage switchgear must be documented with a CAE system according to IEC 60617.

Drawings to be provided: Circuit diagrams, terminal diagrams, schematic diagrams, front views, constructional data and a single-line diagram.

The complete design diagrams must be submitted for inspection and approval before start of manufacture and assembly. Switchgear manufacture may only be started on the basis of released diagrams.

The documentation must be submitted in printed form in A4 format and as pdf file. The final revision must be supplied additionally on data carriers in dxf/dwg format.

Operating instructions

Operating instructions concerning transport, installation, connection and commissioning, maintenance and disposal are part of the scope of supply of the switchgear.

Offer documentation

The following must be enclosed with the offer:

- One front view drawing per switchgear assembly
- Arrangement and floor cutout diagram per switchgear assembly
- Technical data sheet
- Product publications

Order documentation

The following documents are part of the scope of supply:

- Circuit diagrams
- Operating instructions
- Front view
- Arrangement and floor cutout plan

Texts included in circuit diagrams, front views, etc. will be in English as standard. Texts in other languages and customized headers are possible.

5.3.21 Products

5.3.21.1 Main features of the switchgear

The switchgear shall have the following design features:

- Medium-voltage part maintenance-free
- Independent of environmental influences
- No gas work required on site
- Three-phase, hermetically sealed switchgear vessel per panel, made of stainless steel, welded without seals

- Switchgear design with panel-type construction
- Silicone-insulated busbar, bolted outside the gas-filled switchgear vessel
- Use of vacuum circuit-breakers
- Constant insulating properties of the gas, independent of the service life
- Use of ring-core current transformers outside the enclosure (free of dielectric stress)
- Voltage transformers are inductive, metal-coated transformers; the design shall be of the plug-in type, disconnectable at the feeder; they have to be designed for higher voltage stress; when mounted on the busbar, for 80% of the rated power-frequency test voltage according to their voltage ratings and rated frequency; connection of secondary leads of voltage transformers with protection against polarity reversal via plug-in housing at the voltage transformer or plug connector wired to low-voltage terminal in the low-voltage compartment
- Measuring sensors according to IEC 60044 / 61869-10 for current and voltage detection
- Operating mechanisms must be arranged outside the switchgear vessel
- Maximum reliability and personal safety are requested
- Small type of construction and panel dimensions as small as possible due to gas-insulated design

A removable low-voltage compartment is always to be provided in the switchgear. The bus wires shall be pluggable from panel to panel.

The complete switchgear has to be designed according to the standards of the local power supply company, eThekwini Electricity.

Sustainability requirements:

- Compact design and thus efficient use of switchgear rooms
- Highest supply security due to maintenance-free switchgear
- Ensuring personal safety through encapsulation, earthing, interlocking, etc.
- Service life of at least 35 years under normal operation conditions
- Possibility of proper and environmentally friendly disposal
- SF6 can be evacuated and reused
- Environmental product declaration according to ISO 14021, based on a full-scale lifecycle assessment (LCA) study according to ISO 14040/44

5.3.21.2 Communication-capable switchgear

The switchgear shall be prepared for a superior substation control and protection system.

All signals, switch positions, current and voltage values have to be wired to a terminal strip or connected to the control and protection system via the multifunction protection relay with RS485 interface and/or Ethernet interface.

5.3.21.3 Earthquake-resistant design of the switchgear

Earthquake qualification testing is carried out in accordance with the following standards:

- IEC 60068-3-3 "Guidance – seismic test methods for equipment"
- IEC 60068-2-57 "Test Ff: Vibration – Time-history method"
- IEC 60068-2-59 "Test Fe: Vibration – Sine-beat method"

- IEEE 693-2005 "Recommended Practice for Seismic Design of Substations".

For installation on even and rigid concrete or steel structure (without considering building influences), the tested ground accelerations meet the following requirements:

- Uniform Building Code 1997 (UBC) – Zone 4
- California Building Code 1998 (CBC) – Zone 4
- IEEE 693-2005 – High required response spectrum (Figure A.1).

5.3.21.4 General technical requirements

The specified switchgear is a factory-assembled, type-tested, 3-pole metal-enclosed, gas-insulated medium-voltage switchgear in panel-type construction.

The switchgear must be available as single-busbar switchgear and as double-busbar switchgear, and it must be possible to combine it at will.

The following panel types must be available as single-busbar switchgear up to a maximum rated operating current for the busbar of 2500 A:

- Circuit-breaker panel with vacuum circuit-breaker
- Bus sectionalizer with vacuum circuit-breaker
- Circuit-breaker panel of bus sectionalizer
- Disconnector panel of bus sectionalizer
- Switch-disconnector panel with HV HRC fuse combination
- Ring-main panel as switch-disconnector panel without HV HRC fuse combination
- Disconnector panel
- Switch-disconnector panel
- Contactor panel with HV HRC fuse combination
- Metering panel
- Air-insulated transfer metering panel
- Auxiliary transformer panel
- Dummy panel

The panel depth shall be identical regardless of the rated current.

The panel design shall include the following functional modules:

- Busbar compartment with 1-pole insulated, screened, plug-in and bolted busbar
- Switchgear vessels with vacuum circuit-breakers and three-position switches
- Cable compartment with pressure-resistant floor cover
- Pressure relief duct upwards with integrated absorbers, optionally additional horizontal pressure relief duct
- Low-voltage compartment
- Panel enclosure

The complete switchgear has to be designed safe-to-touch, including the busbar and cable compartments.

Moreover, the switchgear has to be conceived in such a way that gas work is neither required during installation, extension or panel replacement, nor throughout the service life of the switchgear.

The individual panels shall be interconnected by bolted, silicone-insulated, screened busbars outside the gas-filled switchgear vessel. The busbar connection shall be bolted tight with a defined tightening torque. The busbar shall be located in a metal-enclosed compartment, and the switchgear must be extensible at both ends of the busbar without gas work.

The vacuum circuit-breaker, the vacuum contactor, as well as the switch-disconnector or disconnector designed as a three-position switch for "CLOSED" - "OPEN" - "READY-TO-EARTH / EARTHED", must be maintenance-free as switching elements including operating mechanism.

The switching devices have to be installed in the switchgear vessel independently of climate and environment.

Operation of the switching devices shall take place via gas-tight metal bellows or rotary bushings welded-in without seals.

The gas-filled vessel must be made of corrosion-resistant stainless steel. Insulation of live parts against the earthed enclosure is provided by the insulating gas.

The cable connections of the 3 phases shall be arranged at the same level, horizontally side-by-side, and be easily accessible from the front. Cables must be connected from the front.

A metallic wiring duct for the control cables shall be provided on the left side of the panel.

The switchgear panels have to be equipped with cable brackets adjustable in height and depth.

The switchgear has to be resistant to internal arc faults according to IEC 62271-200 for short-circuit currents up to a maximum of 31.5 kA (3 sec).

5.3.21.5 Interlocks

Standard interlocks must generally be implemented within the switchgear:

- Three-position disconnector against circuit-breaker (mechanically)
- Disconnector against earthing switch within the three-position switch (mechanically)
- Locking device at the circuit-breaker
- Locking device at the three-position switch
- Interlock between three-position switch and vacuum contactor (electrically)
- Release of circuit-breaker locking device only with "feeder earthed"
- Blocking of undervoltage release at the circuit-breaker

5.3.21.6 Description of medium-voltage part

The medium-voltage part must be maintenance-free and independent of environmental influences.

The switchgear shall be resistant to internal arc faults.

All switching devices are to be operated from the panel front. It shall be possible to control the vacuum circuit-breakers from remote according to their design.

All medium-voltage components of the switchgear must be enclosed hermetically and safe to touch.

Capacitive voltage taps (capacitive voltage dividers) in the bushings to the cable feeder shall enable the verification of safe isolation from supply at the panel front without danger. The degree of protection of the switchgear must not be reduced thereby.

5.3.21.7 Description of switchgear vessel / gas compartment

The hermetically welded gas vessel must have its own pressure relief to the rear and upwards to prevent uncontrolled bursting of the switchgear vessel in case of internal arcing.

The manufacturer must guarantee sufficient pressure reserve between the pickup pressure of the pressure relief devices and the bursting pressure of the vessels.

Specifications for the gas tightness:

The gas compartment must feature a high tightness. The maximum leakage rate shall be less than 0.1 % per year.

The filling pressure must be selected to enable 35 years of operation as a minimum.

The hermetically welded gas compartment vessels shall be designed without refilling device or without valves according to the VDE or IEC classification (sealed pressure systems).

All bushings for electrical and mechanical connections must be welded gas-tight to exclude refilling of insulating gas.

The pressure indication (monitoring) of the insulating gas shall be performed with pressure measurement boxes inside the gas compartment. Complete temperature compensation has to be ensured in this way.

A possible pressure drop shall be indicated outside the gas compartment via coupling magnets, without sealing elements, by means of a ready-for-service indication.

The pressure indication must be independent of the site altitude.

5.3.21.8 IEC standards and specifications

In the following, reference is preferably made to national and international standards. The specifications mentioned there must be fully complied with. The associated verifications must be submitted with the offer.

The switchgear manufacturer has to run and furnish evidence of a certified quality management system according to EN/ISO 9001 and a certified environmental management system according to EN/ISO 14001.

Switchgear	IEC / EN standard	VDE standard
	62271-1	671-1
	62271-200	0671-200
Switching devices	62271-100	0671-100
	62271-102	0671-102
	60265-1	0670-301
	60470	0670-501
	62271-105	0671-105
	62271-304	0671-304
Voltage detecting systems	62271-213	0671-213 (Draft)
Measuring sensors	60044 / 61869-10	
HV HRC fuses	60282	0670-4
	60787	0670-402
Surge arresters	60099	0675

Degree of protection	60529	0470-1
	62262	0470-100
Insulation	60071	0111
Instrument transformers	61869-1	0414-9-1
	61869-2	0414-9-2
	61869-3	0414-9-3
SF6 Insulating gas	60376	0373-1
	62271-4	0671-4 (Draft)
Installation	61936-1	0101
Operation	EN 50110	0105-100

The switchgear must conform to the classifications according to IEC 62271-200.

Partition class: PM

Loss of service continuity category:

- Feeder panels with HV HRC fuses: LSC 2
- Feeder panels without HV HRC fuses: LSC 2

Type of accessibility A

- F Front
- L Lateral
- R Rear (for free-standing arrangement)

5.3.21.9 GOST standards and specifications

In the following, reference is preferably made to national and international standards. The specifications mentioned there must be fully complied with. The associated verifications must be submitted with the offer.

The switchgear manufacturer has to run and furnish evidence of a certified quality management system according to EN/ISO 9001 and a certified environmental management system according to EN/ISO 14001.

Switchgear	IEC / EN standard	GOST standard
	62271-1	12.2.007.0-75
	62271-200	14693-90
Switching devices	62271-100	52565-2006
	62271-102	52726-2007
	60265-1	_____
	602470	_____
	62271-105	_____
	62271-304	_____

Voltage detecting systems	62271-213	_____
Measuring sensors	60044 / 61869-10	
HV HRC fuses	60282	_____
	60787	_____
Surge arresters	60099	_____
Degree of protection	60529	14254-96
	62262	_____
Insulation	60071	_____
Instrument transformers	61869-1	_____
	61869-2	_____
	61869-3	IEC 61869-3-2012
SF6	60376	_____
Insulating gas	62271-4	_____
Installation	61936-1	_____
Operation	EN 50110	_____

The switchgear must conform to the classifications according to IEC 62271-200.

Partition class: PM

Loss of service continuity category:

- Feeder panels with HV HRC fuses: LSC 2
- Feeder panels without HV HRC fuses: LSC 2

Type of accessibility A

- F Front
- L Lateral
- R Rear (for free-standing arrangement)

5.3.21.10 GB standards and specifications

In the following, reference is preferably made to national and international standards. The specifications mentioned there must be fully complied with. The associated verifications must be submitted with the offer.

The switchgear manufacturer has to run and furnish evidence of a certified quality management system according to EN/ISO 9001 and a certified environmental management system according to EN/ISO 14001.

Switchgear	IEC / EN standard	GB standard
	62271-1	GB / T 11022
	62271-200	GB 3906

Switching devices	62271-100	GB 1984
	62271-102	GB 1985
	60265-1	_____
	60470	_____
	62271-105	_____
	62271-304	_____
Voltage detecting systems	62271-213	DL / T 538-2006
	(according to IEC 61958–2008, similar to Chinese standard)	
Measuring sensors	60044 / 61869-10	
HV HRC fuses	60282	GB 15166.2
	60787	_____
Surge arresters	60099	_____
Degree of protection	60529	GB 4208
	62262	_____
Insulation	60071	GB / T 311.2
Instrument transformers	61869-1	61869-1
	61869-2	_____
	61869-3	IEC 61869-3-2012
SF6	60376	GB 1208
Insulating gas	62271-4	_____
Installation	61936-1	GB 1207
Operation	EN 50110	0105-100

The switchgear must conform to the classifications according to IEC 62271-200.

Partition class: PM

Loss of service continuity category:

- Feeder panels with HV HRC fuses: LSC 2
- Feeder panels without HV HRC fuses: LSC 2

Type of accessibility A

- F Front
- L Lateral
- R Rear (for free-standing arrangement)

5.3.21.11 CSA standards and specifications

In the following, reference is preferably made to national and international standards. The

specifications mentioned there must be fully complied with. The associated verifications must be submitted with the offer.

The switchgear manufacturer has to run and furnish evidence of a certified quality management system according to EN/ISO 9001 and a certified environmental management system according to EN/ISO 14001.

Switchgear	IEC / EN standard	CSA standard
	62271-1	_____
	62271-200	_____
Switching devices	62271-100	_____
	62271-102	_____
	60265-1	_____
	60470	_____
	62271-105	_____
	62271-304	_____
Voltage detecting systems	62271-213	_____
HV HRC fuses	60282	_____
	60787	_____
Surge arresters	60099	_____
Degree of protection	60529	_____
	62262	_____
Insulation	60071	_____
Instrument transformers	61869-1	_____
	61869-2	_____
	61869-3	_____
SF6	60376	_____
Insulating gas	62271-4	_____
Installation	61936-1	_____
Operation	EN 50110	_____

The switchgear must conform to the classifications according to IEC 62271-200.

Partition class: PM

Loss of service continuity category:

- Feeder panels with HV HRC fuses: LSC 2
- Feeder panels without HV HRC fuses: LSC 2

Type of accessibility A

- F Front
- L Lateral
- R Rear (for free-standing arrangement)

5.3.21.12 General technical stipulations 7.2 kV, IEC

The switchgear must at least meet the following technical data:

Rated voltage Ur: 7.2 kV

Operating voltage UB: O 3.3 kV

O 3.6 kV

O 4 kV

O 4.16 kV

O 4.2 kV

O 4.8 kV

O 5 kV

O 5.5 kV

X 6 kV

O 6.24 kV

O 6.3 kV

O 6.6 kV

O 6.9 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

20 kV

Rated lightning impulse withstand voltage Up:

60 kV

Rated short-time withstand current Ik:

O 20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.13 General technical stipulations 12 kV, IEC

The switchgear must at least meet the following technical data:

Rated voltage Ur: 12 kV

Operating voltage UB: O 7.2 kV

O 7.6 kV

O 8 kV

O 8.3 kV

O 8.4 kV

O 8.9 kV

X 10 kV

O 10.5 kV

O 11 kV

O 11.4 kV

O 11.5 kV

O 11.6 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

28 kV

Rated lightning impulse withstand voltage Up:

75 kV

Rated short-time withstand current Ik:

O 20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.14 General technical stipulations 15 kV, IEC

The switchgear must at least meet the following technical data:

Rated voltage Ur: 15 kV

Operating voltage UB: O 12 kV

O 12.4 kV

O 12.47 kV

O 12.5 kV

O 12.8 kV

O 13.2 kV

O 13.4 kV

X 13.8 kV

O 14.4 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

36 kV

Rated lightning impulse withstand voltage Up:

95 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.15 General technical stipulations 17.5 kV, IEC

The switchgear must at least meet the following technical data:

Rated voltage Ur: 17.5 kV

Operating voltage UB: O 15 kV

15.8 kV

X 16 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

38 kV

Rated lightning impulse withstand voltage Up:

95 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 25 kA 1s

For free-standing arrangement: IAC A FLR up to 25 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.16 General technical stipulations 24 kV, IEC

The switchgear must at least meet the following technical data:

Rated voltage Ur: 24 kV

Operating voltage UB: O 17.5 kV

O 18 kV

O 19 kV

X 20 kV

O 22 kV

O 22.9 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

50 kV

Rated lightning impulse withstand voltage Up:

125 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 25 kA 1s

For free-standing arrangement: IAC A FLR up to 25 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.17 General technical stipulations 36 kV, IEC

The switchgear must at least meet the following technical data:

Rated voltage Ur: 36 kV

Operating voltage UB: O 23.0 kV

O 24 kV

O 24.94 kV

X 25 kV

O 25.8 kV

O 26 kV

O 26.4 kV

O 27.6 kV

O 29.4 kV

O 30 kV

O 31.5 kV

O 33 kV

O 34.5 kV

O 35 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

1250 A

Rated short-duration power-frequency withstand voltage Ud:

70 kV

Rated lightning impulse withstand voltage Up:

170 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 25 kA 1s

For free-standing arrangement: IAC A FLR up to 25 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.18 General technical stipulations 38 kV, IEC

The switchgear must at least meet the following technical data:

Rated voltage Ur: 38 kV

Operating voltage UB: O 23.0 kV

O 24 kV

O 24.94 kV

X 25 kV

O 25.8 kV

O 26 kV

O 26.4 kV

O 27.6 kV

O 29.4 kV

O 30 kV

O 31.5 kV

O 33 kV

O 34.5 kV

O 35 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

1250 A

Rated short-duration power-frequency withstand voltage Ud:

70 kV

Rated lightning impulse withstand voltage Up:

150 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 25 kA 1s

For free-standing arrangement: IAC A FLR up to 25 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.19 General technical stipulations 7.2 kV, GOST

The switchgear must at least meet the following technical data:

Rated voltage Ur: 7.2 kV

Operating voltage UB: X 6 kV

O 6.3 kV

O 6.6 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

32 kV

Rated lightning impulse withstand voltage Up:

60 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.20 General technical stipulations 12 kV, GOST

The switchgear must at least meet the following technical data:

Rated voltage Ur: 12 kV

Operating voltage UB: X 10 kV

O 10.5 kV

O 11 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

42 kV

Rated lightning impulse withstand voltage Up:

75 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.21 General technical stipulations 24 kV, GOST

The switchgear must at least meet the following technical data:

Rated voltage Ur: 24 kV

Operating voltage UB: O 18 kV

X 20 kV

O 22 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

50 kV

Rated lightning impulse withstand voltage Up:

125 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 25 kA 1s

For free-standing arrangement: IAC A FLR up to 25 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.22 General technical stipulations 7.2 kV, GB

The switchgear must at least meet the following technical data:

Rated voltage Ur: 7.2 kV

Operating voltage UB: X 6 kV

O 6.3 kV

O 6.6 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

30 kV

Rated lightning impulse withstand voltage Up:

60 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.23 General technical stipulations 12 kV, GB

The switchgear must at least meet the following technical data:

Rated voltage Ur: 12 kV

Operating voltage UB: X 10 kV

O 10.5 kV

O 11 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

42 kV

Rated lightning impulse withstand voltage Up:

75 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.24 General technical stipulations 4.76 kV, CSA

The switchgear must at least meet the following technical data:

Rated voltage Ur: 4.76 kV

Operating voltage UB: X 4.16 kV

O 4.2 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

19 kV

Rated lightning impulse withstand voltage Up:

60 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.25 General technical stipulations 8.25 kV, CSA

The switchgear must at least meet the following technical data:

Rated voltage Ur: 8.25 kV

Operating voltage UB: O 4.8 kV

O 5.5 kV

X 6 kV

O 7.2 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

26 kV

Rated lightning impulse withstand voltage Up:

75 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.26 General technical stipulations 15 kV, CSA

The switchgear must at least meet the following technical data:

Rated voltage Ur: 15 kV

Operating voltage UB: O 11 kV

O 12 kV

O 12.47 kV

O 12.5 kV

O 13.2 kV

X 13.8 kV

O 14.4 kV

Rated frequency fr: X 50 Hz

O 60 Hz

Rated continuous current of the busbar:

X 1250 A

O 1600 A

O 2000 A

O 2500 A

Rated short-duration power-frequency withstand voltage Ud:

36 kV

Rated lightning impulse withstand voltage Up:

95 kV

Rated short-time withstand current Ik:

20/1 kA/s

O 20/3 kA/s

X 25/1 kA/s

O 31.5/1 kA/s

O 31.5/3 kA/s

Ambient air temperature (24-h mean):

O 25 °C

O 30 °C

X 35 °C

O 40 °C

O 45 °C

O 50 °C

O 55 °C

Installation of the switchgear:

X Wall-standing arrangement

O Free-standing arrangement

Pressure relief duct: X rear

O rear and horizontal

Internal arc classification:

For wall-standing arrangement: IAC A FL up to 31.5 kA 1s

For free-standing arrangement: IAC A FLR up to 31.5 kA 1s

Communication-capable secondary devices:

O yes

X no

Selectable auxiliary and control voltages: 24/48/60/110/220 V DC, 110/230 V AC

Color: RAL 7035 (light gray)

5.3.21.27 Three-position switch-disconnector up to 17.5 kV

		Stipulation	Offer
Make:			_____
Rated current:		630 A	
Rated short-time withstand current Ik:			
		up to 25 kA	
Class and number of operating cycles:			
Class n			
Disconnecting	M1	(CLOSE/OPEN) acc.to IEC 62271-102	
		2000 times mechanically without maintenance	
Load breaking	M1	(CLOSE/OPEN) acc.to IEC 62271-103	
		1000 times mechanically without maintenance	
	E3	100 times rated mainly active load breaking current I1 without maintenance	
		5 times rated short-circuit making current Ima without maintenance	
Earthing	M0	(CLOSE/EARTHING) acc.to IEC 62271-102	
		1000 times mechanically without maintenance	
	E2	5 times rated short-circuit making current Ima without maintenance	

Test duty 1:

Rated mainly active load breaking current I1:

100 x 630 A _____

Test duty 2a:

Rated closed-loop breaking current I2a:

630 A _____

Test duty 3:

Rated no-load transformer breaking current I3:

40 A _____

Test duty 4a:

Rated cable-charging breaking current I4a:

68 A _____

Test duty 4b:

Rated line-charging breaking current I4b:

68 A _____

Test duty 5:

Rated short-circuit making current Ima:

up to 63 kA _____

Test duty 6a:

Rated earth-fault breaking current I6a:

200 A _____

Test duty 6b:

Rated cable-charging breaking current I6b under earth-fault conditions:

115 A _____

5.3.21.28 Three-position switch-disconnector up to 24 kV

	Stipulation	Offer
Make:		_____
Rated current:	630 A	

Rated short-time withstand current Ik:

up to 20 kA

Class and number of operating cycles:

Class n

Disconnecting	M1	(CLOSE/OPEN) acc.to IEC 62271-102
		2000 times mechanically without maintenance
Load breaking	M1	(CLOSE/OPEN) acc.to IEC 62271-103
		1000 times mechanically without maintenance

	E3	100 times rated mainly active load breaking current I1 without maintenance
		5 times rated short-circuit making current Ima without maintenance
Earthing	M0	(CLOSE/EARTHING) acc.to IEC 62271-102
		1000 times mechanically without maintenance
	E2	5 times rated short-circuit making current Ima without maintenance

Test duty 1:

Rated mainly active load breaking current I1:

100 x 630 A _____

Test duty 2a:

Rated closed-loop breaking current I2a:

630 A _____

Test duty 3:

Rated no-load transformer breaking current I3:

40 A _____

Test duty 4a:

Rated cable-charging breaking current I4a:

68 A _____

Test duty 4b:

Rated line-charging breaking current I4b:

68 A _____

Test duty 5:

Rated short-circuit making current Ima:

up to 50 kA _____

Test duty 6a:

Rated earth-fault breaking current I6a:

200 A _____

Test duty 6b:

Rated cable-charging breaking current I6b under earth-fault conditions:

115 A _____

5.3.21.29 Vacuum circuit-breaker up to 15 kV

Stipulation Offer

Make: _____

Rated short-time withstand current for switchgear with

- tk = 1 s, Ik: up to 31.5 kA
- tk = 3 s, Ik: up to 31.5 kA

Rated short-circuit making current Ima:

up to 90 kA _____

Rated short-circuit breaking current Isc:

up to 31.5 kA _____

Possible rated continuous currents according to definition in the panel.

Class and number of operating cycles:

Class n

M2 10000 times mechanically without maintenance or 30000 times mechanically with maintenance (for details, see panel descriptions)

E2 10000 times rated continuous current without maintenance

50 short-circuit breaking operations without maintenance

C2 very low probability of restrikes

5.3.21.30 Vacuum circuit-breaker up to 24 kV

	Stipulation	Offer
Make:		_____

Rated short-time withstand current for switchgear with

- tk = 1 s, Ik: up to 25 kA
- tk = 3 s, Ik: up to 25 kA

Rated short-circuit making current Ima:

up to 63 kA _____

Rated short-circuit breaking current Isc:

up to 25 kA _____

Possible rated continuous currents according to definition in the panel.

Class and number of operating cycles:

Class n

M2 10000 times mechanically without maintenance or 30000 times mechanically with maintenance (for details, see panel descriptions)

E2 10000 times rated continuous current without maintenance

50 short-circuit breaking operations without maintenance

C2 very low probability of restrikes

5.3.21.31 Vacuum circuit-breaker up to 38 kV

	Stipulation	Offer
Make:		_____

Rated short-time withstand current for switchgear with

- tk = 1 s, Ik: up to 25 kA
- tk = 3 s, Ik: up to 25 kA

Rated short-circuit making current Ima:

up to 63 kA _____

Rated short-circuit breaking current Isc:

up to 25 kA _____

Possible rated continuous currents according to definition in the panel.

Class and number of operating cycles:

Class n

M2 10000 times mechanically without maintenance or 30000 times mechanically with maintenance (for details, see panel descriptions)

E2 10000 times rated continuous current without maintenance

50 short-circuit breaking operations without maintenance

C2 very low probability of restrikes

5.3.21.32 Vacuum contactor up to 15 kV

	Stipulation	Offer
Make:		_____
Rated voltage:	up to 15 kV	
Rated continuous current:	450 A	_____
Rated short-time withstand current of the switchgear Ik:		
	up to 31.5 kA/s	_____
Rated peak withstand current Ip:		
	up to 90 kA	_____
Rated short-circuit making current Ima:		
	up to 90 kA	_____
Rated short-circuit breaking current Isc:		
	up to 90 kA	_____

The following number of operating cycles must be realized without maintenance of the vacuum contactor:

Mechanical:	100000 or 500000	_____
Electrical:	100000 or 500000	_____

Remark: Number of operating cycles 500000 not possible when a mechanical latch is used

5.3.21.33 Vacuum contactor up to 24 kV

	Stipulation	Offer
Make:		_____
Rated voltage:	up to 24 kV	
Rated continuous current:	450 A	_____
Rated short-time withstand current of the switchgear Ik:		
	up to 25 kA/s	_____
Rated peak withstand current Ip:		
	up to 63 kA	_____
Rated short-circuit making current Ima:		
	up to 63 kA	_____
Rated short-circuit breaking current Isc:		
	up to 63 kA	_____

The following number of operating cycles must be realized without maintenance of the vacuum contactor:

Mechanical:	100000 or 500000	_____
Electrical:	100000 or 500000	_____

Remark: Number of operating cycles 500000 not possible when a mechanical latch is used

5.3.21.34 Three-position disconnector up to 15 kV

	Stipulation	Offer
Make:		_____
Rated voltage:	up to 15 kV	

Possible rated continuous currents according to definition in the panel.

Rated short-time withstand current for switchgear with

·	tk = 1 s, Ik:	up to 31.5 kA	_____
·	tk = 3 s, Ik:	up to 31.5 kA	_____

Rated peak withstand current Ip:

	up to 90 kA	_____

Endurance classes according to IEC 62271-102:

The following number of operating cycles must be realized without maintenance of the disconnector:

M1 Disconnecting, mechanically:

	2000 times	_____
M1 Ready-to-earth:	1000 times	_____
E2 Earthing:	50 times	_____

(rated short-circuit making current) by closing the circuit-breaker

5.3.21.35 Three-position disconnector up to 24 kV

	Stipulation	Offer
Make:		_____
Rated voltage:	up to 24 kV	

Possible rated continuous currents according to definition in the panel.

Rated short-time withstand current for switchgear with

·	tk = 1 s, Ik:	up to 25 kA	_____
·	tk = 3 s, Ik:	up to 25 kA	_____

Rated peak withstand current Ip:

	up to 63 kA	_____

Endurance classes according to IEC 62271-102:

The following number of operating cycles must be realized without maintenance of the disconnector:

M1 Disconnecting, mechanically:

	2000 times	_____
M1 Ready-to-earth:	1000 times	_____
E2 Earthing:	50 times	_____

(rated short-circuit making current) by closing the circuit-breaker

5.3.21.36 Three-position disconnector up to 38 kV

	Stipulation	Offer
Make:		_____
Rated voltage:	up to 38 kV	

Possible rated continuous currents according to definition in the panel.

Rated short-time withstand current for switchgear with

·	tk = 1 s Ik:	up to 25 kA	_____
·	tk = 3 s Ik:	up to 25 kA	_____

Rated peak withstand current Ip:

	up to 63 kA	_____

Endurance classes according to IEC 62271-102:

The following number of operating cycles must be realized without maintenance of the disconnector:

M1 Disconnecting, mechanically:

	2000 times	_____
M1 Ready to earth:	1000 times	_____
E2 Earthing:	50 times	_____

(rated short-circuit making current) by closing the circuit-breaker

5.3.21.37 Busbar voltage transformer

Single-pole insulated voltage transformer, plug-in type and metal-coated, for busbar voltage metering.

Designed for 80% of the rated short-duration power-frequency withstand voltage at rated frequency and for repeat test at 80% of the rated short-duration power-frequency withstand voltage with mounted voltage transformer.

Secondary voltage: 100V/root3; 110V/root3; 120V/root3

5.3.21.38 Feeder voltage transformer

Single-pole insulated voltage transformer, plug-in type and metal-coated, for feeder voltage metering.

Switchable through an SF6-insulated disconnecting facility in the switchgear vessel with the switch positions "CLOSED" and "EARTHED".

Operation of the disconnecting facility from outside.

Voltage testing at the switchgear possible with mounted and earthed voltage transformer.

Secondary voltage: 100V/root3; 110V/root3; 120V/root3

5.3.21.39 Busbar current transformer, fixed

Single-pole current transformer, as ring-core transformer for current metering and/or protection tripping at the busbar.

Insulation class: E

Rated continuous thermal current Id: 1.2 x In

Rated secondary current: 1A

5.3.21.40 Feeder current transformer at the panel connection

Single-pole current transformer, as ring-core current transformer for current metering and/or protection tripping at the feeder.

Insulation class: E

Rated continuous thermal current Id: 1.2 x In

Rated secondary current: 1A

5.3.21.41 Surge arrester

Surge arrester pluggable on cable T-plug.

5.3.21.42 Surge limiter

Surge limiter pluggable on cable T-plug when motors with a starting current < 600 A are used.

5.3.21.43 Capacitive voltage detecting system _____

According to 62271-213 or VDE 0671-213 (Draft).

For verification of safe isolation from supply (tapping via capacitive layers in the feeder bushings).

X VDIS system, for plug-in indicator

O VOIS+, integrated indicator, without auxiliary power

O VOIS R+, integrated indicator, with auxiliary power, with signaling relay

O WEGA 1, integrated detecting system, without auxiliary power, integrated repeat test of the interface (self-monitoring)

O WEGA 2, integrated detecting system, with auxiliary power, integrated repeat test of the interface (self-monitoring), with signaling relay

O CAPDIS-S1+, integrated detecting system, without auxiliary power, integrated repeat test of the interface (self-monitoring)

O CAPDIS-S2+, integrated detecting system, with auxiliary power, integrated repeat test of the interface (self-monitoring), adjustable for various voltages (adjustable capacitance C2), with signaling relay

5.3.21.44 Dimensions of the switchgear panels

The panel widths given in the drawings are maximum dimensions and binding. Deviating dimensions must be entered:

Panel widths 630 / 800 / 1000 / 1250 / 1600 A:

450 mm / 600 mm / 900 mm _____

Panel widths 2000 / 2500 A:

900 mm _____

Panel height up to 1250 A:

· without horizontal pressure relief duct,

with low-voltage compartment, height 761 mm

2250 mm _____

· with horizontal pressure relief duct,

and/or with low-voltage compartment,

height 1161 mm 2650 mm _____

Panel height 2000 / 2500 A: 2550 mm _____

Panel depth: 1225 mm _____

Minimum room height required: 2750 mm _____

Width of control aisle for a possible panel replacement:

450 mm and 600mm wide panels:

min. 1400 mm _____

900mm wide panels: min. 1600 mm _____

Total dimensions of the switchgear:

Width (in mm): ____ _____

Height (in mm): ____ _____

Depth (in mm): ____ _____

5.3.21.45 Make stipulation

Manufacturer / type: _____

5.3.21.46 Circuit-breaker panel LS

The circuit-breaker panels must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current of the feeder:

O 630 A

O 800 A

X 1000 A

O 1250 A

O 1600 A

O 2000 A

O 2500 A

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3x single-pole

O with voltage transformers, 3x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10 VA / 0.2

O 10 VA / 0.5

O 10 VA / 1

O 20 VA / 0.2

O 20 VA / 0.5

O 20 VA / 1

O 45 VA / 1

O 60 VA / 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O _____ acc. to description

1 vacuum circuit-breaker

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with maintenance-free operating mechanism as stored-energy spring mechanism,

with motor operating mechanism, with AR capability acc. to VDE / IEC (=O-t-CO-t'-CO),

with mechanical pushbuttons for CLOSING and OPENING,

with auxiliary switch, free contacts: 3NO+4NC,

with mechanical indication and signaling for "closing spring charged" and "circuit-breaker trip",

X with one shunt release (-Y1)

O with two shunt releases (-Y1, -Y2)

O with one shunt release (-Y1) and one undervoltage release (-Y7)

1 three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED - OPEN - READY-TO-EARTH, installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism (panels 630 A up to 1250 A) or spring-operated mechanism (panels 1600 A up to 2500 A) with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch:

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

X 2000/1000/10000

O 5000/5000/30000

O 10000/10000/30000

With capacitive voltage detecting system _____ at the feeder acc. to description.

Current transformers at the feeder:

X without

O 3 current transformers with 1 core

O 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Voltage transformers at the feeder, incl. earthing facility for voltage transformers:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3 x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 10VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 0.2

O 20VA / Cl. 0.5

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Cable connection:

X from front, from bottom

O from rear, from bottom

O from rear, from top

with cable bracket and pre-assembled cable clamp, suitable for connection of cable T-plugs, suitable for outside cone type C

Number of cables per phase:

O 1

X 2

O 3

O 4

O 6

O 8

Zero-sequence current transformer for earth-fault detection:

X without

O with

Zero-sequence current transformer values:

for IEC, GOST, GB:

O 50A / 1A / 1.25VA / Cl. 1 FS 10

O 60A / 1A / 1.25VA / Cl. 1 FS 10

O 100A / 1A / 1.25VA / Cl. 1 FS 10

for CSA:

O 50A / 5A C5

O 100A / 5A C10

O 200A / 5A C10

Surge protection pluggable on cable T-plug:

X without

O with surge arrester

O with surge limiter

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

Protection device 1 according to preliminary description:

O Feeder and overcurrent protection 7SJ82

O Feeder and overcurrent protection 7SJ85

O Motor protection 7SK82

O Motor protection 7SK85

O Generator protection 7UM85

O Differential protection for two-winding transformers 7UT82

O Transformer differential protection 7UT8

O Line differential protection 7SD82

O Distance protection 7SA82

O Voltage and frequency protection 7RW80

O Line differential protection 7SD80

X Time-overcurrent protection 7SJ80

O Motor protection 7SK80

O Time-overcurrent protection 7SR11

O Time-overcurrent protection 7SR12

O Time-overcurrent and earth-fault protection 7SR100

O Motor and generator protection 7SR105

O Current-transformer operated time-overcurrent protection 7SR45

Protection device 2 according to preliminary description:

X without

O Feeder and overcurrent protection 7SJ82

O Feeder and overcurrent protection 7SJ85

O Motor protection 7SK82

O Motor protection 7SK85

O Generator protection 7UM85

O Differential protection for two-winding transformers 7UT82

O Transformer differential protection 7UT8

O Line differential protection 7SD82

O Distance protection 7SA82

O Voltage and frequency protection 7RW80

O Line differential protection 7SD80

X Time-overcurrent protection 7SJ80

O Motor protection 7SK80

O Time-overcurrent protection 7SR11

O Time-overcurrent protection 7SR12

O Time-overcurrent and earth-fault protection 7SR100

O Motor and generator protection 7SR105

O Current-transformer operated time-overcurrent protection 7SR45

5.3.21.47 Disconnector panel TS

The disconnector panels must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current of the feeder:

O 630 A

O 800 A

X 1000 A

O 1250 A

O 1600 A

O 2000 A

O 2500 A

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3 x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 10VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 0.2

O 20VA / Cl. 0.5

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O _____ acc. to description

1 three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED – OPEN – READY-TO-EARTH,

installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism (panels 630 A up to 1250 A) or spring-operated mechanism (panels 1600 A up to 2500 A) with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING

function and manual/motor operating mechanism for READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

2000/1000/-

With capacitive voltage detecting system _____ at the feeder acc. to description.

Current transformers at the feeder:

X without

O 3 current transformers with 1 core

O 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Voltage transformers at the feeder, incl. earthing facility for voltage transformers:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3 x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 20VA / Cl. 0.2

O 10VA / Cl. 0.5

O 20VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Cable connection:

X from front, from bottom

O from rear, from bottom

O from rear, from top

with cable bracket and pre-assembled cable clamp, suitable for connection of cable T-plugs, suitable for outside cone type C

Number of cables per phase:

O 1

X 2

O 3

O 4

O 6

O 8

Zero-sequence current transformer for earth-fault detection:

X without

O with

Zero-sequence current transformer values:

for IEC, GOST, GB:

O 50A / 1A / 1.25VA / Cl. 1 FS 10

O 60A / 1A / 1.25VA / Cl. 1 FS 10

O 100A / 1A / 1.25VA / Cl. 1 FS 10

for CSA:

O 50A / 5A C5

O 100A / 5A C10

O 200A / 5A C10

Surge protection pluggable on cable T-plug:

X without

O with surge arrester

O with surge limiter

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.48 Bus sectionalizer panel LK

The bus sectionalizers must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current:

X 1000 A

O 1250 A

O 1600 A

O 2000 A

O 2500 A

Voltage sensor at the busbar:

1st voltage sensor:

X without

O with (resistor divider)

2nd voltage sensor:

X without

O with (resistor divider)

2 capacitive voltage detecting systems at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O_____ acc. to description

1 vacuum circuit-breaker

Rated continuous current and rated short-time withstand current according to the general technical

stipulations,

with maintenance-free operating mechanism as stored-energy spring mechanism,

with motor operating mechanism, with AR capability acc. to VDE / IEC (=O-t-CO-t'-CO), with mechanical pushbuttons for CLOSING and OPENING, with auxiliary switch

free contacts: 3NO+4NC,

with mechanical indication and signaling for "closing spring charged" and "circuit-breaker trip",

X with one shunt release (-Y1)

O with two shunt releases (-Y1, -Y2)

O with one shunt release (-Y1) and one undervoltage release (-Y7)

1 first three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations, with the switch positions CLOSED - OPEN - READY-TO-EARTH,

installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism (panels 1000 A up to 1250 A) or spring-operated mechanism (panels 1600 A up to 2500 A) with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch:

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

X second three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED - OPEN - READY-TO-EARTH,

installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism (panels 1000 A up to 1250 A) or spring-operated mechanism (panels 1600 A up to 2500 A) with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch:

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

2000/1000/10000

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

Protection device according to preliminary description:

X without

O Feeder and overcurrent protection 7SJ82

O Feeder and overcurrent protection 7SJ85

O Motor protection 7SK82

O Motor protection 7SK85

O Generator protection 7UM85

O Differential protection for two-winding transformers 7UT82

O Transformer differential protection 7UT8

O Line differential protection 7SD82

O Distance protection 7SA82

O Voltage and frequency protection 7RW80

O Line differential protection 7SD80

X Time-overcurrent protection 7SJ80

O Motor protection 7SK80

O Time-overcurrent protection 7SR11

O Time-overcurrent protection 7SR12

O Time-overcurrent and earth-fault protection 7SR100

O Motor and generator protection 7SR105

O Current-transformer operated time-overcurrent protection 7SR45

5.3.21.49 Circuit-breaker panel of bus sectionalizer LK-LS

The circuit-breaker panels of the bus sectionalizers must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current:

X 1000 A

O 1250 A

O 1600 A

O 2000 A

O 2500 A

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3x single-pole

O with voltage transformers, 3x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10 VA / 0.2

O 10 VA / 0.5

O 10 VA / 1

O 20 VA / 0.2

O 20 VA / 0.5

O 20 VA / 1

O 45 VA / 1

O 60 VA / 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

1 capacitive voltage detecting systems at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O_____ acc. to description

Current transformers at the transverse panel interconnection:

X without current transformers at the transverse panel interconnection

O with current transformers at the transverse panel interconnection, 3 current transformers with 1 core

O with current transformers at the transverse panel interconnection, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

1 vacuum circuit-breaker

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with maintenance-free operating mechanism as stored-energy spring mechanism,

with motor operating mechanism, with AR capability acc. to VDE / IEC (=O-t-CO-t'-CO), with mechanical pushbuttons for CLOSING and OPENING, with auxiliary switch

free contacts: 3NO+4NC,

with mechanical indication and signaling for "closing spring charged" and "circuit-breaker trip",

X with one shunt release (-Y1)

O with two shunt releases (-Y1, -Y2)

O with one shunt release (-Y1) and one undervoltage release (-Y7)

1 three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations, with the switch positions CLOSED - OPEN - READY-TO-EARTH,

installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism (panels 1000 A up to 1250 A) or spring-operated mechanism (panels 1600 A up to 2500 A) with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch:

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING

function and manual/motor operating mechanism for READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

2000/1000/10000

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

Protection device according to preliminary description:

O Feeder and overcurrent protection 7SJ82

O Feeder and overcurrent protection 7SJ85

O Motor protection 7SK82

O Motor protection 7SK85

O Generator protection 7UM85

O Differential protection for two-winding transformers 7UT82

O Transformer differential protection 7UT8

O Line differential protection 7SD82

O Distance protection 7SA82

O Voltage and frequency protection 7RW80

O Line differential protection 7SD80

X Time-overcurrent protection 7SJ80

O Motor protection 7SK80

O Time-overcurrent protection 7SR11

O Time-overcurrent protection 7SR12

O Time-overcurrent and earth-fault protection 7SR100

O Motor and generator protection 7SR105

O Current-transformer operated time-overcurrent protection 7SR45

5.3.21.50 Disconnector panel of bus sectionalizer LK-TS

The disconnector panels of the bus sectionalizers must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current:

X 1000 A

O 1250 A

O 1600 A

O 2000 A

O 2500 A

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3x single-pole

O with voltage transformers, 3x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10 VA / 0.2

O 10 VA / 0.5

O 10 VA / 1

O 20 VA / 0.2

O 20 VA / 0.5

O 20 VA / 1

O 45 VA / 1

O 60 VA / 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

1 capacitive voltage detecting systems at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O _____ acc. to description

1 three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations, with the switch positions CLOSED - OPEN - READY-TO-EARTH,

installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism (panels 1000 A up to 1250 A) or spring-operated mechanism (panels 1600 A up to 2500 A) with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch:

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function; 2NO+2NC+2CH.OV. with motor operating mechanism for DISCONNECTING function and manual/motor operating mechanism for READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

2000/1000/-

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.51 Switch-disconnector panel TR

The switch-disconnector panels must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current of the feeder: 200 A

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3x single-pole

O with voltage transformers, 3x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 10VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 0.2

O 20VA / Cl. 0.5

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O _____ acc. to description

1 three-position switch-disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED-OPEN-EARTHED,

installed in the gas-filled stainless-steel vessel for earthing the cable feeder,

operation through spring-operated mechanism with mechanical position indicator, equipped with

X manual operating mechanism for LOAD BREAKING function and EARTHING function + shunt release (-Y3)

O motor operating mechanism for LOAD BREAKING function (-Y2) and EARTHING function + shunt release (-Y3)

with auxiliary switch:

LOAD BREAKING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING

function and manual/motor operating mechanism for EARTHING function

EARTHING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

electromechanical interlock:

O without

O at the switch-disconnector (-Y1)

O at the earthing switch (-Y5)

O at the switch-disconnector and earthing switch

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

1000/1000/-

1 fuse assembly

with single-pole insulation-enclosed HV HRC fuse boxes mounted outside the SF6 vessel,

with 3-pole shutdown when one HV HRC fuse has tripped,

with signaling switch for indication: "HV HRC fuse tripped",

with closing lockout for the HV HRC fuse assembly (prevents any operation when the fuse cover is open)

With capacitive voltage detecting system _____ at the feeder acc. to description.

Current transformers at the feeder:

X without

O 3 current transformers with 1 core

O 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Cable connection from bottom-front with cable bracket and pre-assembled cable clamp, suitable for connection of cable T-plugs, suitable for outside cone type C

Number of cables per phase:

X 1

O 2

Zero-sequence current transformer for earth-fault detection:

X without

O with

Zero-sequence current transformer values:

for IEC, GOST, GB:

O 50A / 1A / 1.25VA / Cl. 1 FS 10

O 60A / 1A / 1.25VA / Cl. 1 FS 10

O 100A / 1A / 1.25VA / Cl. 1 FS 10

for CSA:

O 50A / 5A C5

O 100A / 5A C10

O 200A / 5A C10

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.52 Metering panel ME

The metering panels must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 20VA / Cl. 0.2

O 10VA / Cl. 0.5

O 20VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O _____ acc. to description

1 three-position switch-disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED-OPEN-EARTHED, installed in the gas-filled stainless-steel vessel for earthing the cable feeder,

operation through spring-operated mechanism with mechanical position indicator, equipped with

X manual operating mechanism for LOAD BREAKING function and EARTHING function

O motor operating mechanism for LOAD BREAKING function and manual operating mechanism for EARTHING function

O motor operating mechanism for LOAD BREAKING function and EARTHING function

with auxiliary switch:

LOAD BREAKING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

EARTHING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING

function and manual/motor operating mechanism for EARTHING function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the switch-disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

2000/1000/-

1 fuse assembly

with single-pole insulation-enclosed HV HRC fuse boxes mounted outside the SF6 vessel,

with 3-pole shutdown when one HV HRC fuse has tripped,

with signaling switch for indication: "HV HRC fuse tripped",

with closing lockout for the HV HRC fuse assembly (prevents any operation when the fuse cover is open)

Voltage transformers at the feeder, incl. disconnecting facility for voltage transformers:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3 x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 20VA / Cl. 0.2

O 10VA / Cl. 0.5

O 20VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.53 Air-insulated transfer metering panel aME

The air-insulated transfer metering panels must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Busbar current transformers, left:

X without current transformers

O 3 current transformers with 1 core

O 3 current transformers with 2 cores

Busbar current transformers, right:

X without current transformers

O 3 current transformers with 1 core

O 3 current transformers with 2 cores

Note: Busbar current transformers possible on the left or right, not on both sides.

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system in the instrument transformer compartment (tapping through capacitive layers in the bushings of the instrument transformer compartment)

O without

X _____ acc. to description

O first three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED - OPEN - READY-TO-EARTH, installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch:

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

O second three-position disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED - OPEN - READY-TO-EARTH, installed in the gas-filled stainless-steel vessel for earthing the cable feeder (via circuit-breaker),

operation through slow motion mechanism with mechanical position indicator, equipped with

X manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and manual operating mechanism for READY-TO-EARTH function

O motor operating mechanism for DISCONNECTING function and READY-TO-EARTH function

with auxiliary switch:

DISCONNECTING function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

READY-TO-EARTH function:

1NO+1NC+2CH.OV. with manual operating mechanism for DISCONNECTING function and READY-TO-EARTH function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

2000/1000/10000

Transfer measurement:

Fixed earthing points:

X without

O with

Current transformer mounting position:

X P1 - P2

O P2 - P1

Arrangement of current and voltage transformers for transfer measurement:

O correct current

X correct voltage

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.54 Contactor panel VS

The motor feeder panels with vacuum contactor must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current of the feeder: 450 A

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3 x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 20VA / Cl. 0.2

O 10VA / Cl. 0.5

O 20VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O_____ acc. to description

1 vacuum contactor

Rated current 450A

according to IEC 60470

with magnet coil mechanism

with auxiliary switch 2NO+2NC:

with 100,000 operating cycles or 500,000 operating cycles (not possible when a mechanical latch is used)

Mechanical latch:

X without

O with, electrical latch release: Release according to open-circuit principle

O with, electrical latch release: Release according to closed-circuit principle

1 three-position switch-disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED-OPEN-EARTHED,

installed in the gas-filled stainless-steel vessel for earthing the cable feeder,

operation through spring-operated mechanism with mechanical position indicator, equipped with

X manual operating mechanism for LOAD BREAKING function and EARTHING function

O motor operating mechanism for LOAD BREAKING function and manual operating mechanism for EARTHING function

O motor operating mechanism for LOAD BREAKING function and EARTHING function

with auxiliary switch:

LOAD BREAKING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

EARTHING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

electromechanical interlock:

X without

O at the disconnector (-Y1)

O at the earthing switch (-Y5)

O at the disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / vacuum contactor operating cycles):

X 2000/1000/100000

O 2000/1000/500000

1 fuse assembly

with single-pole insulation-enclosed HV HRC fuse boxes mounted outside the SF6 vessel,

with 3-pole shutdown when one HV HRC fuse has tripped,

with signaling switch for indication: "HV HRC fuse tripped",

with closing lockout for the HV HRC fuse assembly (prevents any operation when the fuse cover is open)

Current transformers at the feeder:

X without

O 3 current transformers with 1 core

O 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

With capacitive voltage detecting system _____ at the feeder acc. to description.

Cable connection from bottom-front with cable bracket and pre-assembled cable clamp, suitable for connection of cable T-plugs, suitable for outside cone type C

Number of cables per phase:

X 1

O 2

O 3

Zero-sequence current transformer for earth-fault detection:

X without

O with

Zero-sequence current transformer values:

for IEC, GOST, GB:

O 50A / 1A / 1.25VA / Cl. 1 FS 10

O 60A / 1A / 1.25VA / Cl. 1 FS 10

O 100A / 1A / 1.25VA / Cl. 1 FS 10

for CSA:

O 50A / 5A C5

O 100A / 5A C10

O 200A / 5A C10

Surge protection pluggable on cable T-plug:

X without

O with surge arrester

O with surge limiter

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

Protection device according to preliminary description:

O without

O Feeder and overcurrent protection 7SJ82

O Feeder and overcurrent protection 7SJ85

O Motor protection 7SK82

O Motor protection 7SK85

O Generator protection 7UM85

O Differential protection for two-winding transformers 7UT82

O Transformer differential protection 7UT8

O Line differential protection 7SD82

O Distance protection 7SA82

O Voltage and frequency protection 7RW80

O Line differential protection 7SD80

X Time-overcurrent protection 7SJ80

O Motor protection 7SK80

O Time-overcurrent protection 7SR11

O Time-overcurrent protection 7SR12

O Time-overcurrent and earth-fault protection 7SR100

O Motor and generator protection 7SR105

O Current-transformer operated time-overcurrent protection 7SR45

5.3.21.55 Ring-main panel RK

The ring-main panels must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Rated continuous current of the feeder: 630 A

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3 x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 10VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 0.2

O 20VA / Cl. 0.5

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O _____ acc. to description

1 three-position switch-disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations,

with the switch positions CLOSED-OPEN-EARTHED, installed in the gas-filled stainless-steel vessel for earthing the cable feeder,

operation through spring-operated mechanism with mechanical position indicator, equipped with

X manual operating mechanism for LOAD BREAKING function and EARTHING function

O motor operating mechanism for LOAD BREAKING function and manual operating mechanism for EARTHING function

O motor operating mechanism for LOAD BREAKING function and EARTHING function

with auxiliary switch:

LOAD BREAKING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

EARTHING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

electromechanical interlock:

X without

O at the switch-disconnector (-Y1)

O at the earthing switch (-Y5)

O at the switch-disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

Operating cycles (mechanical operating cycles, CLOSE-OPEN switching cycle / mechanical operating cycles, OPEN-EARTHING switching cycle / circuit-breaker operating cycles):

2000/1000/-

With capacitive voltage detecting system _____ at the feeder acc. to description.

Current transformers at the feeder:

X without

O 3 current transformers with 1 core

O 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 75A/1A; 10VA / Cl. 1 / FS10

O 75A/1A; 2.5VA / Cl. 10P / 20

O 100-150A/1A; 10VA / Cl. 1 / FS10

O 100-150A/1A; 2.5VA / Cl. 10P / 20

O 200-500A/1A; 10VA / Cl. 0.2 / FS10

O 200-500A/1A; 10VA / Cl. 0.5 / FS10

X 200-500A/1A; 10VA / Cl. 1 / FS10

O 200-500A/1A; 15VA / Cl. 10P / 20

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 600A MR / 5A Cl. 0.3B0.9

O 600A MR / 5A Cl. C200

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Voltage transformers at the feeder, incl. disconnecting facility for voltage transformers:

X without voltage transformers

O with voltage transformers, 3x single-pole

O with voltage transformers, 3x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10VA / Cl. 0.2

O 10VA / Cl. 0.5

O 10VA / Cl. 1

O 20VA / Cl. 0.2

O 20VA / Cl. 0.5

O 20VA / Cl. 1

O 45VA / Cl. 1

O 60VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Cable connection from bottom-front with cable bracket and pre-assembled cable clamp, suitable for connection of cable T-plugs, suitable for outside cone type C

Number of cables per phase:

X 1

O 2

Zero-sequence current transformer for earth-fault detection:

X without

O with

Zero-sequence current transformer values:

for IEC, GOST, GB:

O 50A / 1A / 1.25VA / Cl. 1 FS 10

O 60A / 1A / 1.25VA / Cl. 1 FS 10

O 100A / 1A / 1.25VA / Cl. 1 FS 10

for CSA:

O 50A / 5A C5

O 100A / 5A C10

O 200A / 5A C10

Surge protection pluggable on cable T-plug:

X without

O with surge arrester

O with surge limiter

1 short-circuit indicator according to the selection in the preliminary description

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.56 Auxiliary transformer panel EB

The auxiliary transformer panels must be designed as follows:

In panel-type construction, equipped with:

X 1 set of busbars, insulated, Cu (only possible if there is no lateral cable connection in the panel)

Voltage transformers at the busbar:

X without voltage transformers

O with voltage transformers, 3 x single-pole

O with voltage transformers, 3 x single-pole, with earth-fault winding and damping resistor

Rating / Class:

for IEC, GOST, GB:

O 10 VA / Cl. 0.2

O 10 VA / Cl. 0.5

O 10 VA / Cl. 1

O 20 VA / Cl. 0.2

O 20 VA / Cl. 0.5

O 20 VA / Cl. 1

O 45 VA / Cl. 1

O 60 VA / Cl. 1

for CSA:

O WXY / Cl. 0.3

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Capacitive voltage detecting system at the busbar (tapping through capacitive layers in the busbar bushings)

X without

O _____ acc. to description

1 three-position switch-disconnector

Rated continuous current and rated short-time withstand current according to the general technical stipulations, with the switch positions CLOSED-OPEN-EARTHED, installed in the gas-filled stainless-steel vessel for earthing the cable feeder,

operation through spring-operated mechanism with mechanical position indicator, equipped with

X manual operating mechanism for LOAD BREAKING function and EARTHING function + shunt release (-Y3)

O motor operating mechanism for LOAD BREAKING function (-Y2) and EARTHING function + shunt release (-Y3)

with auxiliary switch:

LOAD BREAKING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

EARTHING function:

1NO+1NC+2CH.OV. with manual operating mechanism for LOAD BREAKING function and EARTHING function; 2NO+2NC+2CH.OV. with motor operating mechanism for LOAD BREAKING function and manual/motor operating mechanism for EARTHING function

electromechanical interlock:

O without

O at the switch-disconnector (-Y1)

O at the earthing switch (-Y5)

X at the switch-disconnector and earthing switch (-Y1; -Y5)

with locking device

with operating mechanism designed for separate operating levers (acc. to FNN recommendation)

1 fuse assembly

with single-pole insulation-enclosed HV HRC fuse boxes mounted outside the SF6 vessel,

with 3-pole shutdown when one HV HRC fuse has tripped,

with signaling switch for indication: "HV HRC fuse tripped",

with closing lockout for the HV HRC fuse assembly (prevents any operation when the fuse cover is open)

With capacitive voltage detecting system _____ at the feeder acc. to description.

Three-phase dry-type transformer:

X 40kVA, uk = 4%, Dyn5

O 40kVA, uk = 4%, Dyn1

O Lateral cable connection with cable bracket and pre-assembled cable clamp, suitable for connection of cable T-plugs, suitable for outside cone type C (only possible if there is no busbar in the panel).

Number of cables per phase: 1 (240 mm2)

Capacitive voltage detecting system _____ at the lateral cable

X without

O _____ acc. to description

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.57 Dummy panel LE

The dummy panels must be designed as follows:

In panel-type construction, equipped with:

1 set of busbars, insulated, Cu

Current transformers at the busbar:

X without current transformers at the busbar

O with current transformers at the busbar, 3 current transformers with 1 core

O with current transformers at the busbar, 3 current transformers with 2 cores

Current transformer values, core 1:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

Current transformer values, core 2:

for IEC, GOST, GB:

O 600A-1200A/1A; 10VA / Cl. 0.2 / FS10

O 600A-1200A/1A; 10VA / Cl. 0.5 / FS10

O 600A-1200A/1A; 10VA / Cl. 1 / FS10

O 600A-1200A/1A; 15VA / Cl. 10P / 20

O 1250A-2500A/1A; 10VA / Cl. 0.2 / FS10

O 1250A-2500A/1A; 10VA / Cl. 0.5 / FS10

O 1250A-2500A/1A; 10VA / Cl. 1 / FS10

O 1250A-2500A/1A; 15VA / Cl. 10P / 20

for CSA:

O 1200A MR / 5A Cl. 0.3B0.9

O 1200A MR / 5A Cl. C200

O 2000A MR / 5A Cl. 0.3B0.9

O 2000A MR / 5A Cl. C200

O 3000A MR / 5A Cl. 0.3B0.9

O 3000A MR / 5A Cl. C200

1 mimic diagram (preferably printed)

1 low-voltage compartment for accommodation of secondary devices, with terminal strips, completely wired, with feeder designation label.

Height:

X 761 mm

O 1161 mm

including the necessary secondary devices for control, protection and monitoring

5.3.21.58 Pressure relief duct

X rear pressure relief duct for the switchgear, for a rated short-time withstand current up to 31.5 kA, with expanded metal layers to reduce the temperature and the pressure.

O additional horizontal pressure relief duct for the switchgear, for a rated short-time withstand current

up to 31.5 kA.

5.3.21.59 Lateral switchgear termination

On the right and left end of the switchgear, a switchgear termination (end wall) has to be provided.

Width per side wall: 52 mm

5.3.21.60 Single-line diagram

Single-line diagram IEC 61082 of the constructed medium-voltage switchgear, to be provided by the supplier, framed behind glass, to be delivered and fitted.

5.3.21.61 Tool drawer

In the end wall of the switchgear, a tool drawer has to be provided to store the switchgear accessories.

5.3.21.62 Medium-voltage substation accessories, including safety labels and notices

Medium-voltage substation accessories

X HV HRC fuse-links

- Set of HV HRC fuse-links according to the selected operating voltage
- For all panels with switch-fuse combination and HV HRC fuse boxes, 1 set of HV HRC fuse-links must be provided each
- The rated current of the HV HRC fuse must be adjusted to the rated power of the transformer
- Rated power of transformer: _____ kVA

X Plug-in voltage detecting system

- 6 nos.
- Verification of safe isolation from supply phase by phase through insertion in each socket pair
- Measuring system and voltage indicator can be tested

X Double-bit key

- Spare key for opening / locking the low-voltage compartment doors

X Operating levers

- For operation of the three-position switch-disconnector, or circuit-breaker without AR capability, and the earthing switch

X Operating levers FNN

- Set of levers according to FNN recommendation for operation of the three-position switch-disconnector, or circuit-breaker without AR capability, and the earthing switch with two different operating levers

X Hand crank

- For charging the closing spring of the vacuum circuit-breaker

X Wall-mounting holder

- For storage of switchgear accessories and HV HRC fuse-links

X Combined test unit

- For the capacitive interfaces of the switchgear, phase comparison and voltage indicators

X Grooved rubber mat, gray, test voltage 45 kV

- Suitable for covering the floor inside the medium-voltage room (in front of the medium-voltage switchgear), thickness approx. 4.5 mm according to the VDE specifications
- Completely cut to size, laid with all necessary accessories
- To be delivered and fitted

X Protective helmet with face protection

- With all necessary accessories

X Insulating gloves

- Up to 1000 V, according to DIN VDE 311 or DIN EN 60903, Class 0, Part 0682

X Earthing rod up to 12 kV, 24 kV or 36 kV

- Depending on the rated voltage of the switchgear, to be delivered and fitted completely with holder

X Earthing cable as earthing and short-circuiting facility

- According to DIN VDE 0683, three-phase, including holder
- Short-circuit cables: 95 mm²
- Earthing cable: 70 mm²
- To be delivered and fitted ready for service incl. holder

X Portable LED spotlight with emergency light function

- Portable LED spotlight with batteries, charger and system connection cable for use as emergency lamp, with system voltage indication, enclosure made of synthetic material (IP54)
- Monitoring of the charging circuit and function indication by green LED
- Power of main light adjustable: Eco mode for extended battery operation (3.0 W) or boost mode for higher luminous flux (5.5 W), secondary light with 6 LEDs (1.5 W) and wide-beam light distribution, up to 14 h of light (secondary light) and 5.5 h (main light eco) with 4 Ah battery
- To be delivered and fitted ready for service including wall-mounting holder

X Carbon dioxide portable fire extinguisher, fire behavior class B

- Including holder and foam pipe
- Filling quantity: 5 kg

X Safety labels and notices

- Complete set of safety labels and notices comprising:
- Safety labels: "Do not operate, work in progress", "Hazardous electrical voltage", "High voltage, danger"
- Notices: Notice DIN VDE 0105, "First aid" notice, "Firefighting" notice, "Prevention of accidents" notice, "Safety rules" notice

5.3.22 Installation, Operation and Maintenance

5.3.22.1 Model data (3D) for use in BIM process

In addition to the written documentation of the system, 3D data to the planned system has to be provided in a suitable format (e.g., .RVT (Autodesk Revit), .IFC (Industry Foundation Classes)) in order to be integrated in the BIM (Building Information Modeling) of the building project.

Using the 3D data in the BIM process contributes to efficient and thus sustainable planning thanks to

the following factors:

- More efficient planning resulting from the same level of information for all persons involved with respect to the information that is relevant for them
- Possibility of early, efficient, and precise error and weak point analyses in the planning process
- Consideration of aspects concerning the optimization of operation and maintenance already in the planning phase

5.4 DESIGN AND CONSTRUCTION

5.4.1.1 Cable compartment, Terminations and Competency Requirements

5.4.1.2 Cable Compartment:

Cable compartments shall be suitable for the termination of cables in air and shall comply with the requirements of NRS 012;

The cable trench below the cable termination compartment is fitted with chequer plates. The method of supporting the cable shall not interfere with the removal of these chequer plates. Furthermore, it sometimes collects free water, therefore the cable box design shall cater for condensation;

Bushings shall be screened Type C dimensions in accordance with EN 50181

5.4.1.3 Cable Terminations:

The phase sequence on all cable terminations shall be identical on all panels in the switchboard

The successful Tenderer shall be responsible for the supply and installation of the cable terminations and connectors

Requirements of Screened Separable Connectors (SSCs):

- SSCs shall be supplied as a complete indoor termination kit in accordance with clause 4.1.4 of NRS 053/SANS 1332 and as specified in this technical specification;
- SSCs shall be of the dead-break, bolted contact type and shall be suitable for connecting to an outside cone plug-in type bushing with interface type ‘C’ having an M16 □ 2 thread
- The SSCs shall be able to accommodate 95 mm2, 150 mm2, 240 mm2 and 300 mm2 (3 cores cable sizes and types)
- Each SSC shall be supplied with a stainless-steel fixing stem and all associated components (e.g. end plug, test point cap)
- SSCs shall be supplied in sets of three in a complete termination kit, i.e. allowing for the termination of one three-core cable
- SSCs shall be supplied with lugs suitable for the standard ranges specified in this specification

Where SSCs are provided with an external length of insulated conductor that is required for the earthing of the SSC housing, the conductor shall be:

- an insulated copper conductor of nominal cross-sectional area of at least 4 mm^2;
- of length 700 mm;
- terminated at the non-SSC end with a lug having an M12 fixing hole;

5.4.1.4 Earth Components of Cable Termination Kit:

The main earth conductor of the termination kit shall be a 70 mm^2 tinned copper braid

The main earth conductor shall be 700 mm in length

The main earth conductor shall be terminated with a tinned copper lug that has a M12 fixing hole

The earth fault current rating of the main earth conductor is limited to 10 kA for 1 second

The main earth conductor shall be water blocked to prevent ingress of moisture into the cable termination. The positioning of waterproofing shall be clearly indicated in the installation instructions

The main earth conductor of the cable termination kit shall be connected to the steel wire armour of the cable **either** with constant forces springs, fixed over layers of tinned copper mesh

A 16 mm^2 earth braid together with a constant force spring shall be used to earth each copper tape screen of each core of the cable to the steel wire armour of the cable

The constant force spring shall have a minimum width of 20 mm and shall be suitable for the relevant cable dimensions

Filler tape shall be used and suitably positioned to smoothen sharp edges around installed constant force springs. This filler tape shall also serve to restrain the springs

Constant force springs that form part of the main earth connection shall **not** be used to secure any ferrous metal enclosures used for mechanical protection of the cable termination

The constant force springs shall be suitable for the relevant cable dimensions

5.4.1.5 Requirements for Mechanical Torque Shear Connectors:

Range taking mechanical torque shear lugs shall comply with dimensional requirements of Table 1 of Figure 1 of NRS 075 for the range 95 mm^2 to 300 mm^2 size conductors

The mechanical torque shear connector shall be capable of connecting to the following combinations of conductors:

- Both aluminium and copper
- Both round and sector shape;
- Both compacted and uncompacted;

The mechanical torque shear connectors shall be “Class A” as per SANS IEC 61238-1 and NRS 075;

The mechanical torque shear connector shall be capable of withstanding, without deterioration, the normal operating currents and short-circuit currents to which the electrical system may be subjected to;

Mechanical torque shear connectors shall be designed to connect both copper and aluminum conductors together without galvanic reaction;

Mechanical torque shear connectors shall be free of surface and internal defects such as burrs, cracks, rolled seams, blisters, twists, press and chatter marks;

Mechanical torque shear connectors shall be of a one-piece construction i.e. two dissimilar materials shall not be used in the construction of the connector barrel;

The bore of the barrel of connectors shall be chamfered to facilitate easy conductor entry;

The inside of the connectors shall be ridged (grooved) and the contact area greased with an anti-oxide paste (Mo-based) for corrosion protection. The bolts shall be greased with anti-friction grease;

The mechanical torque shear connector shall be fitted with centered inserts to be used for centering conductors of smaller cross-sectional area;

Center rings shall be colour coded indicating the different conductor sizes **and/or** the conductor size shall be marked indelibly on the inserts;

The mechanical torque shear connector shall be rated on the current carrying capacity of the largest conductor of the range;

5.4.1.6 Test Requirements:

Complete termination kit for impregnated paper insulated cables shall meet test requirements of **NRS 053/ SANS 1332** for specified rated voltage of the cable;

Complete termination kit for cross linked polyethylene insulated cables shall meet test requirements of **NRS 053/SANS 1332** for specified rated voltage of the cable;

The acceptance of alternative test reports shall meet requirement of **NRS 053/SANS 1332.**

5.4.1.7 Test Reports and Certification:

Test Reports shall meet requirement of **NRS 053/SANS 1332;**

A complete Test Report certifying that the kit offered meets requirement of **NRS 053/SANS 1332** shall be included in the bid;

5.4.1.8 Testing after Installation:

The successful Tenderer shall ensure that after the installation of the cable termination onto the switchgear, the power cables shall be tested at a value specified for cables complying with SANS 10198-13 for XLPE cables and SANS 97 for PILC cables, for the same system voltage as the switchgear. The test results shall be submitted to Engineering Support: MV/LV Operations;

5.4.2 Competency Requirements:

5.4.2.1 Competency of staff undertaking installation of the cable terminations and connectors:

The name/s of the Electrical Artisans shall be listed in **Section 1.14 of C3.6**

The Successful Tenderer shall ensure that prior to orders commencing, the Electrical Artisans listed in **Section 1.14 of C3.6** are sent to eThekwini Electricity Training Centre to be deemed a Competent Person on the following:

- eThekwini Electricity's Codes of Practice;
- eThekwini Electricity's Safety Rules;
- eThekwini Electricity's Underground Mains; and
- eThekwini Electricity's Substations.

Note: The cost of this training shall be borne by the Successful Tenderer.

The Head: eThekwini Water and Sanitation, his/her representative will have the right at any time to summon the Successful Tenderer to the site of works to attend to defects or breakdowns on work undertaken by him/her, and failure of the Successful Tenderer to respond promptly to such calls will be regarded as a breach of the contract. The Successful Tenderer shall provide the Head: eThekwini Water and Sanitation with a list of the names, addresses and telephone numbers of his (the Successful Tenderers) employees who are available to be summoned for this purpose, and such list shall be kept up to-date;

The Successful Tenderer agrees that, in and about the execution of the contract, he will not contract any other than regular and duly qualified and competent persons to do such work as is usually done by skilled workmen in contracts of this nature. No work shall be done unless carried out under the direct and personal supervision of the Competent Person referred to above. Any contractor of the Successful Tenderer who is not deemed a Competent Person, or who shall act in an improper manner, shall be removed by the Successful Tenderer on the order of the Head: Electricity and such person

shall not again be employed for the purpose of this contract without permission from the Head: eThekwini Water and Sanitation or his representative.

5.5 COMMUNICATION AND SCADA ACCESSORIES

5.5.1 The SCADA system is not part of this scope: All physical hardware shall be capable of having the SCADA system added at a later date as per the following requirements:

5.5.2 The Communication and SCADA Accessories consist of:

5.5.2.1 A substation SCADA Gateway, which is linked through an available communication channel to the MV PLC, HMI & SCADA and enables remote and monitoring of the substation

5.5.2.2 A Communication Panel, which accommodates the SCADA gateway and other communication equipment including MV PLC;

5.5.2.3 A Fibre Termination Panel, which accommodates terminations into the communication system of EWS

5.5.2.4 A Substation Managed Ethernet switch, to connect all Ethernet devices to the substation LAN with 40% spare ethernet ports

5.5.2.5 A Communication cabling system, to link relays and other devices to the SCADA gateway, or Substation Ethernet Switch.

5.5.2.6 Communication Modem to provide a secondary/redundant communication link to the EWS industrial network.

5.5.3 PLC or SCADA Gateway

5.5.3.1 A detailed user manual shall be provided for the configuration of the PLC or SCADA gateway

5.5.3.2 The SCADA gateway shall be a slave to EWS PLC & SCADA master station and shall be able to communicate fully over DNP3.0 class 0/1/2/3 and IEC 60870-5-104 supporting both solicited and unsolicited modes. The PLC use Modbus TCP/IP protocol therefore the gateway should be able to convert DNP3 to Modbus TCP/IP

Note: The Tenderer shall detail the protocols used in the internal operation of the PLC/SCADA Gateway. The internal architecture together with a flow chart of the PLC/SCADA Gateway hardware shall be included in the bid submission.

5.5.3.3 The communication configuration of the SCADA Gateway for communication with substation devices shall be according to IEC 61850, using the single Substation Configuration Tool according to the IEC 61850 specification and shall make use of the Substation Configuration Language. A single engineering tool shall be able to configure the entire automation scheme viz. the IEDs, the SCADA Gateway, and communications between these devices

5.5.4 Communication and Fibre Termination Panels

5.5.4.1 Fiber patch panel shall be at the back of MV PLC panel if possible, otherwise it can be inside at the bottom of the PLC panel;

5.5.5 Substation Ethernet Layer 3 Switch

5.5.5.1 General:

All substation communication equipment shall be new

Demonstration of System:

- The Tenderer shall be prepared to arrange a fully working display of the main components of the system to demonstrate the system's functions and capabilities to representatives of eThekwini Water and Sanitation. This demonstration will take place at the request of eThekwini Water and Sanitation and shall be held at the eThekwini Water and Sanitation Quarters.

5.5.5.2 Technical requirements for Substation Ethernet Switch:

The Substation Ethernet switch shall have the following features:

- 19" Rack Mountable 1U height or Din Rail mountable 4U height
- Ingress Protection – IP30
- Metal housing with ports on front
- Dual Power supply: 48 VDC (36-72VDC); and
- Terminal blocks connections

5.5.5.3 The Substation Ethernet switch shall have the following interfaces:

- 16 x 10/100 TX Copper Access Ports
- 2 x Optical ports with SFP cages; and
- 2 x single mode SFPs to be supplied 1310nm, support minimum distance of 10 km, dual LC connectors and extended temperature range ºC to +75 ºC (1000 BASE LX)

2 x 10/100/1000TX Copper Access Ports

5.5.5.4 The Substation Ethernet switch shall be designed for the following switching requirements:

Switching method: Store and Forward;

Switching latency: typ. 7 us;

Switching bandwidth: 10 Gbps;

MAC Address Table size: 8192;

VLAN (802.1Q);

VLANs: 255;

Traffic prioritization: minimum of 4 queues;

Port Rate Limiting (Ingress & Egress) in steps of kbps;

Flow Control (IEEE 802.3x);

Link Aggregation IEEE 802.3ad (LACP, Link Aggregation Control Protocol);

RSTP (Rapid Spanning Tree Protocol) IEEE802.1D;

MSTP 802.1Q-2005 (formerly 802.1s);

Quality of Service (802.1p);

5.5.5.5 Management of the Substation Ethernet switch shall be achieved by:

Port mirroring;

RMON (Remote Monitoring);

IGMP snooping doe multicast filtering;

SNMP V1, V2c, V3, Configuration;

Command Line Interface / Telnet access;

WEB Interface;

SFP Diagnostics;

LLDP topology discovery;

SNTP (Simple Network Time Protocol) V2;

Trivial File Transfer Protocol (TFTP);

Dynamic Host Configuration Protocol (DHCP);

POE - Per port power consumption setting;

POE - Ability to view Per port PoE power sensing;

Remote viewing of configuration through web browser;

5.5.5.6 The Substation Ethernet switch shall have the following security features:

Authentication (IEEE802.1x);

Mac address filtering;

Local Logfile and Syslog reporting;

SSH encryption;

Radius centralized password management;

Multi-level user passwords;

Disabling of Ports;

Firewall;

VPN;

IP address filtering;

5.5.5.7 The Substation Ethernet switch shall be designed with the following features:

EMC hardened as per IEEE1613;

IEC61850-3 Electric Utility Substations;

be able to withstand an extended temperature rating from -40° - +85°C continuous and humidity of 99 % non-condensing at 55°C;

Fan-less design;

All electronic modules shall be conformal coated;

CSA/UL approval;

The Substation Ethernet switch Warranty:

5 Years - Applicable to design and manufacturing related product defects;

Applicable Environmental and EMI tests: The Substation Ethernet switch shall comply with:

- IEC 61850-3;
- IEEE 1613;
- Environmental tests;
- Ethernet Standards;

5.5.5.8 Protocols supported for the Substation Ethernet switch shall as follows:

IGMPv1/v2 - Internet Group Management Protocol;

SNMPv1/v2c/v3 - *Simple Network Management Protocol*;

DHCP Server/Client - Dynamic Host Configuration Protocol;

TFTP - *Trivial File Transfer Protocol*;

SNTP - Simple Network Time Protocol;

RMON - The Remote Network Monitoring;

HTTP;

HTTPS;

Telnet;

RADIUS - Remote Authentication Dial In User Service;

TCP - TRANSMISSION CONTROL PROTOCOL;

Multilink PPP – Point-to-Point Protocol;

GOOSE Messaging;

Layer 3 Redundancy: VRRP;

Layer 3 Routing: Static routing;

RIP V1/V2 - *Routing Information Protocol*;

OSPF -*Open Shortest Path First*;

5.5.5.9 Safety and Certification shall be in accordance with:

Safety of Information Technology Equipment: UL 60950-1;

EMI: FCC Part 15 Subpart B Class A, EN 55022 Class A;

Laser Eye Safety (FDA/CDRH): 21 CFR Chapter1, Subchapter J;

5.5.6 Substation Communication Cabling:

5.5.6.1 All protection relays shall be IEC 61850 compliant;

5.5.6.2 CAT6 STP cables shall be used to connect between the Ethernet Switch and all IEC 61850 relays;

5.5.6.3 CAT6 STP cables shall be appropriately earthed and screened and fitted with screened RJ45 connectors

5.5.6.4 An overhead galvanized wire mesh cable tray, with bend limitation/control shall be installed above the 11 kV switchboard (where applicable), between the 11 kV switchboard, communication panel and termination panel

5.5.6.5 The CAT6 STP communication cable shall be housed in 100 mm x 100 mm PVC trunking mounted along the length of the top of the overhead galvanized wire mesh cable tray

5.5.6.6 Each single mode fibre optic cable for differential protection will run in a 23 mm HDPE Flexible Corrugated Conduit (Stock Code: 0114462) between the protection relay and fibre termination panel and supported by the overhead galvanized wire mesh cable tray

5.5.7 Clock Synchronising Network:

5.5.7.1 It is recommended that time synchronising of the relays and the SCADA Gateway shall be implemented via an IRIG-B GPS unit that would be housed in the SCADA Gateway. Further to this, the SCADA Gateway shall also have a NTP server that serves time over the LAN to all end devices. Times accuracy of the end devices must be better than 1 ms accurate;

5.5.8 Communication Modem:

5.5.8.1 The wireless communication modem shall be an industrial grade device capable of supporting reliable, fast and secure data transmission between two sites over public mobile networks and the internet. The wireless router shall use open protocols and conform to the following specifications:

The wireless router shall support the following Hardware properties:

- Network: Quad band HSPA/UMTS 800/850/1900/2100MHz, GSM/GRPS/EDGE 850/900/1800/1900 MHz with Transparent hand-over between UMTS and GSM networks. IEEE 802.11 2.4-2.483GHz WiFi capable;
- Transmit power: GSM 900MHz ≥ 2W, GSM1800 ≥ 1 W, UMTS/HSPA ≥ 0.25 W, EDGE900 ≥ 0.5 W, EDGE1800≥0.4 W;
- Data rates: max. 7.2 Mbps downlink / 2 Mbps uplink;
- GPS receiver: Integrated GPS receiver;
- Ethernet Switch: 4 port Ethernet switch 10/100BaseTX, RJ45 connector, Auto MDI/MDIX;
- Subscriber Identity Module (SIM) card: 2 x SIM trays;
- Antenna interface: 50 Ohm SMA female (GSM and GPS);
- Input voltage range: 9 -72 VDC;
- Temperature range: -20° C to +70° C;
- Humidity: 0 to 95 % (30°C, non-condensing);
- Overvoltage category: IEC1010 CAT II;
- Mounting: DIN rail mountable. A suitable mounting kit must be supplied;

The wireless router shall run a Linux based operating system and support the following software features:

- Interface and connection management tool for SIM and PIN management, Automatic or Manual network selection, Dial out (on demand, permanent) and fallback to backup profile or SIM
- The system shall support Static routing, NAPT/ Port forwarding
- The security module shall feature a stateful inspection firewall, Access control lists and NAPT / Port forwarding
- The system shall feature secure network access by supporting an OpenVPN 2.0 Native Client. The system must support data confidentiality and integrity protection

The Wireless router shall support the following Network protocols:

- ICMP, TCP/IP, UDP, DHCP, Telnet, DNS, SNMP, HTTP, SMTP, HTTPS, SNTP, ARP, SSL, RTSP, IPSec.

Wireless router shall support the following services:

- DHCP Server;
- Web server;
- SSH Server;
- Telnet Server;
- SNMPv1/v2c/v3Agent;
- Unstructured Supplementary Service Data (USSD);

- GPS Daemon;
- NTP server;
- E-mail and SMS Client for Notification;

System administration configuration and management shall be possible via the following:

- Configuration via Web Manager;
- Configuration via Command Line Interface (CLI) accessible via Secure Shell (SSH) and telnet c) Batch configuration with text files;
- User administration;
- Troubleshooting tools;
- Over the air software update;

The Wireless modem shall be supplied with antenna/s with mounting brackets. Two types of antennas are required i.e. a medium gain and a high gain unit. The high gain antenna shall be utilised in areas where the signal strength is low. The antenna shall meet the requirements below:

- Frequency: GSM 900 MHz, PCN 1800 MHz, DCS 1900 MHz, 3G (UMTS 2.1 GHz), GPS 1575.42 MHz, IEEE 802.11 2.4-2.483 GHz;
- Polarization: GSM - Horizintal, GPS – RHCP;
- Gain: GSM: Medium gain: 2-3 dBi, High gain: 4-6 dBi, GPS: 3-5 dBic, IEEE 802.11 4-7 dBi omnidirectional;
- VSWR: < 2.5:1;
- Operating Temperature: -20° C to +75° C;
- Connector (GSM, GPS): 50 Ohm SMA male;
- Cable: Type RG174 coaxial. Length: 5m standard, 10m optional. All cables must be labelled;
- Mounting: Screw on vandal proof hole /roof mounting or L-bracket mountable;

5.5.9 A Panel PC (PPC) is to be provided to communicate and interrogate the status of the medium voltage network. Full software engineering is required to utilise the available information from each of the RTUs installed at the various locations where MV switchgear has been installed. Attributes should include but not be limited to the following:

5.5.9.1 Temperature range 0 to 55°C, 1Grms Operating vibration;

5.5.9.2 Fan-less design, uses Solid State Drive (SSD);

5.5.9.3 At least have an 18.5-inch display with widescreen 1920x1080 resolution;

5.5.9.4 Intel core processor, 8GB RAM, Windows 10 Enterprise OS;

5.5.9.5 Must include software licensing;

5.5.9.6 Scalable from 550 to 16K composite SCADA points;

5.5.9.7 Must support Modbus, DNP3, IEC 60870, IEC 61850 all third-party SCADA controllers;

5.5.9.8 Must comply to ISA99 Level 2 security model with built-in user-based security;

5.5.9.9 Common engineering and HMI tools;

5.5.9.10 Capable of connecting to multiple PLCs/RTUs, with high trending, alarm & display capacity;

5.6 PROTECTION RELAYS

5.6.1 Requirements for the manufacturer:

5.6.1.1 Certifications:

- The Digital Relay manufacturer shall have a valid ISO 9001 (2000 version) certification and an applicable Quality Assurance and Quality Control system
- The Digital Relay manufacturer shall have the Environment Certification ISO 14001

5.6.1.2 Experience:

- The Digital relay manufacturer shall have a long-term experience in designing and manufacturing Digital Protective Relays linked to switchgear applications and have relevant business volume and references in order to provide credibility in his commitments and a long-term support capability

5.6.1.3 Local support:

- The manufacturer/supplier shall have a permanent representative office with a trained and skilled support staff, in the country or in the region where the Digital Relays are delivered, in order to prove his commitment for local or regional support and to provide a channel for communication.
- The engineers employed by the supplier's local or regional office shall be certified by the manufacturer and provide start-up service including physical inspection of the Digital Relay, connected wiring and final adjustment, to ensure that the Digital Relay meets the required performance.
- The manufacturer shall be able to offer commissioning of the Digital relay to be carried out by the local or regional office.

5.6.2 Basic requirements for the Digital Protective Relay:

5.6.2.1 The Protection and Control device shall be of numerical type and designed to meet a high degree of dependability and security;

5.6.2.2 The local human machine interface (HMI) shall be based on a user-friendly and menu-structured program. The device shall include a 128x64 LCD matrix display which supports mimic (e.g. single line diagram can be drawn) and freely assignable analogue values as well as unicode language support;

5.6.2.3 All functions and displays of the Human Machine Interface (HMI) shall be remotely accessible (from the most advantageous location for operation and monitoring);

5.6.2.4 The device shall include navigation push buttons, freely programmable function push buttons with user configurable legend texts. The keypad buttons have to provide tactile feedback to safely operate the device HMI;

5.6.2.5 The device shall have control buttons for direct or select-execute CB control. Also the device has to have at least 12 LEDs with user configurable legend texts. At least 8 LEDs shall be freely programmable;

5.6.2.6 Access to protection setting mode shall be protected by a password that can be personalized by the user. There shall be at least three separate user levels with dedicated password protection at least two out of three of the highest levels;

5.6.2.7 The device shall be compact, easy to install and the device shall be housed in 4U metal cases for panel mounting;

5.6.2.8 The device shall have screw terminals for connection of wires for all CT/VT inputs, power supply, logic inputs and outputs. Also ring lug connection method for all CT/VT shall be available as an option;

5.6.2.9 The terminal for connection of wires of CT, VT, DI, DO shall be detachable from the relay, with CT shortening;

5.6.2.10 CT 1/5A nominal current shall be available for phase and residual current input. Also option for 0,2A/1A nominal current for residual current shall be available. The current values shall be scalable. Rated voltage input shall be 100V and configurable for VT secondaries between 50-120 V. The device shall support user adjustable rated frequency 50/60 Hz with measuring and setting range of 45…65 Hz;

5.6.2.11 One common relay's management software (based on standard Windows operating systems) shall provide all necessary tools and functions to operate the devices. Via the management software relay parameters, configurations and recorded data can be exchanged between PC and the device. Supporting the comtrade format, the management software also incorporates tools for analyzing relay events, waveforms and trends from data recorded but the device;

5.6.2.12 The relay's management software shall offer the possibility to simulate energy injection in order to test the relay after configuration;

5.6.2.13 The device shall be provided with at least 16 digital inputs and 7 digital outputs (trip relays);

5.6.2.14 A minimum of two setting groups have to be provided in the device. These shall be activated locally, remotely or via a dedicated input;

5.6.2.15 At least 1 alarm relay and 1 self-diagnostic watchdog output have to supported;

5.6.2.16 The operating temperature range shall be from –40°C to +65°C (or –40°F to +149°F). Storage and transport temperature range shall be from –40°C to +70°C (or –40°F to +158°F);

5.6.2.17 The devices' digital inputs shall have minimum 3 activation levels to choose from. The nominal activation levels shall be: 24V ac/dc, 110V ac/dc and 220V ac/dc;

5.6.2.18 The device shall support two auxiliary voltage options. These options have to be: 40-265 A ac/dc or 18-36 V dc;

5.6.2.19 The current inputs shall be capable of thermal withstanding: 20 A continuously, 100A for 10s and 500A for 1s;

5.6.2.20 Approved type tests from certified laboratories shall be carried out in the manufacturer works on each device;

5.6.2.21 The devices shall meet the applicable IEEE/ IEC design standards. (Disturbance tests, electrical safety tests, mechanical tests and environmental tests);

5.6.2.22 The device shall have IEC61850 ed. 1 and ed. 2 certificate;

5.6.3 Protection:

5.6.3.1 The device shall contain all the necessary protection functions/ completed protection scheme for feeder and motor applications. The functions are as follows:

Feeder Protection:

- Overcurrent (50/51), 3 stages
- Earth fault (50N/51N), 4 stages
- Directional overcurrent (67), 4 stages
- Directional earth fault (67N), 3 stages
- Broken line (46R)
- Thermal overload (49)
- Zero sequence voltage (59N), 2 stages
- Overvoltage (59), 3 stages
- Undervoltage (27), 3 stages

- Over frequency (81H), 2 stages
- Underfrequency (81L), 2 stages
- Rate of change of frequency (81R)
- Magnetizing inrush (68F2)
- Over excitation (68F5)
- Reverse power (32)
- Auto reclose function (79)
- Circuit breaker failure (50BF)
- Synchrocheck (25)
- Latched trip (86)
- Programmable stages (99), 8 pcs

Motor Protection:

- Overcurrent (50/51), 3 stages
- Earth fault (50N/51N), 4 stages
- Directional overcurrent (67), 4 stages
- Directional earth fault (67N), 3 stages
- Current unbalance (46)
- Incorrect phase sequence (47)
- Stall (48)
- Frequent start (66)
- Undercurrent (46)
- Thermal overload (49)
- Zero sequence voltage (59N), 2 stages
- Overvoltage (59), 3 stages
- Undervoltage (27), 3 stages
- Overfrequency (81H), 2 stages
- Underfrequency (81L), 2 stages
- Rate of change of frequency (81R)
- Magnetizing inrush (68F2)
- Over excitation (68F5)
- Reverse power (32)
- Circuit breaker failure (50BF)
- Synchrocheck (25)
- Latched trip (86)
- Programmable stages (99), 8 pcs

5.6.3.2 Overcurrent protection shall have a wide range of time overcurrent protection curve settings, providing a choice of curve types:

Standard delay characteristics curve family: IEC, IEEE, IEEE2 and RI;

Standard delay formulae with free parameters selecting a curve family (IEC, IEEE, IEEE2) and defining one's own parameters for the selected formula;

Fully programmable inverse delay characteristics;

5.6.3.3 Pick-up setting of three over current stages have to be able to control remotely;

5.6.3.4 Changing setting groups has to able to do via: manually, digital inputs, virtual inputs, virtual outputs or LED indicator signals;

5.6.3.5 The device shall have force start and trip condition for testing;

5.6.3.6 Any protection function has to be able to block by internal and external signals using block matrix;

5.6.3.7 The IED shall have eight programmable stages where user can choose any of the following signal per stage: IL1, IL2, IL3, Io, U12, U23, U31, UL1, UL2, UL3, Uo, f, P, Q, S, Cos ϕ, Io calculated, I1, I2, I2/I1, I2/In, U1, U2, U2/U1, UL (average), Tan ϕ, Prms, Qrms, Srma, THDIL1…3, THDUa…c, IL1…3RMS. Each signal shall have task priority, compare condition, pick-up, operation delay and hysteresis settings. A compare condition shall be possible to be received through IEC 61850 communication protocol;

5.6.4 Applicable standards

The Digital Protective Relay shall comply with the most relevant national, international standards and recommendations for industrial electrical distribution as per tables 1-4 below:

5.6.4.1 Disturbance tests

Table 1: Disturbance tests

Test	Standard & Test class / level	Test value
Emission	IEC/EN 60255-26 (ed3)	
- Conducted	EN 55022, Class A & IEC 60255-25 & CISPR 22	0.15 – 30 MHz
- Emitted	EN 55011, Class A / IEC 60255-25 / CISPR 11	30 – 1000 MHz
Immunity	IEC/EN 60255-26 (ed3)	
- 1Mhz damped oscillatory wave	IEC/EN 61000-4-18 & IEC 60255-22-1	±2.5kVp CM, ±2.5kVp DM
- Static discharge (ESD)	IEC/EN 61000-4-2 Level 4 & IEC 60255-22-2	±8 kV contact, ±15 kV air
- Emitted HF field	IEC/EN 61000-4-3 Level 3 & IEC 60255-22-3	80 - 2700 MHz, 10 V/m
- Fast transients (EFT)	IEC/EN 61000-4-4 Level 4 & IEC 60255-22-4	±4 kV, 5/50 ns, 5 kHz
- Surge	IEC/EN 61000-4-5 Level 3 & IEC 60255-22-5	±2 kV, 1.2/50 µs, CM ±1 kV, 1.2/50 µs, DM
- Conducted HF field	IEC/EN 61000-4-6 Level 3 & IEC 60255-22-6	0.15 - 80 MHz, 10 Vemf
- Power-frequency magnetic field	IEC/EN 61000-4-8	300A/m (continuous), 1000A/m 1-3s
- Pulse magnetic field	IEC/EN 61000-4-9 Level 5	1000A/m, 1.2/50 µs
- Voltage dips	IEC/EN 61000-4-29 & IEC/EN 61000-4-11	30%/1s, 60%/0.2s, 100%/0.05s
- Voltage alternative component	IEC/EN 61000-4-17	15% of operating voltage (DC) / 10min
- Voltage short interruptions	IEC/EN 61000-4-29 & IEC/EN 61000-4-11	30%/10ms, 100%/10ms, 60%/100ms, 100%/5000ms

5.6.4.2 Electrical safety tests

Table 2: Electrical safety tests

Test	Standard & Test class / level	Test value
- Impulse voltage withstand	IEC/EN 60255-27 & EN 60255-5, Class III	5 kV, 1.2/50 µs
- Dielectric test	IEC/EN 60255-27 & EN 60255-5, Class III	2 kV, 50 Hz
- Insulation resistance	IEC/EN 60255-27& EN 60255-5	
- Protective bonding resistance	IEC/EN 60255-27	
- Power supply burden	IEC 60255-1	

5.6.4.3 Mechanical tests:

Table 3: Mechanical tests

Test	Standard & Test class / level	Test value
Device in operation		
- Vibrations	IEC 60255-21-1, Class II / IEC 60068-2-6, Fc	1Gn, 10Hz – 150 HZ
- Shocks	IEC 60255-21-2, Class II / IEC 60068-2-27, Ea	10Gn/11ms
- Seismic	IEC 60255-21-3 Method A, Class II	2G horizontal / 1G vertical , 1Hz-35Hz
Device de-energized		
- Vibrations	IEC 60255-21-1, Class II / IEC 60068-2-6, Fc	2Gn, 10Hz – 150 HZ
- Shocks	IEC 60255-21-2, Class II / IEC 60068-2-27, Ea	30Gn/11ms
- Bump	IEC 60255-21-2, Class II / IEC 60068-2-27, Ea	20Gn/16ms

5.6.4.4 Environmental tests

Table 4: Environmental tests

Test	Standard & Test class / level	Test value
Device in operation		
- Dry heat	EN / IEC 60068-2-2, Bd	65°C (149°F)
- Cold	EN / IEC 60068-2-1, Ad	-40°C (-40°F)
- Damp heat, cyclic	EN / IEC 60068-2-30, Db	• From 25°C (77°F) to 55°C (131°F) • From 93% RH to 98% RH • Testing duration: 6 days
- Damp heat, static	EN / IEC 60068-2-78, Cab	• 40°C (104°F) • 93% RH • Testing duration: 10 days
Device in storage		
- Dry heat	EN / IEC 60068-2-2, Bb	70°C (158°F)
- Cold	EN / IEC 60068-2-1, Ab	-40°C (-40°F)

5.6.5 Specific requirements:

5.6.5.1 Measurement:

The device shall offer complete set of measurement functions. The measurement functions cover phase, line and residual currents, current imbalance, system frequency and harmonics from phase currents. Condition monitoring has to monitor continuously trip circuits, breaker wear and current transformers. The following measurements and protection functions followed from them as to be available:

- Type of measurement: Primary current:
  - Three-phase current;
  - Zero sequence current;
  - Positive sequence current;
  - Negative sequence current;
  - Ratio of negative and positive current;
- Type of measurement: Primary voltage:
  - Phase to earth, phase to phase voltages;
  - Zero sequence voltage;
  - Positive sequence voltage;
  - Negative sequence voltage;
  - Ratio of negative and positive voltage;
  - Short circuit fault reactance, fault location;
  - Earth fault reactance, fault location;
- Type of measurement: Frequency;
- Type of measurement: Power:
  - Active power;
  - RMS active power;
  - Reactive power;
  - RMS reactive power;
  - Apparent power;
  - RMS apparent power;
  - Active energy, exported/imported;
  - Reactive energy, exported/imported;
  - Cosine Phi;
  - Tan Phi;
  - Power angle;
  - Power factor;
  - Phasor diagram view of voltages;
  - Phasor diagram view of currents;
- Type of measurement: Harmonics:
  - 2nd to 15th harmonics and THD of currents;

- 2nd to 15th harmonics and THD of voltages;
- Condition monitoring CB wear;
- Condition monitoring CT supervision;
- Trip circuit supervision (TCS);
- Voltage interruptions;

- Type of measurement: Voltage sags/swells:
- Voltage sags and swells;
- Disturbance recorder;

5.6.5.2 Diagnostics:

- The device shall be equipped with minimum 12 LEDs and 8 out them shall be freely programmable;
- Event log within the device shall be provided:
- Event log has to have a buffer for event codes with time stamp including date and time;
- Events has to be readable to SCADA systems, front panel or by setting software;
- Event buffer size can be modified from 50-2000 events;
- The devices shall further provide disturbance records:
- Triggering shall be settable on any selected measured signal (currents, voltages, status information of DI and DO);
- The sample rate of the recording has to settable from 32/cycle up to 1per minute;
- Each record shall be able to contain 12 channels;
- Memory shall be at least capable of recording 12 faults;
- Continuous self-supervision function with self-diagnostic possibilities shall be included in the devices:
- An internal function self-monitoring mechanism, which activates one fail-safe watchdog changeover contact;
- An automatic device for switching to the fail-safe mode, disabling output controls when a major internal failure is detected;
- Indication of self-test status of the device by LED (alarm) and text;
- The device shall have four diagnostic registers which are readable through remote protocols;

5.6.5.3 Control:

The device shall support customer defined programmable logic for Boolean signals. User configurable logic has to support also something that is not provided by the relay as default;

Following logic functions shall be supported: AND, OR, XOR, AND+OR, CT (count+reset), INVAND, INVOR, OR+AND, RS (set +reset), RS_D (set+D+load+reset);

- Maximum number if input gates shall be 32 and maximum number of logic outputs has to be 20;
- The device shall support also virtual inputs and outputs. The virtual inputs shall act like normal digital inputs. The state of the virtual input can be changed from local display, communication bus and via setting software. There has to be at least 4 virtual inputs and 6 virtual outputs with reset and activation time less than 5 ms;

- The device shall supports also output and block matrixes. Through these matrixes output signals of the various protection stages, digital inputs, logic outputs and other internal signals can be connected to the output relays. Block matrix enables blocking of any protection stage;
- The device has to allow controlling of min. six objects (circuit breakers, disconnectors and grounding switches). Controlling has to be done by “select-execute” or “direct control” principle. Controlling has to be possible by: local HMI, remote communication, via digital input or via function key;

5.6.5.4 Communication:

The device shall have USB communication port in the front for the setting software use and at the back there has to be one of these communication ports: RS-485, 2xRJ-45 Ethernet port or 2xLC Ethernet;

The device shall support wide range of communication protocols: IEC 61850 edition 1 and edition 2, IEC 60870-5-101, IEC 60870-5-103, Modbus TCP, Modbus RTU, DNP 3.0, SPA-bus communication, Human-Machine communication, display and Human-machine communication, PC;

The IEC 61850 communication has to support peer to peer communication (GOOSE). The IEC 61850 interface has to able configure through setting software. Also the same setting software has to be able to generate ICD files;

In case the IED hardware supports two communication gates two separate protocols must be possible to be used simultaneously;

The protective relay shall embed web services to give access to an advanced HMI through a smartphone / tablet application via Wifi local area network;

The following functions has to be accessible in the application:

- Measurements;
- wave-form records;
- Alarms;
- Control functions;
- Active settings;
- Documentation;

The protective relay shall embed a web-server with accessible web-pages to access the device information through a computer, with access to settings, measurements, wave-form records, alarms, control functions;

5.6.5.5 Operation & Maintenance:

Testing:

- Digital protective relays shall be tested prior to commissioning in order to maximise availability and minimising the risk of malfunctioning of the assembly being commissioned;
- Because of the use of digital technology the relay shall guarantee the reproducibility of announced performances over time and shall have undergone full factory qualification;
- The Protective Digital Relay shall therefore be ready to operate without requiring any additional qualification testing that concerns it directly;

Maintenance:

- The Digital Protective Relay shall not need any internal and specific maintenance over time, mainly for parameter settings and after commissioning;

- Nevertheless, connections to the relay shall be checked preventively as well as the quality of output relay contacts to ensure that tripping and closing coils are properly energised and all control logic orders are properly transmitted;
- Communication test possibility should be permanently performed;

Tender documents:

- To support its technical offer description, the bidder shall submit the following documents relative to the Digital Protective Relay:
  - Relay architecture single line diagrams;
  - Technical data sheets;
  - Catalogues;
  - User manuals and installation guide;
  - Test and conformity certificates;
  - Reference lists for similar application;

5.6.5.6 Sustainable development:

The relay manufacturer must ensure that the source of raw materials come from reliable source in terms of sustainable environment development. The manufacturer shall possess RoHS certificate which refers to EU directive: RoHS Directive 2002/95/EC and be able to supply the Product Environmental Profile (P.E.P) of the device on the engineer's request;

5.6.5.7 Buszone arc protection:

All power compartments shall be fitted with an arc detection device as specified below:

- The arc detection device shall be able to detect all possible arcs of different magnitude and spectrums that may occur in any power compartment. The arc detection device shall be monitored by the protection relay;
- Operating Philosophy:
  - The operation of the buszone arc detection scheme shall be a minimum of 2 trip criteria (2 out of 2) and shall be user configurable i.e. light and current, light only, current only, etc;
  - The arc detection scheme shall provide 2 zones of protection separated by the bus section breaker. In the event of the trip criteria being met in any panel in any zone, the arc detection scheme shall isolate that zone by tripping all respective panels in that zone including the bus section. The arc detection scheme shall indicate which arc detection sensor on which panel initiated the bus zone operation;
  - In the event of the failure of an arc sensor in a panel, the arc detection scheme shall disable the buszone arc detection scheme for that respective panel only and shall indicate an alarm accordingly;
  - Breaker failure: A breaker fail element shall be provided such that the respective zone in the buszone arc protection scheme is initiated in the event of a breaker fail condition for any panel;

5.7 AUXILIARY AND SECONDARY WIRING

5.7.1 The auxiliary and secondary wiring shall comply with the requirements for panel/cubicle cables in SANS 1574, IEC 6022-3, IEC 6022-4 or IEC 6022-5 and shall withstand an A.C voltage of 2 kV to earth for 1 minute;

5.7.2 All auxiliary and secondary terminals of wire shall be marked with wire markings. The markings shall be permanent black characters on a glossy contrasting colour background (preferred yellow). Both

ends of the wire shall be marked identically, and shall be consistent with associated drawings, circuit functions and designations and shall comply with **Annex A** of NRS 003/SANS1885;

5.7.3 All dc circuits shall be protected by fuses (black body) in the positive lead and links (white body) shall be provided in the negative lead;

5.7.4 Fuses and links shall be so positioned that they are readily accessible to a person standing on the floor in front of the switchgear. Exceptions are fuses and links mounted on the voltage transformer;

5.7.5 Suitable termination for auxiliary wiring, such as pilot wire connections for cable differential protection, battery supplies, alarm circuits, etc., shall be provided at the rear of each panel;

5.7.6 The minimum external creepage and clearance distances between adjacent terminals and between terminals and earth shall be in accordance with the requirements of SANS 152;

5.7.7 An additional alarm circuit shall be entirely separate from all other circuits and an alarm cancellation switch shall be provided. The alarm cancellation switch shall be of the double throw type, so connected as to avoid the possibility of the alarm cancellation switch being inadvertently left off, after the circuit breaker has been re-closed. The alarm pair of wires shall be terminated at the back of each panel. Further all alarms from the protection relays shall be individually brought back to the communication panel;

5.8 PROTECTION AGAINST CORROSION

5.8.1 The painting process is considered to be of major importance in the highly corrosive climate of the eThekwini area;

5.8.2 The manufacturer shall ensure that the coating system used on the switchgear will satisfy the tests stipulated in **Clause 5.9.5**

5.8.3 The metal shall be treated by means of a zinc phosphate process and thereafter powder coated by means of an electrostatic process;

5.8.4 All washers, nuts and bolts shall be stainless steel;

5.9 TESTS

5.9.1 General:

5.9.1.1 It shall be the responsibility of the supplier to ensure that type tests are valid. eThekwini Electricity may require drawings from the supplier to take to a testing authority for validity;

5.9.1.2 Should reasonable doubt exist as to the validity of test certificates submitted, for example by virtue of modifications made to the switchgear, eThekwini Electricity may direct that further tests be carried out at a recognized test facility in the presence of a representative of the purchaser, on a sample unit of the switchgear in question. The cost of these tests shall be for the expense of the supplier;

5.9.1.3 If switchgear of South African manufacture or assembly to overseas design is offered, test certificates relating to the South African complete switchgear assembly shall be submitted, and shall be accompanied by a statement that the South African manufactured unit is identical (this shall be verified by an accredited test authority in accordance with ILAC, see note below) with the overseas product and the number of such units already produced and installed in South Africa shall be stated;

Note: Identical in terms of all design parameters as developed and tested by the original manufacturer.

5.9.2 Type Test:

5.9.2.1 The supplier shall prove the ability of the switchgear to pass all the mandatory type tests as stated in clause 6.1 a) to g), j), k), n) and o) and if applicable clauses h) and l) of SANS 62271-200. The supplier shall also provide a humidity test report;

5.9.3 Routine tests:

5.9.3.1 The routine test shall be made on each transport unit at the manufacturer's works to ensure that the switchgear is in accordance with the equipment on which the type test has been carried out. All the routine tests shall be in accordance with clause 7.0 of SANS 62271-200;

5.9.4 Tests after erection on site:

5.9.4.1 All switchgear, once installed on site, will be subjected by the purchaser to 90 % power frequency voltage test in accordance with clause 7.105 of SANS 62271-200;

5.9.4.2 All mechanical and electrical functional tests shall be done in accordance with **Section 1.13 of C3.6 – Pre-Commissioning Check Sheet** of this technical specification;

5.9.4.3 Resistance test on all primary connections at not less than 100 A and up to the rated current of the circuit;

5.9.4.4 Primary injection tests with standard settings;

5.9.4.5 Secondary injection tests with standard settings. The results shall be generated via the test set electronically. Example: omnicron or equivalent test set;

5.9.5 Tests on painted surfaces:

5.9.5.1 Protection of coatings against corrosion shall be assessed using test samples of the same materials used in the construction of the switchgear and subjected to the same painting procedures as the switchgear. The following tests shall be performed:

Adhesion test in accordance with SANS 2409: the cross-cutting coefficient shall be not less than 8;

exposure to salt fog for 168 h in accordance with latest version of SANS 9227: the coated surface shall show no visible defects and the underlying metal shall be free from corrosion and scale;

scratch resistance test in accordance with SANS 279: when a mass-load of 1 kg is applied to the test needle, the scratch produced shall not have penetrated to the underlying metal. The scratch shall have no jagged edges;

5.10 MARKING/LABELLING

5.10.1 Main circuit designation labels:

5.10.1.1 Main circuit designation labels shall be blank sandwich-board or equivalent (white-black-white) that can be removed easily for engraving. These shall be located on the front and back of each switchgear panel and shall be at least 150 mm wide and 35 mm high;

5.10.2 Rating plates:

5.10.2.1 All rating plates shall comply with the relevant requirements of clause 5.10 of SANS 62271-200 and shall be of intrinsically corrosion-resistant metal with the following details clearly, legibly and indelibly marked thereon:

- the manufacturer's name;
- the manufacturer's type number;
- the manufacturer's serial number;
- the year of manufacture;
- the rated values;
- the short-time withstand current; and
- arc classification

5.10.2.2 Circuit-breaker rating plates shall comply with the requirements of SANS 62271-100 and shall include the actual ratings to which the circuit-breaker has been type tested. These shall be fixed in a position that is visible when the circuit-breaker is in the service position;

5.10.2.3 Current transformer rating plates shall comply with the requirements of SANS IEC 60044, and shall be duplicated, one fixed to the current transformer, the other fixed in a conspicuous position on the corresponding circuit breaker panel, such that it can be read when the switchgear panel is in service;

5.10.2.4 A main switchboard label shall be supplied with every switchboard. The label shall be mounted centre top of the switchboard. The font size shall be 30 mm in height. The material shall be corrosion resistant metal;

5.10.3 Function labels:

5.10.3.1 All relays shall be appropriately identified to indicate their function;

5.10.3.2 All relays, instruments, fuses, control switches, luminous indicator, test blocks and links, the functions of which are not identified by signs or pictograms, shall be clearly labelled in text with black letters of minimum height 5 mm on a white background, to indicate their functions. All labels shall be securely attached;

5.10.3.3 Fuse labels shall include the fuse rating;

5.10.3.4 Where necessary, labels shall be repeated inside the switchgear;

5.10.3.5 Terminal blocks or rail-mounted terminals shall be labelled to identify them when more than one block is used;

5.10.3.6 Removable doors and panels shall be labelled to facilitate replacement in the correct position;

5.10.3.7 Main circuit labels shall be either on a fixed portion of the panel or on a bracket. They shall not be fixed to removable doors;

5.10.3.8 ON, OFF and EARTH position labels shall comply with clause 5.12 of SANS 62271-1;

5.10.4 Wiring labelling standard for SCADA Gateway

5.10.4.1 The following labeling standard shall be used:

Tele-Control Labeling

W – Control

X– Status Digital IP

XC – Current Analog

XE – Voltage Analog

Other Field Wiring

J12 – DC unfused

A– Main protection Differential

B– Bus Zone

C– Backup Protection

T– Pilots

K– Fused DC

D– Metering

E– VTs

AL– Alarms (General)

5.10.5 Communication Network Labels:

5.10.5.1 All hardware components of the system shall be clearly labelled to indicate its purpose and designation. The switch shall be labelled with the IP address;

5.10.5.2 All cables shall be labelled according to the specification by the eThekwini Electricity Communication Networks Branch;

5.11 SPARES

5.11.1 Spares will not be ordered unless suppliers indicate up front that a particular spare is absolutely necessary to avoid long delays should a component fail. A list of critical spares shall be supplied;

5.12 GENERAL

5.12.1 Switch panels may be rejected if not delivered complete, with all relays, instruments, rating plates and eThekwini Water and Sanitation number plates;

5.12.2 Metering current transformers and voltage transformers shall be sent to eThekwini Electricity, Test Section, Control Centre, 1 Jelf Taylor Crescent Durban, 4001, for testing. The removal and subsequent installation of these instrument transformers in the panels shall be carried out by the successful Tenderer;

5.13 SUPPLY, DELIVERY ASSEMBLY AND COMMISSIONING

5.13.1 Ordering information

The order shall be placed in the following manner:

5.13.1.1 Each order shall be placed for a set of breakers to form a switchboard;

5.13.1.2 An MV schematic with all relevant information will be supplied with each order, which shall also detail the protection requirements;

5.13.1.3 The address (any area within eThekwini Water and Sanitation perimeter) where the switchboard is to be assembled shall be specified at the time of ordering;

5.13.1.4 With respect to the assembly, eThekwini Water and Sanitation contact person name and number will be given;

5.13.1.5 The estimated date of delivery of the switchgear to the address specified in d) above will be given;

5.13.2 Tenderers shall note that the complete assembly, testing and commissioning of the switchboard shall comprise:

5.13.2.1 The supply of the equipment as per the order in **5.13.1** above;

5.13.2.2 Delivery to the address in **5.13.1.3** above;

5.13.2.3 Complete the assembly of the switchboard and the communication panel and its associated control wiring;

Note 1: The successful Tenderer shall be responsible for the full commissioning of the SCADA Gateway from relay to SCADA Gateway;

Note 2: The successful Tenderer shall ensure that handover is undertaken through a data-pack that includes: 61850 configuration of the relays and scheme, configuration of the switch, configuration of the RTU and supervisory schedules & SCADA Gateway cabinet key;

- The installation of the battery charger, its associated batteries as specified in the document;
- All auxiliary cabling shall be installed above the switchgear in cable racks;

- Supply and installation of the cable terminations and connectors as detailed in clauses 5.4.11 and 5.4.12;
- Electrical and mechanical tests and checks shall be performed on the switchboard. Tenderers shall note that the tests and checks shall at least be comprehensive as eThekwini Electricity's tests and checks detailed in Section 1.13 of C3.4 – Pre-Commissioning Check Sheet. Any other tests and checks that are deemed necessary by the successful Tenderer shall be carried out. On completion of the installation and commissioning of the switchgear, the test results and a hand over certificate shall be handed to an official of eThekwini Electricity;

5.14 DOCUMENTATION

5.14.1 Tenderers shall provide the following documentation with each bid:

5.14.2 a typical drawing of each type of switchgear panel, showing all relevant dimensions, including the height of the cable gland plate (if any) above the floor level, a floor plan giving the loads imposed on the foundations and detailed methods of mounting;

5.14.3 a schematic diagram of the primary connections;

5.14.4 a schematic diagram of the LAN;

5.14.5 a logical diagram of GOOSE dependencies;

5.14.6 Configuration files of the IEDs, switches and RTU;

NOTE: TENDERERS SHALL SEPARATE INFORMATION (SCADA, PROTECTION, COMMUNICATION, SWITCHGEAR, GENERAL, etc.) INTO ITS OWN FILES FOR THE EASE OF EVALUATION.

5.14.7 The Tenderer shall submit the following:

5.14.7.1 a fully dimensioned general arrangement of the switchboard, illustrating cable boxes and/or cable clamping and cable termination arrangement;

5.14.7.2 a schematic diagram of the auxiliary circuits of each type of switchgear panel;

5.14.7.3 a comprehensive copy of operating and maintenance manuals;

5.14.8 Failure to submit such information may preclude further consideration of the bid;

5.14.9 When requested an electronic copy of all the drawings shall be supplied;

5.14.10 An electronic copy of the rating plate, auxiliary equipment and DC registration number shall be supplied with every hand over certificate. The electronic copy shall be in a MICROSOFT EXCEL;

5.14.11 All type test certificates shall be supplied with the bid document in a separate file;

5.15 TRAINING

5.15.1 Training shall be provided as follows:

5.15.1.1 Switchgear Operator training priced **per session** comprising of 10 candidates. There will be approximately 5 Sessions required;

5.15.1.2 Switchgear Maintenance and Inspection training shall be undertaken by the OEM specialist and be priced **per session** comprising of 10 candidates. There will be approximately 5 Sessions required;

5.15.1.3 Protection relay training priced per session comprising 10 candidates. There will be approximately 5 Sessions required;

5.15.1.4 SCADA training priced per session comprising 10 candidates. There will be approximately 5 Sessions required;

Note: The SCADA training shall include the complete configuration of the RTU and include a site or workshop installation for DNP3 point testing.

5.15.1.5 Communication equipment training priced per session comprising 10 candidates. There will be approximately 2 Sessions required;

5.15.1.6 The venue shall be provided by successful tenderer;

5.15.1.7 All hardware and firmware shall be provided by the successful Tenderer;

5.15.1.8 All training material shall be provided by the successful Tenderer and shall be in the form of a comprehensive booklet as well as a DVD;

5.15.1.9 The content of the training for items 4.16.1.1 and 4.16.1.2 shall be in accordance with the manufacturers' requirements and eThekwini Electricity's Safety Regulations;

5.15.1.10 The format of the content for the training for items 4.16.1.1 shall be in accordance with the requirements of eThekwini Electricity's SHERQ and Training Centre. A sample of an existing format can be obtained from the Training Centre;

5.15.1.11 The content for 4.16.1.3 and 4.16.1.4 shall cover the engineering of the configuration as well as the setting of the entire protection relay;

5.16 FAILURE INVESTIGATION

5.16.1 Any failure related to the any equipment supplied on this contract within the guarantee period shall be referred to the successful Tenderer. Such failures shall be investigated by the successful Tenderer and a detailed written report be submitted to eThekwini Water and Sanitation within 2 weeks of the successful Tenderer being notified of the failure. The successful Tenderer's portion of the cost of the investigation shall be for the successful Tenderer's account;

5.17 HEALTH, SAFETY, AND ENVIRONMENTAL ISSUES

5.17.1 Tenderers shall provide the following information in respect of each product offered:

5.17.1.1 A list of all materials used in the product, including packaging, and associated chemical data sheets;

5.17.1.2 Whether the product poses any health or safety risks to persons handling the product. In addition, if there are risks, the protective gear required to handle the product, e.g. leather gloves, masks, etc.;

5.17.1.3 How the product should be disposed at the end of its useful life or in the event of failure of the product;

5.17.1.4 Whether any toxic by-products are produced (whether in gaseous, solid or liquid form) in the event of the product being exposed fire or heated to elevated temperatures;

5.17.1.5 Any other pertinent and relevant information relating to health, safety, and environmental issues;

5.17.1.6 What percentage of the product can be recycled;

5.17.2 The Tenderer shall complete an Acceptance of undertaking in terms of the Occupational Health and Safety Act (Act 85 of 1993);

5.17.3 The successful Tenderer's installation team shall undergo eThekwini Electricity's Safety Rules course and a subsequent test, after which these persons would be deemed Specifically Trained Persons and issued with a contractor's identity card.

6. SCOPE AND SPECIFICATION OF MINI-SUBSTATIONS AND "SMART" RING MAIN UNITS

6.1 SCOPE OF SUPPLY/SERVICES

6.1.1 General

6.1.1.1 This specification details the manufacture, testing, supply and delivery of mini-substations and ring main units as specified below and in **Section 1.19 of C3.6**

6.1.1.2 The section is applicable to the same information as described above in section 5: Fixed pattern switchgear and ring main unit technology

6.1.1.3 Tenderers shall note that, as all standards are subject to revision, they are encouraged to investigate the possibility of applying the most recent edition of the above standard;

6.2 COMMON REQUIREMENTS OF MINI-SUBSTATIONS AND RING MAIN UNITS

6.2.1 The ring main units shall be manufactured from either Aluzinc, stainless steel or 3CR12 steel. Other material may be accepted at the discretion of the Project Engineer. The ring main units shall be installed within the eThekwini area of supply and shall thus be protected from corrosion for the conditions as specified in **clause 6.2.2**. All items shall be supplied with a minimum 5-year warranty against corrosion;

6.2.2 Outdoor ring main units shall be housed within an enclosure and fitted onto a concrete plinth. All enclosures shall be manufactured of 3CR12 steel. All nuts, bolts, washers and hinges used in the assembly of the housing and for mounting onto the concrete plinth shall be manufactured with marine grade stainless steel (316). Mini substations shall be supplied on a concrete plinth;

6.2.3 All enclosures shall be protected from corrosion taking into consideration the environmental conditions as in **clause 6.2.2**, and as defined in ISO 9223 for C5 environmental conditions. Details of the coating system used shall be submitted with the bid document, together with proof of compliance to satisfactory performance in C5 environments. All items shall be supplied with a minimum 5-year warranty against corrosion;

6.2.4 The colour of the mini-substation and ring main unit enclosures shall be an acceptable match to colour C37 (light stone) of SANS 1091: 2012;

6.2.5 Transformers shall be protected from corrosion in accordance with SANS 780 for transformers used in corrosive environments;

6.2.6 Door contacts shall be provided for all doors on enclosures and wired to terminal blocks. These contacts shall be integrated into the Intelligent Electronic Device (IED) or Remote Terminal Unit (RTU) for the items fitted with these devices to allow signals to be transmitted to eThekwini Water and Sanitation 's Control Centre;

6.2.7 All enclosure access doors shall be secured with three-point locking mechanisms. No allen cap screws shall be fitted. The doors shall be capable of being padlocked to prevent unauthorised access. A padlock protection facility in accordance with SANS 1029 shall be provided, however, the door handle and padlock protection facility shall accommodate a 50 mm high security padlock with a shackle diameter of 10 mm. The lock used by eThekwini Water and Sanitation is the Union SH50SO high security padlock;

6.2.8 The left door of the LV compartment on the mini-substation enclosure, and the left door of the ring main unit enclosure (for outdoor ring main units) shall be drilled with 4 × 5 mm holes prior to coating of the doors. The holes shall be used by eThekwini Water and Sanitation to pop rivet an A4 sized label to the door. A template of this label and confirmation of the mounting position shall be supplied to the successful Tenderers at time of award. These holes shall be sealed with plastic weatherproof studs/grommets;

6.2.9 The mini-substations shall comply fully with SANS 1029, except where amended by this specification;

6.2.10 Ring main units and ring main unit compartment:

6.2.10.1 The ring main unit and ring main unit compartment of the mini-substation shall comply with the requirements of clause 5.0 of this specification;

6.2.11 The centre switch function of the ring main unit shall be used for connection onto the transformer. This shall be clearly labelled (black writing on a white background) with the words 'LOCAL TRANSFORMER';

6.2.12 Low voltage (LV) switchboard assembly:

6.2.12.1 General:

6.2.12.2 The LV assembly shall comprise of one floor mounting frame supporting:

- 1 × set of 900 A, triple pole and half-size neutral busbars (Aluminium);
- 1 × earth bar (Aluminium) extending the full length of the frame;
- 1 × incoming 630 A switch disconnector;
- 1 × instrument panel;
- 6 × blanking off plates for outgoing circuits;

6.2.12.3 LV assemblies shall comply with SANS 60439-1;

6.2.12.4 All assemblies shall be fitted with removable devices at each end and, as near as possible to the balance line, to facilitate handling during transport;

6.2.13 The incoming switch disconnector shall be positioned as near as practical to the right of the LV assembly. Additional outgoing distributor units will be mounted by eThekwini Water and Sanitation side-by-side. The spacing between the centres of outgoing distributor units shall be 120 mm ± 5 mm;

6.2.14 LV assemblies shall be so designed to ensure that thermal interaction does not unduly affect the performance of any of the components;

6.2.15 Insulating materials shall be of high quality, flame retardant and as non-hydroscopic and resistant to tracking as good manufacturing techniques permit. The main current carrying components shall be electro-tin or electro-silver plated. All fasteners, nuts, bolts etc. shall be hot-dipped galvanized and shall have corrosion-proof locking features;

6.2.16 All parts of the LV assembly shall, as far as practicable, be readily accessible and replaceable without excessive dismantling. All parts of equal size and rating shall be inter-changeable. The general design shall be such that the number of joints shall be kept to a minimum. Storage facilities shall be provided on the mounting frame for all loose devices, e.g. operating handles, padlocking devices;

6.2.17 The minimum rated operational/insulation voltage (Ue/Ui) shall be 400 V/440 V respectively. The rated impulse withstand voltage shall be 8 kV;

6.2.18 The complete LV switchboard assembly shall provide an equivalent protection to IPXXB and it shall not be possible to come into contact with any exposed current carrying components;

6.2.19 Mounting frame:

6.2.19.1 The mounting frame shall be fabricated from mild steel and adequately protected against eThekwini Municipality's highly corrosive environment as specified in clause 6.2.2, be of a robust construction and provide adequate support for the incoming switch disconnector, busbars and outgoing distributor units. Material other than mild steel may be considered at the sole discretion of the Project Engineer, if it is deemed to satisfy all other requirements above;

6.2.19.2 The LV assembly shall readily facilitate the termination of cables from the front;

6.2.19.3 A channel (Unistrut or equal) shall be provided to support outgoing cables. The channel shall be positioned approximately 50 mm above ground, towards the rear and extend the full length of the assembly. There shall be a minimum distance of 450 mm between the centre of the channel and cable terminals of outgoing distributor units;

6.2.20 Busbars:

6.2.20.1 Busbars shall be three-phase, neutral and earth, and, be manufactured from Aluminum. The busbars shall be tinned for heavy duty applications;

6.2.20.2 The neutral bar shall be rated at not less than half that of the phase busbar rating;

6.2.20.3 The earth bar shall be capable of carrying the rated short time withstand current corresponding to that specified in clause 4.7.8 of this specification and as determined by SANS 60439-1;

6.2.20.4 Phase and neutral busbars shall be situated at the rear of the equipment and positioned vertically above each other and in a sequence, red, yellow, blue and neutral from top to bottom. The earth bar shall be mounted in the lower part of the assembly; behind the outgoing cables and immediately above the channel supporting the cable cleats. The spacing between centres from red to white shall be 185 mm and from white to blue shall be 185 mm;

6.2.20.5 Phase busbars shall be colour identified in sequence from top to bottom, red, yellow, and blue. The neutral busbar shall be colour identified black and the earth busbar shall be unmarked;

6.2.20.6 The neutral busbar shall be insulated from the framework and include one terminal for each, incoming circuit and outgoing distributor unit;

6.2.20.7 The earth bar shall be bolted to the frame and include an earth M12 terminal projecting through the right hand end of the frame. The earth terminal shall be suitable for connecting to an external earth bonding conductor and be complete with a corrosion proof flat washer, lock washer and nut;

6.2.20.8 A removable bolted link shall connect the neutral busbar to the earth bar;

6.2.21 Bases:

6.2.21.1 Steel bases shall be hot dip galvanised in accordance with the relevant requirements of SANS 121, be coated with black epoxy tar paint and shall extend the full length of the mini-substation;

6.2.22 Enclosure:

6.2.22.1 The enclosure of the mini-substation shall be manufactured of 3CR12 steel. The colour of the mini-substation shall be an acceptable match to colour C37 (light stone) of SANS 1091: 2012. The roof shall be of the removable type. It shall only be possible to lift the complete mini-substation with the roof installed;

6.2.23 Type and dimensions:

6.2.23.1 The mini-substation shall be of a unitary design and comply with Type B mini-substations in accordance with SANS 1029: 2016. To this effect, the Type B mini-substation base and plinth dimensions shall be taken into account when designing the mini-substation;

6.2.24 Internal arc classification (IAC):

6.2.24.1 The internal arc classification of the mini-substation shall be IAC-AB FLR 25 kA, 0,5 s in accordance with SANS 1029;

6.2.25 Transformers:

6.2.25.1 All transformers shall be manufactured in accordance with SANS 780;

6.2.25.2 All transformers shall be provided with Type C bushings on the medium voltage (MV) side and single phase porcelain bushings on the low voltage (LV) side; these bushings shall be clamped as called for in SANS 780;

6.2.25.3 Transformer terminals shall be suited for the acceptance of both aluminium and copper conductors. To this effect, bushing terminals shall be tinned or silver plated, etc;

6.2.25.4 Connections between the transformer and the cable terminal in the MV compartment shall be made by means of single-core screened cross-linked polyethylene copper cables in accordance with SANS 1339 for the rated voltage of the connected equipment and having a conductor of minimum cross-sectional area rated for the transformer. The connectors shall comply with SANS 876: 2016 for Type 4 connectors. These connectors shall be fitted on both the transformer as well as the switchgear side of the cable;

6.2.25.5 Linear tap switches shall not be accepted. The tap switch shall have two O-ring gaskets;

6.2.25.6 Transformers shall have a tapping range of -5 %, -2,5 %, 0 %, +2,5 %, +5 %, achieved by means of an off-circuit tapping switch;

6.2.25.7 The operation of the off-circuit tapping switch shall be such that by turning the handle clockwise, the tap position number is increased;

6.2.25.8 If corrugated cooling radiators are utilised in the design of the transformer, then this design is to ensure that the cooling radiators are adequately protected against mechanical damage as well as corrosion;

6.2.25.9 The transformer shall be fitted with a bolted main tank lid; The transformer shall be fitted with a prismatic oil gauge mounted onto the tank. Alternative oil gauges shall be subject to the approval of the Project Engineer;

6.2.25.10 The oil gauge and tap switch depicting the respective tap positions shall be easily visible and readily accessible with the transformer door of the mini-substation open;

6.2.25.11 A suitable barrier in accordance with SANS 1029 shall be fitted over the LV terminations of the transformer;

6.3 SPECIFIC REQUIREMENTS OF MINIATURE-SUBSTATIONS

6.3.1 Service conditions:

6.3.1.1 The “Smart” RMU shall be suitable for continuous operations under the basic service conditions indicated below:

- Altitude: maximum 1000 m above sea level;
- Ambient air temperature: - 25 ° C to + 50 ° C;
- Maximum ambient temperature average value during 24 h: 50 °C;
- Maximum relative humidity: maximum 95%;

6.3.1.2 As in conditions beyond above ‘basic service condition’, manufacturer shall declare whether current de-rating is necessary;

6.3.1.3 The RMU shall be capable of being exposed to high relative humidity and ambient air pollution;

6.3.1.4 The RMU shall be capable of being installed in either concrete indoor substations or in compact metal substations and kiosks with an IP54 rating. Manufacturer shall give all details regarding its solution for free-standing outdoor installations when requested;

6.3.2 System parameters:

Type of construction	Metal enclosed switchgear
Insulating medium	Vacuum
Expected operating lifetime	30 years
Switchgear partition class	PM
Loss of service continuity class	LSC2

Degree of protection	
High voltage live parts	IP67
Front face	IP3X
Low voltage control compartment	IP3X
Mechanism	IP2XC
Cable compartment	IP2XC
Outdoor enclosure	IP54
Protection against mechanical impact	IK07

Rated voltage	**Ur**	(kV)	12		17.5	24		
Rated frequency	**f**	(Hz)	50 / 60					
Rated short-time withstand current	**Ik**	(kA rms value)	21	25	21	12.5	16	20
	Duration **tk**	(s)	1		1 or 3	1 or 3		
Making capacity of switch and earthing switch (by 50Hz)	**Ima**	(kA peak value)	52.5	62.5	52.5	31.25	40	50
Short-circuit breaking capacity of circuit breaker	**Isc**	(kA)	21	25	21	12.5	16	20
Industrial frequency withstand voltage (50 Hz 1min)	Insulation **Ud** Phase-phase, phase-earth	(kV rms value)	28		38	50		
	Isolation **Ud** Across isolating distance	(kV rms value)	32		45	60		
Lightening Impulse withstand voltage (1.2/50µs)	Insulation **Up** Phase-phase, phase-earth	(kV peak value)	75		95	125		
	Isolation **Up** Across isolating distance	(kV peak value)	85		110	145		

Number of phases	Three
Rated Current	
Switch	400 or 630 A
Transformer feeder	Depends on the fuse installed
Branch circuit breaker feeder	630 A

Rated current cable charging on switch	110 A
Rated current no-load transformer breaking capacity on switch	16 A
Internal arc class	A-FL up to 20 kA 1 s (with option)
Number of mechanical cycles Switch and earthing switch Circuit breaker	 1000 2000
Number of electrical cycles at rated current	100
Number of operations at rated short-circuit current on circuit breaker	3 breaking operations

6.3.3 Function requirements:

6.3.3.1 The following functions shall be available for the RMU:

- Switch-disconnector;
- Disconnecting circuit breaker 630 A for network points;
- Transformer protection feeder by disconnecting circuit breaker 630 A;
- Transformer protection feeder by fuse-switch combination;
- Bus coupler by switch-disconnector;
- Bus coupler by disconnecting circuit breaker;
- Direct cable connection to busbars;
- MV Metering;

6.3.4 General stipulations regarding design and development of switchgear:

6.3.4.1 Introduction:

- Maximum 5 MV function units could be combined in one metallic enclosure, extensible or compact, for connection, power supply and protection of transformer;

6.3.4.2 Switchboards:

- The switchgear and busbar shall all be contained in a stainless steel enclosure filled with SF6 at maximum 0.3 bar relative pressure to ensure the insulation and breaking functions. This compartment is a sealed pressure system, in accordance with the IEC 62271-1 standard, with a service life time of 30 years. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1 % per year. No refilling of the gas shall be required during the whole service life time;
- It shall provide full insulation, making the switchgear insensitive to the environment (temporary flooding, high humidity...). Assembled, the active parts of the switchgear shall be maintenance-free;
- The tank shall be made of ≥2 mm AISI 304 unpainted stainless steel and be able to withstand an accidental internal overpressure of ≥ 2.1 bars (relative). The colour shall be RAL 9002 for the enclosure and RAL9005 for the mimic panel;

- The switchboards shall be suitable for mounting on a trench or base. Each switchboard shall be identified by an appropriately sized label which clearly indicates the functional units and their electrical characteristics;
- The switchgear and switchboards shall be designed so that the position of the different devices is visible to the operator on the front of the switchboard;
- The switchboards shall be designed so as to prevent access to all live parts during operation without the use of tools;

6.3.4.3 Dielectric medium:

- Gas is the preferred medium for MV RMUs. Oil filled switchgear will not be considered;

6.3.4.4 Earthing of metallic parts;

- There shall be continuity between the metallic parts of the switchboard and cables so that there is no electric field pattern in the surrounding air, thereby ensuring the safety of people. The main earthing connection point shall be designed for connection to substation frames without dismantling any bars;

6.3.4.5 Earthing of the main circuit:

- The cables shall be earthed by an earthing switch with short-circuit making capacity, in compliance with IEC 62271-102 standard. The earthing connection can only be operated when the switch is open;
- The earthing switch shall be fitted with its own operating mechanism and manual closing shall be driven by a fast-acting mechanism, independent of operator action;
- The moving contacts of the earthing switch shall be visible in the closed position through transparent covers;

6.3.4.6 Switch-disconnector:

- They shall be maintenance-free with breaking in low pressure SF6 gas. The position of the contacts shall be clearly visible on the front of the switchboard. The position indicator shall provide positive contact indication in accordance with IEC 62271-102 standard;
- The switches shall be of the extended mechanical endurance in accordance with IEC 60265-162271-103 standard. The switch shall have 3 positions, open-disconnected, closed and earthed, and will be constructed in such a way that natural interlocking prevents unauthorized operations;
- They shall be fully mounted and inspected in the factory;
- Manual opening and closing will be driven by a fast-acting mechanism, independent of operator action;
- Each switch can be fitted with an electrical operating mechanism in a special reserved location, without any modification of the operating mechanism and without de-energizing the switchboard;

6.3.4.7 Transformer Protection:

- The MV/LV tee-off transformer shall be protected by circuit-breaker, or by switch-fuse combination;

6.3.4.8 Circuit breaker:

- The circuit breakers shall be vacuum interrupter type;

- It shall be maintenance free. The position of the power and earthing contacts shall be clearly visible on the front of the switchboard. The position indicator shall provide positive contact indication in accordance with IEC 62271-102 standard;
- The circuit breakers shall have 3 positions: open-disconnected, closed and earthed and shall be constructed in such a way that natural interlocks prevent all unauthorised operations;
- They shall be fully mounted and inspected in the factory. They shall be fully mounted and inspected in the factory;
- The rated current of circuit breaker as network points shall be of 630A. The rated current of circuit breaker as transformer feeder shall be of 630A;
- An operating mechanism can be used to manually close the circuit breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping by an integrated push button. There will be no automatic reclosing;

6.3.4.9 Circuit-Breaker Protective Relay:

- The circuit breaker shall be associated with an integrated electronic/ micro-processor type protection unit;
- The system shall be self power (from current sensors) for the basic overcurrent protection; i.e. phase-phase and phase-earth overcurrent;
- The current sensors, SE brand, shall be mounted on the bushings, in order to protect cable termination, and be independent of the MV cables;
- The minimum activation current of the relay shall be.
  - 15A for 630A feeder;
  - 10A for 630A feeder (trx);
  - 5A for special application on small size transformer feeders;
- Each relay shall have following features:
  - Phase-phase overcurrent protection;
  - Phase-earth overcurrent protection;
  - Display with indication of flow current, peak current;
  - Feature to neutralize the inrush current of power transformer (so as not to trip the phase-earth current);
  - Trip indication, with origin of the fault;
- The complete system shall have Trip circuit supervision (ANSI 74TC);
- The protection system shall be all mounted, wired, tested at factory;
- As option the relay will have:
  - Communication link (Modbus RS485);
  - Thermal overload (ANSI49);
  - Load history;
  - Breaking current history;
  - Event history;
  - External trip input;

- Very sensitive earth fault;

- It is accepted that relay is dual powered for these additional options (ie self power for basic protections and auxiliary powered for the options);

- Protection relay and CT should be provided with same brand as cubicle;

6.3.4.10 Transformer protection feeder by switch-fuse combination:

- The switches in switch-fuse combination shall be of the maintenance-free, gas type. The position of the contacts shall be clearly visible on the front of the switchboard. The position indicator shall provide positive contact indication in accordance with IEC 62271-102 standard;

- The switches shall have 3 positions, open-disconnected, closed and earthed, and will be constructed in such a way that natural interlocking prevents unauthorised operations;

- The switches shall be fully mounted and inspected in the factory;

- An operating mechanism can be used to manually close the switch and charge the mechanism in a single movement;

- It shall be fitted with a local system for manual tripping by an integrated push button;

- Fuses shall be installed in 3 individual sealed chambers metallised on the outside and detachable. They shall be mounted in series with the switch with the following operating mode: blowing of a fuse releases a striker pin which causes three-phase opening of the switch and prevents reclosing. The fuse chamber shall be able to be changed when needed;

6.3.4.11 MV Metering:

- MV Metering shall be carried out by a factory assembled air insulated cubicle with type-tested design;

- This unit shall be totally closed, without any ventilation. Connection with adjacent cells will be direct through bus bar and MV cables shall not be used;

- VTs could be plugged upstream or downstream of CT's and a fuse protection shall be possible;

- The following configuration shall be available:

- 2 VTs phase-phase, 2 VTs phase-earth, 3 VTs phase-earth;

- 2 or 3 CTs;

6.3.4.12 RMU bushings:

- It is preferable to have all bushings accessible from the front of the RMU. Bushings along the sides or the rear of the RMU are not acceptable. The bushings should be conveniently located for working with cables specified and allow the termination of these cables in accordance with the instructions supplied;

- The profiles of the cable connection bushings shall be in compliance with EN 50181 standard;

6.3.4.13 RMU cable clamps:

- A non ferro-magnetic cable clamp arrangement must be provided for all network cables terminated on the RMU;

6.3.4.14 Padlocking facilities:

- Circuit breakers, switches and earthing switches can be locked in the open or closed position by 1 to 3 pad locks;

6.3.4.15 Voltage indicators and phase comparators:

- Each function shall be equipped with a Voltage Presence Indicator System on the front cover to indicate whether there is voltage in the cables. The voltage indicator shall be in compliance with IEC 62271-206 standard. The capacitive dividers will supply low voltage power to the lamps. The lamps shall be of high performance LED technology to insure high visibility and long life duration. Three inlets will be used to check the phase concordance;
- As an option, the voltage Presence Indicator shall be able to provide an analog output signal;
- For all models, the lamp visibility shall not be altered by a fault on the connection to the phase concordance unit, even a short circuit;
- It shall be possible to replace the voltage presence indicator while unit remains energized, guaranteeing the safety of people;
- The manufacturer shall provide the phase concordance checking unit;

6.3.4.16 Voltage Measurement:

- The voltage measurement should be provided by LPVT sensors since LPVT, without magnetic cores, is insensible to core saturation due to overvoltage, ferro resonance issues and short-circuits on secondary side;
- LPVT sensors should be mountable on T cable connectors for each phase during cable installation. And it's no need to disconnect for cable testing 42kV 15min;
- Each phase voltage data should be fed back through a unique hub linked to the FRTU with RJ45;
- LPVT sensors should be IEC 60044-7 certified. This information should be listed in the nameplate of LPVT;
- LPVT sensors should be 0.5 Class to ensure proper power measurement;

6.3.4.17 Safety of people:

- Any accidental overpressure inside the sealed chamber will be limited by the opening of a pressure limiting device in the lower part of the enclosure. Gas will be released to the rear of the switchboard away from the operator;

6.3.4.18 Operating lever:

- An anti-reflex mechanism on the operating lever shall prevent any attempts to reopen immediately after closing of the switch or earthing switch. All manual operations will be carried out on the front of the switchboard;
- The effort exerted on the lever by the operator should not be more than 250 N for the switch and 250 N for the circuit breaker;

6.3.4.19 Front plate:

- The front plate shall have an IP3X degree of protection. The front shall include a clear mimic diagram which indicates the different functions. The position indicators shall give a true reflection of the position of the main contacts. They shall be clearly visible to the operator;
- The lever operating direction shall be clearly indicated in the mimic diagram. The manufacturer's plate shall include the switchboard's main electrical characteristics;

6.3.4.20 Cable insulation testing:

- It must be possible to test the core or the sheath insulation of the network cables while RMU remains energized at rated voltage, without access to cable compartments. It shall be possible to

carry out the phase by phase testing through a built-in facility. The maximum test voltage shall be 42 kV DC for 10 minutes;

6.3.4.21 Dimensions:

- The overall dimensions shall not be greater than the followings:

RMU standard non-extensible:			
	Height	Depth	Width
1 functions	1200 mm	775 mm	500 mm
2 functions	1200 mm	775 mm	860 mm
3 functions	1200 mm	775 mm	1050 mm
4 functions	1200 mm	775 mm	1480 mm
RMU standard extensible:			
1 function double-extensible	1200 mm	775 mm	500 mm
For RMU with 2, 3, 4 or 5 functional units: 50 mm more than non-extensible range on each extensible side:			
RMU non-extensible with free choice of each functional unit:			
2 functions	1200 mm	775 mm	1050 mm
3 functions	1200 mm	775 mm	1480 mm
For RMU with 2 or 3 functional units: 50 mm more than non-extensible range on each extensible side.			

6.3.4.22 Finishing:

- The device shall be low-maintenance;
- All metallic parts shall have rust protection. Operating mechanisms shall be able to operate after a 200 hours salt fog test as defined in IEC 60068-2-11;
- Two lifting rings shall be installed on the top of the switchboards for handling;

6.3.4.23 Rating plate:

- An external rating plate shall be fixed to each LV switchboard assembly detailing the following information:
  - Serial number which shall be unique to each assembly;
  - Year of manufacture;
  - Normal current rating of the phase busbar;
  - Gross weight, when fully equipped (kg); and
  - Manufacturer's name and reference number;

6.3.4.24 Circuit labels:

- Each incoming switch disconnector unit shall be provided with a circuit label;
- The circuit labels shall be 75 mm × 50 mm and made of insulating material. This label shall be mounted at the top of each circuit and securely fitted without the use of screws. It shall be possible to slot the label into position and remove it from the front of the assembly. The labels shall be suitable for engraving by the eThekwini Water and Sanitation to show black letters on a white background;

6.4 ADDITIONAL REQUIREMENTS FOR "SMART-READY" RING MAIN UNITS (OUTDOOR)

6.4.1 Where 'Smart Ready' ring main units are specified, these units shall be fitted with all auxiliary equipment required for automation (control and indication) of the ring main unit, with the only omission being the remote terminal unit itself. As such, all position switches, motor mechanisms, current transformers and all other associated equipment shall be completely fitted to the ring main unit and wired to the female end of a plug connector(s) which shall be located/mounted in the remote terminal unit enclosure;

6.4.2 A remote terminal unit enclosure shall be securely fitted onto the left side of the ring main unit enclosure, shall be side facing and elevated off the ground level. Corrosion protection requirements shall apply as per this specification. The enclosure shall have suitable space and mounting arrangements to accommodate the remote terminal unit with associated wiring and equipment, as well as have an additional 350 mm height across the length of the RTU enclosure to accommodate for the modem and communication equipment. A pre-cut hole of 20 mm diameter for the antenna cabling shall be supplied and sealed with a weatherproof grommet on the top of the remote terminal unit enclosure;

6.4.3 The remote terminal unit used shall be in accordance to clause 6.5 of this specification. In addition, all wiring from the remote terminal unit shall terminate into the male end of a plug connector(s) of clause 6.4.1 to achieve full functionality of the remote terminal unit and ring main unit.

6.4.4 No additional wiring or modifications to the 'Smart Ready' ring main units shall be required. It shall be possible to connect the remote terminal unit of clause 6.5 to the ring main unit via the plug connector(s) to achieve full functionality;

6.4.5 The LV supply to the remote terminal unit shall be via the ring main unit enclosure. Refer to clauses 6.4.1 and 6.4.2. The LV supply shall be wired to a terminal block within the RTU enclosure;

6.4.6 All wiring schematics used shall be supplied with the bid documents;

6.4.7 Manual operation of 'Smart Ready' ring main units shall not require the winding/charging of the opening/closing mechanism via the handle for operation;

6.5 ADDITIONAL REQUIREMENTS FOR RING MAIN UNITS FITTED WITH AN RTU (INDOOR)

6.5.1 Where ring main units are specified to be fitted with remote terminal units, the remote terminal unit used shall be in accordance with clause 6.5 of this specification;

6.5.2 The remote terminal unit shall be fitted to the left side of the ring main unit and shall be front facing;

6.5.3 All wiring between the ring main unit and remote terminal unit shall be via a plug connector(s) as for 'Smart Ready' ring main units in clauses 6.4.1 and 6.4.2 to achieve full functionality of the remote terminal unit and ring main unit;

6.5.4 The LV supply to the remote terminal unit shall be wired from the top end of an LV supply connector block with spring-loaded terminals mounted to the left side of the ring main unit below the remote terminal unit. These terminals shall be clearly marked live, neutral and earth;

6.5.5 Further provision shall be made to clamp the substation LV supply cable below these terminals;

6.5.6 Manual operation of ring main units with remote terminal units shall not require the winding/charging of the opening/closing mechanism via the handle for operation;

6.6 REQUIREMENTS OF REMOTE TERMINAL UNITS (RTUs)

6.6.1 'Smart Ready' ring main units and ring main units fitted with RTUs (as specified) shall be integrated into an automation system. This shall be achieved via the RTU. The RTU and associated components shall be housed within a lockable cabinet. Operation functions via the RTU shall be possible without unlocking the cabinet. Access to the components of the RTU shall only be possible with the RTU cabinet unlocked;

6.6.2 The automation and monitoring functions shall achieve the following:

6.6.2.1 Short circuit/earth fault indication for remote and local reading;

6.6.2.2 Remote switch position indication;

6.6.2.3 Remote opening/closing of switches;

6.6.2.4 Remote measurement of current;

6.6.2.5 Local/remote switch;

6.6.2.6 A.C. fail alarm;

6.6.2.7 Battery charger faulty alarm;

6.6.2.8 RTU door open alarm; and

6.6.2.9 Ring main unit door open alarm (outdoor units).

6.6.3 The RTU shall be fitted with a battery and charger unit compatible for its operation/duty. A separate a.c. circuit breaker shall be provided to isolate a.c. supply to the RTU and modem. A d.c. supply of 12-32 V, 1,5 A shall be provided to power the modem and shall be clearly labelled;

6.6.4 The RTU shall be able to communicate via DNP3.0 over TCP/IP. The bidder shall provide a DNP3.0 over Ethernet TCP/IP certificate of compliance issued by an independent authority listed on the DNP3 website (www.dnp.org) and the full implementation table of the protocol;

6.6.5 The RTU shall have a 10/100 Ethernet port. The Ethernet port shall allow for DNP3.0 communication to the master station and shall also allow for remote configuration. The RTU shall have the capability of being configured through the web browser. The status of the equipment shall be represented through the web browser. The RTU shall have the ability to import a configuration file for the SCADA point mapping. A template configuration file shall be loaded on each RTU delivered to eThekwini Water and Sanitation. This template shall be developed by eThekwini Water and Sanitation together with the successful bidder. The configuration file shall be exportable and in a readable format and shall be workable when the RTU is disconnected i.e. when offline;

6.6.6 The RTU shall have comprehensive self-test and diagnostic facilities. Alarms from self-test shall be able to be configured as internal indication bits within the DNP3.0 protocol;

6.6.7 The RTU shall have the ability to force remote points and shall support wireless updates;

6.6.8 A modem mounting plate shall be supplied to accommodate a modem of size 300 mm (width) × 250 mm (height) × 100 mm (depth) within the RTU cabinet'

6.6.9 A pre-cut hole of 20 mm diameter for the antenna cabling shall be supplied and sealed with a weatherproof grommet on the top of the RTU cabinet (for both indoor and outdoor RTU units);

6.6.10 All LV wiring shall be wired to spring-loaded terminals within the MV compartment;

6.6.11 All wiring shall be marked with clip-on labels. The wiring labelling standard for SCADA which shall be used is as follows:

6.6.11.1 Tele-Control Labelling:

W – Control
X – Status Digital IP
XC – Current Analogue
XE – Voltage Analogue

6.6.11.2 Other Field Wiring:

A – Main protection Differential
AL – Alarms (General)
B – Bus Zone
C – Backup Protection
D – Metering
E – VTs
J12 – Unfused D.C.
K – Fused D.C.
T – Pilots

6.6.12 Full wiring diagrams shall be supplied with the bid documents;

6.6.13 Basic Units

- Compact module for combined automation and telecontrol function for DIN rail mounting and local operation with integrated four function keys and display.
- Dimension 124 x 128 x 123 mm (HxWxD).
- Integrated power supply DC 24-60 V DC
- Internal 12 galvanically isolated digital inputs and 8 digital outputs
- max. 116 in-/outputs via coupling module up to max. 6 external I/O modules
- max. 20.000 data points
- 2x Ethernet LAN, 1x RS485 and 1x RS232 interface
- Data storage on SD card up to 2 GB, plug-and play for start-up service
- Multi-point communication with RS232 or RS485,
- Freely selectable protocols:
- IEC 60870-5-101, IEC 60870-5-103
- DNP3 and Modbus RTU as well other serial protocols
- LAN/WAN networks accordance with the standards
- IEC 60870-5-104,
- IEC 61850 Client + Server Ed.1/2, DNP3 TCP/IP or Modbus TCP
- Dial up traffic via modem: PSTN, ISDN, GSM and TETRA
- Temperature range:
- X -25°C to +70°C
- O -40°C to +70°C
- Basis unit with modular design for combined automation and telecontrol function for DIN rail mounting
- Dimension 132 x 30 x 142 mm (HxWxD)

- max. 128 in-/outputs via coupling module up to max. 8 external I/O modules
- max. 20.000 data points
- Extended Temperature range -40°C to +70°C
- Support of redundant power supply
- Data storage on SD card up to 2 GB, plug-and play for commissioning and service
- Multi-point communication with RS232 or RS485,
- Freely selectable protocols:
- IEC 60870-5-101, IEC 60870-5-103
- DNP3 or Modbus RTU as well other serial protocols
- LAN/WAN networks accordance with the standards
- IEC 60870-5-104,
- IEC 61850 Client + Server Ed.1/2, DNP3 TCP/IP or Modbus TCP
- Dial up traffic via modem: PSTN, ISDN, GSM and TETRA
- Communication interfaces
- X 2x Ethernet LAN, 1x RS485 and 1x RS232 interface
- O 2x Ethernet LAN, 1x RS485, 1x RS232, 1x selectable interface RS232/RS485 and one Integrated GPRS Modem
- Power Supply
- Dimension 132 x 30 x 142 mm (HxWxD)
- X DC 24 to 60 V; DC 110 to 220V, (12W)
- O DC 24 to 60 V, (12W)
- O DC 110 to 220 V, AC 230 V (45W)
- Redundant Power Supply
- Dimension 132 x 30 x 142 mm (HxWxD)
- X DC 24 to 60 V; DC 110 to 220V, (12W)
- O DC 24 to 60 V, (12W)
- O DC 100 to 220 V, AC 100-240 V (45W)
- O Basis module for combined automation and telecontrol function for DIN rail mounting
- Dimension 132 x 30 x 142 mm (HxWxD)
- max. 400.000 data points
- Operation temperature range -25°C to +70°C
- 2x Ethernet LAN, 1x RS484 and 1x RS232
- Expandable with external I/O modules; local and up to 15 remote I/O rows, each row with max. 8 I/O modules
- Optionally with additional communication interface modules
- Up to 30x serial interfaces or
- Up to 10 Ethernet interfaces or
- Up to 5 Ethernet and 25 serial interfaces
- Multiple communication with up to 8 protocols (expandable up to 24 protocols) via RS232, RS486 and LAN/WAN- networks according standards:
- IEC 60870-5-104, IEC 61850 Client and Server Ed.2, DNP3 TCP/IP, Modbus TCP
- Others: Profibus DP Master, PROFINET I/O Master
- Dial up traffic via modem: PSTN, ISDN, GSM and TETRA
- Power Supply
- Dimension 132 x 30 x 142 mm (HxWxD)
- O DC 24 to 60 V; DC 110 to 220V, (12W)
- O DC 24 to 60 V, (12W)
- X DC 110 to 220 V, AC 230 V (45W)
- Redundant Power Supply
- Dimension 132 x 30 x 142 mm (HxWxD)
- X No
- O DC 24 to 60 V; DC 110 to 220V, (12W)
- O DC 24 to 60 V, (12W)
- O DC 100 to 220 V, AC 100-240 V (45W)

- Interface module for connection of remote I/O rows, with up to 15 I/O rows, each with up to 8 I/O modules or up to 4 remote 19“ racks equipped with up to 16 I/O modules or mixed configuration of I/O rows and 19“ racks
- Ring-, Star and Daisy Chain-configurations are possible
- Dimension 132 x 30 x 142 mm (HxWxD)
- X without
- O with interface module for extension
- Communication module for Ethernet, max. 2 modules
- Dimension 132 x 30 x 142 mm (HxWxD)
- Free configurable, integrated software-based firewall,
- Redundancy protocols RSTP, HSR, PRP, Line mode
- O without
- X 1x module with up to 5 Ports for connection of Ethernet based communication
- structures
- O 2x module with up to 10 Ports for connection of Ethernet based communication
- structures
- O In conjunction of a hardware-based-application-layer-firewall
- Communication module, 5x serial interfaces
- 3x RJ45 (2x RS232, 1x RS485)
- 2x Push-In terminal 8-pole (switchable RS232/RS485/RS232)
- Transmission rate up to 115.2 kbit/s (depending on the protocol)
- O without
- X with 1x serial communication modules (5 serial ports)
- O with 2x serial communication modules (10 serial ports)
- O with 3x serial communication modules (15 serial ports)
- O with 4x serial communication modules (20 serial ports)
- O with 5x serial communication modules (25 serial ports)
- O with 6x serial communication modules (30 serial ports)
- Extensions of the functionality through additional licenses
- The licenses easily be transmitted with the Import function into the parameter set with the engineering tools.
- The licenses are delivered on USB sticks.
- O Extended processing/communication with virtual CPUs
- Up to 4x EPCI (extended processing)
- EPCI = Extended-Processing-Communication-Interface
- Up to 4 protocols on each EPCI (max. 24 protocols)
- Each EPCI with one additional logic function (PLC)
- Max. 400.000 data points on each EPCI
- Coupling of existing 19“ racks with I/O modules
- For permanent operation a license for each EPCI
- O Redundancy
- Device redundancy with PLC synchronization via the Ethernet based I/O bus incl. singular I/Os (via encrypted I/O bus)
- Device redundancy with PLC synchronization via routed IP network
- Integrated system voter function
- Global and protocol-selective voting
- Soft or hardware voting to select the active device
- For permanent operation a license for each EPCI
- O IEC 60870-5-104 Application Layer Firewall with stand-alone TCP/IP stack
- (stack separation)
- unencrypted IEC 60870-5-104 central/substation
- Routing of the data of the network interface taken place only on layer 7 (stack separation)
- IEC 60870-5-104 Edition 2.0 interoperability
- IEC 60870-5-104 Redundancy according IEC 60870-5-104 Edition 2.0
- Up to 100 remote stations
- Data throughput limit

- White list filter
- No other network services are possible on this interface
- For permanent operation a license for each EPCI
- O Third-party applications using Container technology
- Web based HMI APP (customer specific web server, using RTU data)
- Server APP LDAP, Radius, Syslog, FTP within a secure environment Customer specific APP: user defined communication protocols and data point conversions
- Separation of external application and RTU functionality
- (telecontrol, automation and interfaces)
- No connection and no impact in the RTU system
- (telecontrol, automation and interfaces)
- Up to 3 external applications supported on each device
- For permanent operation a license for each EPCI
- Optional I/O modules for extension of the basis unit
- O LED Extension module for I/O-rows
- Dimension 132 x 30 x 142 mm (HxWxD)
- For horizontal and vertical mounting
- Operating temperature -40°C .. +70°C
- Power consumption < 0.6W
- Position is free selectable (on the right side of the power supply)
- Display of process information for up to 8x I/O modules
- Additional error information per I/O module
- Subsequent extension without additional engineering
- O Binary Input module
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 16 binary inputs (2 groups of 8 each) for single point, double-point or count pulses
- Galvanically insulated by opto-couplers
- Each group has a common return
- Signal voltage 24 VDC, 48/60 VDC, 110 VDC or 220VDC
- Removable screw terminals
- Acquisition with a resolution of 1 ms
- Firmware filter
- Bounce suppression
- O Binary Output module (Relais)
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 8 relay outputs (4 groups, 2 each)
- Galvanically insulated
- Secure output for pulse commands 1-pole, 1 1/2-pole or 2-pole
- Single, double and tap commands as well indications
- Configurable command output
- Switching voltage 24 - 220/110 VDC or 230 VAC
- Outputs switchable with DC and AC voltages
- Removable screw terminals
- 1-out-of-n Check
- O Binary Output module (Relais), secure command output
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 12 relay outputs (4 group)
- Galvanically insulated
- Secure output for pulse commands 1-pole, 1 1/2-pole or 2-pole
- Single, double and tap commands as well indications
- Configurable command output
- Nominal switching voltage 24/48&60/220 VDC
- Current switching capacity capacity 1A continously, up to 4A short term

- 1-out-of-n Check
- External circuit test before command output (current flow test)
- Removable screw terminals
- O Binary Output module (Transistor)
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 16 transistor outputs (2 groups each 8)
- Galvanically insulated
- Secure output for pulse commands 1-pole
- Single, double and tap commands as well indications
- Switching voltage 24-60 VDC
- Continuous current nominal 0,5A; max. 1A
- Removable screw terminals
- O Analog Input module 4x +/- 20mA/ +/- 10 V
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 4 analog inputs (4 groups of 1 each) for currents and voltages
- Galvanically insulated by transformers
- Acquisition of currents ±20 mA
- Acquisition of voltages ±10 V
- Resolution of 0.004% refer to the measuring range
- Accuracy of 0.15% at +25C
- Removable screw terminals
- Automatic calibration
- O Analog Input module for temperature (4x Pt100/Pt1000/Ni100)
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 4 inputs (2 groups each 2) for temperature
- Galvanically isolated via optocoupler
- Acquisition via Pt100/Pt1000/Ni100 resistance measurement in 2-wire, 3-wire and 4-wire technology
- Resolution 10 m□ (Pt100, Ni100) and 100 m□ (Pt1000)
- Accuracy of 0,19% to 50°C
- Removable screw terminals
- O Analogue Input module
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 3x Low-Power (LoPo) inputs for measurement current 225 mV acc. IEC 60044-8 Input voltage
- max. measurement current 200% I
- 3x Inputs for measurement voltage 100/√3 VAC, 230 VAC, 415/√3 VAC (parameterizable)
- max. measurement voltage range 150% U
- 16 Bit resolution
- Sampling of 20 values per system period
- Removable screw terminals
- O Analogue Input module
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 3x Low-Power (LoPo) inputs for measurement current 225 mV acc. IEC 60044-8 Input voltage
- max. measurement current 200% I
- 3x Low-Power (LoPo) inputs for measurement voltage 3.25/√3 VAC
- max. measurement voltage range 150% U
- 16 Bit resolution
- Sampling of 20 values per system period
- Removable screw terminals
- O Current transformer adapter for analog inputs
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail

- Current transformer adapter for analog input module
- 3x nominal current max. 1A or 5 A with 100% overrange
- Acquisition of currents through measuring sensors
- Measuring range 1 A or 5 A with 200% overrange
- Output through low-power outputs
- Nominal voltage 225 mV
- Measuring range 0 V to 450 mV
- O Analog Output module
- Dimension 132 x 30 x 142 mm (HxWxD)
- Assembly on 35 mm DIN rail
- 4 outputs
- Galvanically insulated by optocouplers
- Output of currents +/- 20 mA, +/- 10 mA
- Output of voltages +/- 10 V
- Removable screw terminals
- Setpoint values by means of currents and voltages
-

6.7 MARKINGS AND LABELLING:

6.7.1 Each mini-substation and ring main unit shall comply fully with SANS 1029 and SANS 1874 for all markings and labelling;

6.7.2 A brass registration number plate of size at least 15 mm × 60 mm shall be securely fitted to each ring main unit and transformer. The number to be inscribed on the registration number plate shall be given at time of ordering;

6.8 TESTS:

6.8.1 The mini-substation shall be type tested in accordance with SANS 1029;

6.8.2 The ring main unit shall meet or exceed the requirements of the type tests of SANS 1874;

6.8.3 Type test reports detailing the test procedures and test results on the mini-substations and ring main units offered, shall be submitted with tender documents. The test reports shall be from a recognised test authority. Failure to provide details of tests called for may result in the rejection of the bid;

6.9 DOCUMENTATION:

6.9.1 Full technical and descriptive details, relating to all the items offered in this enquiry, shall be submitted so that the offer can be fully evaluated. This shall include:

6.9.1.1 Materials used;

6.9.1.2 Method of manufacture;

6.9.1.3 Details of quality assurance procedures;

6.9.1.4 Drawings; etc.

6.9.2 An electronic copy in an excel format of the rating plate data and information of the mini-substations and ring main units shall be provided with each delivery. eThekwini Water and Sanitation will provide the template in which the data shall be entered and submitted as required;

6.9.3 Each item shall be delivered together with an inspection checklist for the item. The checklist shall be provided by eThekwini Water and Sanitation to the successful bidder and may be subject to revision;

6.9.4 A copy of the RTU associated software shall be issued with the as-built information with a full set of operating parameters, user guide and licenses;

6.10 TRAINING

6.10.1 Training shall be provided as follows:

6.10.1.1 Switchgear Operator training priced per session comprising of 10 candidates;

6.10.1.2 Switchgear Maintenance training priced per session comprising of 10 candidates;

6.10.1.3 SCADA and RTU training priced per session comprising of 10 candidates;

6.10.2 The venue shall be provided by eThekwini Water and Sanitation;

6.10.3 All hardware and firmware shall be provided by the successful bidder;

6.10.4 All training material shall be provided by the successful bidder;

6.10.5 The content of the training for items 6.10.1.1 and 6.10.1.2 shall be in accordance with the manufacturer's requirements;

6.10.6 The content for item 6.10.1.3 shall include installation and commissioning of the RTU as well as all aspects relating to settings and engineering of configurations;

6.11 DELIVERY REQUIREMENTS:

6.11.1 Delivery of goods shall be to eThekwini Water and Sanitation, Southern WasteWater Treatment Works

6.11.2 The successful tenderer shall give a 24 hour notice of arrival of each batch of mini-substations and ring main units by road transport to avoid delays in off-loading. Deliveries shall not be accepted on Saturdays, Sundays, public holidays and after hours;

6.12 HEALTH, SAFETY, AND ENVIRONMENTAL ISSUES:

6.12.1 Tenderers shall provide the following information in respect of each product offered:

6.12.2 A list of all materials used in the product, including packaging, and associated chemical data sheets;

6.12.3 Whether the product poses any health or safety risks to persons handling the product. In addition, if there are risks, the protective gear required to handle the product, e.g. leather gloves, masks, etc.;

6.12.4 How the product should be stored and its shelf life;

6.12.5 How the product should be disposed at the end of its useful life or in the event of failure of the product;

6.12.6 Whether any toxic by-products are produced (whether in gaseous, solid or liquid form) in the event of the product being exposed fire or heated to elevated temperatures;

6.12.7 Any other pertinent and relevant information relating to health, safety, and environmental issues; and

6.12.8 What percentage of the product can be recycled;

7. SCOPE AND SPECIFICATION OF DISTRIBUTION TRANSFORMERS

7.1 SCOPE

7.1.1 This specification details eThekwini Water and Sanitation requirements, for the purpose of designing, manufacturing, testing, supplying and delivering of oil-filled distribution transformers up to 12 kV and 1000 kVA (class 0 and class 1) for application on the eThekwini Water and Sanitation medium voltage network;

7.2 GENERAL REQUIREMENTS

7.2.1 The design, manufacture and testing of distribution transformers (class 0 and class 1) shall be in accordance with SANS 780, as defined in **Section 1.11 and 1.12 of C3.6** and as per the specific requirements detailed below and in clause 7.3;

7.2.2 All distribution transformers offered shall be of the oil immersed type.;

7.2.3 Oil filling and impregnation of the cellulose insulation shall be done under full vacuum. The tenderer shall provide method statements and documentation to prove that the temperatures, vacuum and impregnation time is suitable for the application. This process will be verified by eThekwini Water and Sanitation during the factory inspection;

7.2.4 The transformer cooling method shall be ONAN;

7.2.5 The life expectancy of class 0 and class 1 transformers on eThekwini Water and Sanitation network is 20 years, and the onus is on the manufacturer to ensure that the transformers are built and designed to meet this requirement;

7.2.6 The transport and handling of the class 0 and class 1 transformers shall be carried out in accordance with clause 7.8 below;

7.2.7 All transformers shall carry a 36-month warranty from the date of manufacture, effective from the date of handover;

7.2.8 All transformers shall be fitted with bolted main tank lids;

7.3 SPECIFIC REQUIREMENTS

7.3.1 DESIGN

7.3.1.1 Electrical Clearances:

- Transformers shall be designed with sufficient safety margins and clearances to accommodate for the stresses posed by over voltages and fast transients on overhead networks. The manufacturer will have to prove via design reviews that adequate measures have been taken to ensure a robust and efficient design;

7.3.1.2 Inter-turn winding insulation:

- The wire insulation shall be either enamel or paper insulation;
- The enamel wire insulation shall be Grade 3 or better, as defined in the SANS 60317-0-1. Paper tape covered wire shall have a minimum covering of 0.125 mm, a minimum impulse withstand of 21 kV and a minimum power frequency withstand of 9 kV between turns. Point stresses on the active part shall not exceed 5 kV/mm taking into the requirements of clause 7.3.1.3;

7.3.1.3 Interlayer winding insulation:

- The interlayer stresses shall not exceed 5 kV/mm in any part of the winding. This parameter is considered to be an absolute upper limit;
- If corrugated cooling fins are utilised in the design of the transformer, then this design is to ensure that the cooling fins are adequately protected against mechanical damage;

7.3.2 BUSHINGS AND TERMINALS:

7.3.2.1 General

- Lid mounted bushings are not acceptable. The bushings shall be side-wall mounted;
- All MV bushings shall be clamped at the base of the bushing;

- The bushing clamp applied to the MV bushing must ensure that there is no excessive mechanical load applied to the bushing collar. Clamping forces must be distributed evenly over the area of the bushing collar thereby eliminating point loading;
- All terminals shall be suited for the acceptance of both aluminium and copper conductors. To this effect, bushing terminals shall be tinned or silver plated, etc;

7.3.2.2 LV – the LV bushings shall be porcelain. These bushings shall comply with the relevant requirements detailed in SANS 1037 and SANS 60137. These bushings shall be supplied with tinned flags installed. The flags shall be designed such that it accommodates the "number of torque sheer lugs" detailed in column 3 of Table 1. The palm dimension on the torque sheer lug can be considered as 50 mm x 50 mm (worst case). The minimum clearance (i.e. 60 mm between live metal phase-to-phase and phase-to-earth) shall be maintained taking into account the torque sheer lug, flag orientation and fasteners required to connect the cable to the bushing. Detailed drawings for the torque sheer lug layout on the bushing flag shall be submitted for approval;

7.3.2.3 MV – the MV bushings shall be Type C bushings in accordance with BS EN 50180. These bushings shall comply with the relevant requirements detailed in SANS 60137. The minimum specific creepage distance for the MV bushing shall be 31 mm/kV, specified for 'Heavy to Very Heavy" pollution as per SANS 60815 for use in eThekwini Electricity's polluted coastal environment;

1	2	3		4		5	6
Transformer rating (kVA)	**Size and type of LV Cable**	**Number of Torque sheer lugs**		**Number of cable gland holes**		**Cable gland type and size**	**Size of gland hole**
		Per Phase	**Neutral**	**Per Phase**	**Neutral**		
315 kVA	240 mm^2 Copper 1 – core	1	1	1	1	Mechanical non-insulating No. 4	Ø 40 mm
500 kVA		2	2	2	2		
800 kVA		3	2	3	2		
1000 kVA		4	2	4	2		
1600 kVA		6	3	6	3		

Table 1 – LV Layout for torque sheer lugs and gland details

7.3.3 MOUNTING:

7.3.3.1 Transformers for these items shall be bolted onto a raised base and shall be supplied as one piece. Design engineers shall take note not to exceed the maximum overall height detailed in Annexure B when designing the base.

7.3.4 CABLE TERMINATION ENCLOSURES:

7.3.4.1 LV termination enclosure:

- Transformers for these items shall be fitted with air filled top and bottom entry LV cable boxes with removable gland plates;
- The enclosure shall have one bushing per phase and shall be suitable for the termination of the size, type and number of LV cables specified in Table 1;

- The gland plate shall make provision for the fitting of cable glands by providing pre-punched gland holes suitable for the size, type and number of LV cables given in Table 1;
- The gland plate holes shall be aligned with the bushing centres;
- The size and number of cable glands holes for each phase and for the neutral is detailed in Table 1. The glands used are No.4 mechanical non-insulating and number of glands per phase is indicated in Table 1;
- The neutral shall be connected to the earth boss of the LV side via an adequately rated aluminium bus bar;

7.3.4.2 MV termination enclosure:

- Transformers for these items shall be fitted with bolt-on air filled termination enclosures that are bottom entry. The design of the enclosure shall comply with the relevant requirements detailed in SANS 876;
- The MV cable termination enclosure gland plate shall be removable and designed in such a way that, once removed, the entire bottom of the cable termination enclosure is open (i.e. the bottom of the cable termination enclosure shall form the gland plate). The gland plate shall have a predrilled/punched cable entry hole of 110 mm diameter that is positioned below the attachment point of the centre phase bushing;
- A polyurethane clamp shall be installed below and as close as possible to the gland plate;

7.3.5 OIL LEVEL GAUGE:

7.3.5.1 Transformers for these items shall be fitted with prismatic oil level gauges mounted onto the tank. Alternative oil gauges are subject to the approval of Senior Manager: Technology Services;

7.3.6 TAP CONNECTIONS:

7.3.6.1 The tapping connections shall be in accordance with SANS 780**;**

7.3.6.2 Transformers shall have a tapping range of –5 %, –2.5 %, 0 %, +2.5 %, +5 %, achieved by means of an off-circuit tapping switch;

7.3.6.3 The operation of the off-circuit tapping switch shall be such that by turning the handle clockwise, the tap position number is increased;

7.3.6.4 Linear tap switches shall not be accepted. All tap switches shall have two O-ring gaskets;

7.3.7 TRANSFORMER OIL, HANDLING AND OIL IMPREGNATION:

7.3.7.1 Transformers shall be of the oil immersed type;

7.3.7.2 Every effort must be made to handle and store oil appropriately and according to methods prescribed by the oil supplier;

7.3.7.3 The mineral oil shall be compliant with the class C oil specification as specified in the Eskom Standard: 240-75661431;

7.3.7.4 Oil filling of the transformer and oil impregnation of the cellulose insulation must be done under full vacuum. Alternative methods for oil filling and impregnation can be submitted for approval to Senior Manager: Technology Services;

7.3.7.5 The onus is on the supplier to ensure that all materials used in the manufacture of the transformer are compatible with each other;

7.3.8 CORROSION PROTECTION:

7.3.8.1 Corrosion protection shall be in accordance with the Eskom Standard: 240-56030674 applicable for new units to allow for protection in C5-M (Very High Marine) environments whilst noting the final colour detailed in clause 7.3.8.3 below;

7.3.8.2 Each coat of corrosion protection shall have a designated colour that will be associated with the application of that specific layer of paint. This will allow for easy identification of the paint layer and will be verified during factory inspections;

7.3.8.3 The colour of the final coat shall be colour **G35 "Navy light grey**" as specified in SANS 780;

7.3.9 SURGE ARRESTORS:

7.3.9.1 All outdoor transformers shall have brackets, as shown on Figure 2 of SANS 780, welded to the transformer tank on the primary side. The brackets shall be designed to accept 11 kV surge arresters with the clearances specified in SANS 780;

7.3.9.2 The surge arresters shall be supplied and installed on the aforementioned brackets. The surge arresters shall comply with the technical specification detailed below;

7.3.9.3 Surge arresters shall also be supplied separately in the case where EE undertakes separate orders for surge arresters only;

7.3.9.4 The surge arrester shall comply with SANS 60099-4 except where modified by this specification;

7.3.9.5 Design and Rating:

- The surge arrester shall be of the gapless metal-oxide type;
- The surge arrester shall have a minimum rated (power frequency) voltage of 12 kV;
- The surge arrester shall be of the heavy duty distribution class, with a nominal (induced lightning current impulse) 8/20 µs, discharge current rating of 10 kA;
- The surge arrester shall have a maximum continuous operating (power frequency) voltage of 10 kV;
- The surge arrester enclosure shall be completely moisture proofed and shall withstand severe temperature cycling in a very humid atmosphere and as detailed in 7.2.2. The quality of the moisture seal will be a major consideration in assessing bids;
- The surge arrester shall be of the polymeric housing design;

The surge arrester shall conform to the following physical dimensions detailed in **Table 2**;

Un (kV)	A (mm)	B (mm)	C (mm)
11	200 - 300	75 (max)	130 (min)

Table 2 – Physical dimensions

7.3.9.6 Automatic Earth Lead Disconnectors:

- The surge arrester shall be fitted with an automatic earth lead disconnector which shall operate in case of failure of the surge arrester, to provide a visual indication if the surge arrester is internally damaged;
- Tenderers shall provide details of the disconnector operating time versus current curves;

7.3.9.7 Materials:

- Where ferrous and ferrous alloy parts are used in the design, these parts shall be hot-dip galvanised in compliance with:
  - SANS 121, where the minimum thickness of the zinc coating shall be that for heavy duty applications; and
  - SANS 4998 or SANS 3575, where the class of the zinc coating shall be Z600;
- Alternatively, depending on the application, the metal and metal alloy parts shall be manufactured of 3CR12 or stainless steel of grade 304, 316 or 317;
- All bolts, nuts and washers of size M8 and smaller shall be manufactured of stainless steel of grade 304, 316 or 317;
- All electrical contact surfaces shall be of adequate cross-section area and shall be suitable for the acceptance of both aluminum and copper connectors;
- All materials used in the design shall not deteriorate to an extent whereby the overall performance and estimated lifespan of the design is affected;
- Where different metals and alloys are used in the design, the design shall be such that there shall be no contact between dissimilar metals and alloys unless these metals and alloys are galvanically compatible or unless suitable steps have been taken to prevent galvanic corrosion;

7.3.9.8 Installation Arrangement:

- The surge arrester is installed between phase and earth directly on the tanks of transformers;
- The surge arrester shall be fully functional when installed at a mounting orientation of up to 900 from the vertical;

7.3.9.9 Terminals and Conductors:

- The line and earth terminals of the surge arresters shall be provided with high tensile steel nuts, bolts and flat washers for the connections of:
- both aluminum and copper terminal lugs having a single 12 mm diameter hole; and
- both aluminum and copper conductors with diameters from 5 mm to 14 mm;
- The line side of the surge arrester shall be provided with an adequately rated insulated aluminum or copper conductor and its associated lug as detailed in a) above. The length of the conductor with the lug shall be minimum 300 mm;
- The earth side of the surge arrester shall be provided with an adequately rated bare flexible aluminum or copper conductor and its associated lug as detailed in a) above. The length of the flexible conductor with the lug shall be minimum 300 mm;

7.3.10 LV PROTECTION:

7.3.10.1 Tenderers shall submit an offer for a transformer together with a LV protection solution under the Bill of Quantities/Schedule of Rates;

7.3.10.2 The LV protection shall be achieved by using a moulded case circuit breaker (MCCB). The MCCB shall have overload and overvoltage protection;

7.3.10.3 The purpose of the MCCB is to prevent overloading as well allow for overvoltage protection in the event of a loss of neutral;

7.3.10.4 The MCCB shall comply with the requirements of SANS IEC 60947-1 and 2;

7.3.10.5 The MCCB shall be appropriately sized, i.e. for all current and voltage ratings as specified in SANS IEC 60947-2 for the specific rating of the transformer;

7.3.10.6 The MCCB shall be housed in an enclosed LV cable box. A mechanical device shall be designed to allow for the MCCB to be operated from the ground level via a telescopic link stick;

7.3.10.7 The LV cable box shall have removable gland plate. The gland plate shall have 5 × 38 mm diameter holes. These holes shall be blanked off with grommets. The LV cable box shall also house a set of bus-bars for the phases, neutral and earth. These bus-bars shall have at least 5 × 10 mm diameter holes. Hot dip galvanised M10 bolt, nut, spring and flat washer combinations shall be fitted to these bus-bars. All components for this LV assembly shall comply with SANS 10142-1 for partially type testing. The star point of the transformer shall be earth;

7.4 DRAWINGS

7.4.1 Tenderers shall submit detailed drawings (1 x hardcopy and 1 x electronic copy), in accordance with this specification, for each item offered on the Bill of Quantities//Schedule of Rates as follows:

7.4.1.1 General assembly (GA) with outline dimensions;

7.4.1.2 Surge arrester dimensions noting that the relevant clearance should be indicated for the minimum and maximum values;

7.4.1.3 Position of tapping switch and tap arrangement;

7.4.1.4 Single pole mounting bracket;

7.4.1.5 Mounting hole dimensions and abbreviations;

7.4.1.6 Terminal arrangement and labelling;

7.4.1.7 Earthing terminals;

7.4.1.8 Bushing (including clamp) and flag detail; and

7.4.1.9 Rating and diagram plate.

7.4.1.10 General assembly (GA) with outline dimensions;

7.4.1.11 Position of cable termination enclosures and transformer radiator(s);

7.4.1.12 Position of tapping switch;

7.4.1.13 Position of rating and diagram plate;

7.4.1.14 Position of earthing terminals (tank and cable termination enclosures);

7.4.1.15 Height of raised base;

7.4.1.16 MV and LV gland plate design showing gland hole positions, sizes, thickness and material;

7.4.1.17 Position of MV cable entry with rubber grommet;

7.4.1.18 Position of MV cable support clamp;

7.4.1.19 Distance from MV gland plate to MV bushing centre line;

7.4.1.20 Position of MV and LV bushings and labelling;

7.4.1.21 Distance between bushing centres and between outer bushing centres and cable termination enclosure side walls;

7.4.1.22 The overall height, width and depth of the MV and LV cable termination enclosures;

7.4.1.23 Rating and diagram plate layout and details including section where the DC number detailed on 7.5.1 will be inserted;

7.5 REGISTRATION AND NAME PLATES

7.5.1 The successful tenderer shall provide registration number plates with each distribution transformer. The registration numbers shall be provided at the time of ordering but shall be of the format “DC 12345";

7.5.2 An electronic copy of the rating plate, and DC registration number shall be supplied with every hand over certificate. The electronic copy shall be in a MICROSOFT EXCEL;

7.5.3 MARKINGS

7.5.3.1 The surge arresters shall be identified by the following information which shall appear on a nameplate permanently attached to the surge arresters:

7.5.3.2 Maximum continuous operating voltage;

7.5.3.3 rated voltage;

7.5.3.4 nominal discharge current;

7.5.3.5 manufacturer's name or trade mark;

7.5.3.6 type designation; and

7.5.3.7 year of manufacture.

7.6 INSPECTIONS, TESTS AND INVESTIGATIONS

7.6.1 Distribution Transformers:

7.6.1.1 All inspection and tests shall be in accordance with clause 10 of SANS 780;

7.6.1.2 Further, Section 1.11 and 12 of C3.6 shall be so designed and constructed as to withstand, without sustaining any damage, the thermal and dynamic effects of an external short circuit. The ability to withstand the dynamic effects of short circuit shall be demonstrated by type testing the design. Type test certificates shall be submitted with the bid offer;

7.6.1.3 For Section 1.11 and 12 of C3.6, the dynamic ability to withstand short circuit shall be demonstrated by calculations and design characteristic consideration in accordance with Annex A of SANS IEC 60076-5. The transformer under evaluation shall be based on a comparison to a reference transformer that has successfully passed the short-circuit test. The identification of a reference transformer shall be considered similar to the transformer under evaluation only if the reference transformer has common characteristics defined in Annex B of SANS IEC 60076-5. Tenderers shall submit all necessary documentation related to the reference transformer as well as the transformer under evaluation;

7.6.1.4 Any transformer faults that cannot be explained adequately by eThekwini Electricity staff, will be referred to the supplier. Such faults shall be investigated by the supplier and a detailed written report submitted to eThekwini Electricity within 2 weeks of the supplier being notified of the fault. The supplier’s portion of the cost of the investigation will be for the supplier’s account;

7.6.1.5 Items in Section 1.11 of C3.6 that are fitted LV protection shall be tested in accordance with clause 10.3.5 of SANS 780 i.e. short circuit trip test and transformer short-circuit withstand test;

7.6.2 Surge Arrester:

7.6.2.1 Type tests and routine tests, applicable to surge arresters for outdoor use, must be carried out in accordance with SANS IEC 60099-4;

7.6.2.2 Visual examination of the test samples after each of the type tests and routine tests should reveal no evidence of puncture, flashover, cracking or other significant damage of the surge arrester components;

7.6.2.3 The external insulation of the surge arrester housing shall have a one minute wet power frequency withstand voltage of 28 kV, minimum;

7.6.2.4 The surge arrester shall have a maximum steep current impulse residual voltage of 50 kV, during the passage of a 10 kA, 1/20 µs, discharge current;

7.6.2.5 The surge arrester shall have a maximum lightning impulse residual voltage of 40 kV, during the passage of the 10 kA nominal, 8/20 µs, discharge current;

7.6.2.6 The external insulation of the surge arrester housing shall have a lightning, 1,2/50 µs, impulse withstand level of 52 kV that is 1,3 times the maximum lightning impulse residual voltage (refer to 7.8.5);

7.6.2.7 The surge arrester shall have a line discharge class 1 rating with a long duration current, 2 000 µs, impulse withstand of 250 A, when subjected to a charging voltage equal to 3,2 times the rated voltage;

7.6.2.8 The surge arrester shall have a (direct lightning strike) high current, 4/10 µs, impulse withstand of 100 kA;

7.6.2.9 The non-operation and operation tests on the automatic earth lead disconnector shall be in accordance with SANS 60099-4;

7.6.2.10 The partial discharges in the surge arrester energized at 1,05 times the maximum continuous operating voltage shall not exceed 50 pC;

7.6.3 Pressure Relief Device

7.6.3.1 The surge arrester shall be fitted with a pressure relief device, which shall be tested in accordance with SANS 60099-1;

7.6.3.2 The high current pressure relief value shall be 15 kA;

7.6.3.3 The low current pressure value shall be 0,8 kA;

7.6.3.4 When the surge arrester is energised at the rated voltage, the radio influence voltage at 1 MHz, measured in accordance with NEMA publication 107, shall not exceed 250 µV;

7.6.3.5 Full particulars of the results of type tests shall be submitted to confirm that the surge arresters meet or exceed the requirements of SANS 60099-4 and the pressure relief test, where applicable, of SANS 60099-1:

7.6.3.6 Type tests and routine tests, applicable to surge arresters for outdoor use, must be carried out in accordance with SANS IEC 60099-4;

7.6.3.7 Visual examination of the test samples after each of the type tests and routine tests should reveal no evidence of puncture, flashover, cracking or other significant damage of the surge arrester components;

7.7 DOCUMENTATION

7.7.1 Full technical and descriptive details, relating to all the items offered in this enquiry, shall be submitted so the offer can be fully evaluated. This shall include:

7.7.1.1 Materials used;

7.7.1.2 Method of manufacture;

7.7.1.3 Details of quality assurance procedures; and

7.7.1.4 Drawings as per clause 7.4 above;

7.7.2 Failure to submit such information may preclude further consideration of the bid;

7.8 DELIVERY REQUIREMENTS

7.8.1 Delivery of goods shall be to eThekwini Electricity, Electrical Workshops, 11 Electron Road, (off Umgeni Road), Springfield, Durban;

7.8.2 The successful tenderer shall give 24 hours notice of arrival of each batch of transformers by road transport to avoid delays in off-loading. Transformers will not be accepted on Saturdays, Sundays, Public Holidays and after 16:00 on Monday to Friday;

7.9 HEALTH, SAFETY, AND ENVIRONMENTAL ISSUES

7.9.1 Tenderers shall provide the following information in respect of each product offered:

7.9.1.1 A list of all materials used in the product, including packaging, and associated chemical data sheets;

7.9.1.2 Whether the product poses any health or safety risks to persons handling the product. In addition, if there are risks, the protective gear required to handle the product, e.g. leather gloves, masks, etc. shall be specified;

7.9.1.3 How the product should be stored and its shelf life;

7.9.1.4 How the product should be disposed at the end of its useful life or in the event of failure of the product;

7.9.1.5 Whether any toxic by-products are produced (whether in gaseous, solid or liquid form) in the event of the product being exposed to fire or heated to elevated temperatures;

7.9.1.6 Any other pertinent and relevant information relating to health, safety, and environmental issues; and

7.9.1.7 What percentage of the product can be recycled

8. ELECTRICAL TECHNICAL SPECIFICATION - FIBRE OPTIC RING

8.1 GENERAL

8.1.1 Communications between the respective network Switches and the MV RTU's shall be via multi-core fibre optic cable making use of the MV trench were possible. See drawings for detail on the cable route and trench detail;

8.1.2 The cable identification on the outer sheath is important to the client as is the position within the trenches to assist with easy identification of the cables in the field;

8.1.3 The MV Control and Data Acquisition Fibre Cable is to be cable strapped to the MV Cable at 1.5 m intervals while the network cable is to be laid 200mm from the MV Cable on the side of the trench;

8.1.4 The optical fibres shall comply with SANS IEC 60793 and the optical fibre cables shall comply with SANS IEC 60794, and shall be installed in accordance with SANS IEC 60794-1-1;

8.1.5 All cables or cable lengths shall be supplied along with Factory Test Certificates. Cable ends shall be suitably made off / protected to avoid water ingress, damage etc while in storage;

8.1.6 The cables shall be constructed to the following specification:

8.1.6.1 Fibre optic cables shall be armoured, ie protected by PVC / SWA / PVC sheaths over the inner cladding;

8.1.6.2 The fibre optic cable shall consist of 12 fibres (50 / 125µm), graded index, 850 / 1300nm, multimode and armoured, as stated above;

8.1.6.3 Fibre Optic cables may be run in the same trenches as the power cables, but care must be taken to prevent mechanical damage to the cable. A separate cable marker shall be used to indicate that a fibre optic cable is installed in the electrical trench;

8.1.6.4 Tubes shall not be filled with water blocking compound;

8.1.6.5 The cable core shall be filled with water blocking compound;

8.1.6.6 The cable shall be designed with sufficient strength members to meet installation and service conditions so that the fibres are not subjected to strain of more than the limits specified by the manufacturer;

8.1.6.7 A moisture barrier shall be provided by a metallic tape applied over the cable core with a longitudinal overlap and bonded to the sheath;

8.1.6.8 The inner sheath shall be made of polyethylene;

8.1.7 The specialist Communications Contractor shall be required to supply and install the necessary interface ST Leads (Single Core Monofilament Fibre Optic Patch Lead) between the respective patch panels.

8.1.8 The cable type shall comply as follows:

8.1.8.1 Type: 50/125 mico m graded index, 850/1300 nm Multimode;

8.1.8.2 12 Fibre cores;

8.1.8.3 Max Tensile Strength: 1.5kN;

8.1.8.4 Crush Resistance as per IEC 794-1-E3;

8.1.8.5 Cable Sheath: Black Low Halogen (LH) Polyethylene Sheath;

8.1.8.6 Steel Wire Armour;

8.1.8.7 Joints Fusion Type with .15dB max Loss (Only if absolutely necessary);

8.1.8.8 Termination ST Type;

8.2 FIBRE JOINTS

8.2.1 Optic Fibre joints shall be kept to an absolute minimum but where individual cable lengths exceed the maximum drummed cable lengths from the Manufacturer the cables will need to be jointed;

8.2.2 The joints shall be contained within an underground FOSC Slim In–Line enclosure type Tyco FOSC-500AA;

8.2.3 The fusion connections shall be made within the enclosure and protected via Type Tyco SMOUV Fibre Optic Fusion Splice Protectors;

8.2.4 The Contractor must NOTE:

8.2.4.1 Where fusion Joints are required within the trench, he shall ensure that the cable ends overlap by 10 meters. This is to allow for the jointer to perform the joint in a clean environment;

8.3 FIBRE TERMINATIONS

8.3.1 Fibre optic cables shall be terminated in optical fibre termination boxes, and shall be made off with pigtails / fly-leads of approximately 3 m. The ends of the fibres shall be ST type connectors, of nylon or PVC type material. A label shall be attached to the termination closure warning of the danger of laser beams;

8.3.2 Fibre Optic cables shall be supplied, installed, terminated and tested by a specialist;

9. ELECTRICAL SPECIFICATION FOR INDOOR MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVES

9.1 SCOPE

9.1.1 This specification covers the complete labour, materials, equipment, and incidentals required to place into operation an integrated medium voltage variable frequency drive (VFD) system. This specification may be applied to any type of medium voltage (MV) AC motor application.

9.1.2 Every variable frequency drive system shall meet the performance, protection, safety, testing, and certification criteria of this specification. This system may include incoming harmonic filter/power factor correction unit, input isolation transformer, VFD rectifier/DC link/inverter, and output filter.

9.1.3 The VFD system must:

9.1.3.1 Represent a fully integrated and serviceable package.

9.1.3.2 Include all material necessary to interconnect any VFD system elements, even if shipped separately.

9.1.3.3 Any modifications to a standard product provided to meet this specification shall be performed by the VFD manufacturer only.

9.1.3.4 The VFD system as defined in 1.2 shall be completely factory pre-wired, assembled, and then tested as a complete package by the VFD manufacturer, before delivery, to assure a properly coordinated, fully integrated drive system.

9.1.3.5 Unless otherwise specified components such as Switchgear or Heat Exchangers shall be drop shipped

9.1.3.6 Any 3rd party certification, safety, or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.

9.2 GENERAL

9.2.1 Codes and Standards

9.2.1.1 Provide equipment in accordance with the latest applicable rules, regulations, and standards for medium voltage drives:

- IEC 61800-3 EMC requirements of VFD systems
- IEC 61800-4 VFD systems
- IEC 61800-5-1 VFD systems
- IEEE 519 Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
- IEC 62477-2:2018 Safety requirements for power electronic converter systems and equipment – Part 2: Power electronic converters from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC
- VFDs shall be manufactured, assembled, tested and designed in accordance with CE standards as applicable.

9.2.2 Quality Standards

9.2.2.1 Variable frequency drives shall be manufactured by the VFD supplier at its own facility which has an Integrated Management System, certified in accordance with ISO Standard 9001.

9.2.3 Acceptable Manufacturers

9.2.3.1 The VFD manufacturer shall be able to demonstrate at least 15 years of experience in manufacturing VFDs at medium voltage and their capability to provide parts and service support. A user's list of similar design equipment, complete with contact names and telephone numbers, shall be furnished upon request. To ensure timely onsite support, spare parts availability and product life cycle support drives that are manufactured by a third party and/or "brand labelled" shall not be acceptable.

9.2.4 Product Experience

9.2.4.1 It is the intention of this specification to purchase dependable and reliable equipment offering the best performance available from currently proven technology. All equipment furnished under this contract must, therefore, have documentation showing proof of actual operation for a minimum of 15 years in similar service.

9.3 PERFORMANCE

9.3.1 Operating Envelope

9.3.1.1 VFD shall meet the following speed and torque requirements:

- The VFD shall be capable of producing a variable AC voltage/frequency output to provide continuous operation over the normal system 20-100% speed range. The VFD must be capable of operation at 1/10 speed without a load to facilitate checkout and maintenance of the driven equipment. As a commissioning and troubleshooting feature, the VFD power circuit shall be capable of operating without a motor connected to the VFD output.
- VFD shall be capable of operating any standard AC motor of equivalent rating (power and speed) over the specified speed range.
- The VFD shall be able to produce full rated torque at any speed in the operating range (constant torque capability).
- If high breakaway / acceleration torque is required, the VFD shall be selected to provide in excess of the required breakaway / acceleration torque for the nominated duration of the acceleration cycle.
- One minute overload capability of 110% for 1 minute every 10 minutes shall be provided as a standard or over ratings consistent with the application requirements defined in this specification.

9.3.2 Input Harmonics

9.3.2.1 VFDs shall comply with the latest edition of IEEE 519 for total harmonic current distortion, calculation and measurement, and meet the above distortion limits without causing the VFD to operate at a leading input power factor from 30% to 100% of rated speed.

9.3.2.2 If the equipment requires input filters to meet IEEE 519, the supplier of the equipment must ensure that input filters are tune properly and evaluated regularly to prevent unnecessary input voltage rise.

9.3.2.3 Voltage Harmonics: individual or simultaneous operation of the VFDs shall not add more than 3% total harmonic voltage distortion while operating from the utility source, or more than 5% while operating from standby generator (if applicable).

9.3.2.4 Total harmonic current distortion limits for each individual VFD shall not exceed 5% as calculated and measured at the point of common coupling, defined as the input connection of each VFD.

9.3.2.5 The VFD converter section shall be 24 or more pulse to eliminate the need for harmonic filters. Harmonic filters are highly undesirable due to resonance problems, and they require tuning whenever other inductive/capacitive loads are placed on the system or when the power system changes.

9.3.2.6 Upon request compliance shall be verified by the VFD manufacturer with field measurements of harmonic distortion differences at point of common coupling with and without VFDs operating. The point of common coupling (PCC) for all harmonic calculations and field measurements for both voltage and current distortion shall be defined as the input connection of each VFD. In the event the initial field measurements do not meet the latest edition of IEEE-519, the VFD manufacturer shall be responsible for any additional equipment needed for compliance.

9.3.2.7 Power quality metering shall be inherent to the VFD system to continuously monitor and display input and output power quality. This will allow easy customer verification of power quality and efficiency for the VFD system. The power quality data shall include the following:

- Input voltage (average rms value)
- Input current (individual phase rms values and average rms value)
- Input frequency

- Input power factor
- Input kW, kVAr
- Input kWHr
- Input current THD (average of 3 phases)
- Calculation of total input current or voltage harmonic demand distortion
- Drive efficiency
- Motor voltage (rms)
- Motor current (rms)
- Motor speed (in RPM or %)
- Motor flux (%)
- Motor torque current (%)
- Drive output power (kW)
- Output kW-Hr

9.3.3 Motor Compatibility

9.3.3.1 VFD system shall provide an output waveform that will allow utilization of motors with insulation level of 5 kV, without the need of any special insulation or de-rating. Motor life expectancy should not be compromised in any way by operation with the VFD system. The system must comply with all elements of the output harmonics section of this specification. The VFD must provide motor overload protection in any operating condition.

9.3.3.2 VFD output waveform shall be suitable for operating a squirrel cage induction motor without de-rating or requiring additional service factor. To ensure that there are no problems with motor heating, VFD output current waveform, as measured at the motor, shall be inherently sinusoidal at all speeds, with a total harmonic current distortion not exceeding 3% referenced to the full load output current fundamental between 10% and 100% speed.

9.3.3.3 The system design shall not have any inherent output harmonic resonance in the operating speed range.

9.3.3.4 The VFD output shall produce minimum electrically-induced pulsating torque to the output shaft of less than 1% up to 95% of the speed and less than 3.5% at the top of the speed eliminating the possibility of exciting a resonance caused by VFD induced torque pulsations.

9.3.3.5 VFD shall inherently protect motor from high-voltage □v/□t stress, independent of cable length to motor. VFD shall not require non-standard insulation systems or insulation ratings above the VFD output voltage rating. The VFD system shall be designed to produce no standing waves or over-voltage conditions based on cable lengths below 7500 feet (2300 m). This is a typical length which will cover most application requirements and allow for potential future cable run changes from VFD to motor. If the VFD requires an output filter to meet this requirement, it shall be an integral part of the VFD system.

9.3.3.6 An integral input transformer shall be included with the VFD system to provide common mode voltage protection and allow the use of a standard motor. Special high-voltage motor insulation is not an acceptable method for protection against common mode voltages. VFD systems that do not include an integral input transformer will not be accepted.

9.3.4 VFD System Efficiency

9.3.4.1 Guaranteed minimum VFD system efficiency (□sys) shall be above 96.5% at 100% load, and above 95% in the 100% to 50% load range. Efficiency evaluation shall include input transformer, harmonic filters, and power factor correction (if applicable), VFD converter, and output filter, as indicated below.

The VFD system efficiency is as follows: $\eta_{sys} = \eta_{VFD} \times \eta_{xfmr} \times \eta_{pfc} \times \eta_{harm} \times \eta_{filter}$

Converter/Inverter (VFD)	η_{VFD}
Input Transformer	η_{xfmr}
Power Factor Correction	η_{pfc}
Input Harmonic Filter	η_{harm}
Output Filter	η_{filt}

VFD System Efficiency (η_{sys}) must be 96.5% at full load and 95% at 50% load.

9.3.4.2 If required, a factory test shall be performed at the VFD manufacturer's facility certifying that efficiencies have been met. A penalty (in dollars per kW) will be assessed if efficiency is not achieved and will be deducted from the contracted price.

9.3.5 System Input Power Factor

9.3.5.1 VFD system shall maintain a 0.95 minimum power factor from 30% to 100% of rated speed. VFD system including power factor correction and/or harmonic filter shall never have a leading power factor under utility or generator operation. VFD manufacturer is to supply a power factor correction system, if required, to meet this requirement. Power factor correction unit shall include a separate input isolating contactor with fuses, power factor correction grade capacitors (voltage class shall be consistent with the VFD system input voltage), and series harmonic de-coupling reactors, all integrated into VFD system and mounted within the VFD enclosure.

9.3.5.2 For VFD systems employing a capacitive input filter, an electrical system analysis shall be performed by the VFD vendor to ensure the VFD will not create a leading power factor or a resonant condition while operating on utility or back-up generator power. This analysis shall be provided with the bid.

9.3.6 Speed Regulation

9.3.6.1 VFD control system speed regulation shall be ±0.5% without encoder or tachometer feedback.

9.4 AVAILABILITY

9.4.1 Firing Signals

9.4.1.1 All internal firing signals and other communications with power components, such as status and diagnostic signals, must meet noise immunity and safety requirements as defined by the applicable standards referenced in Section 9.2.1.

9.4.2 Multi-cell H-bridge topology

9.4.2.1 Drives with multi-cell H-bridge topology shall have 750V cells for the nominal output voltage of 3.3kV and above to offer best reliability and footprint.

9.4.3 Failed Power Electronic Ride-Through Capability

9.4.3.1 If bypass feature is included as an option in power electronics section, the failure of any power switching device (SCR, diode, IGBT, IGCT, etc.) in both the converter and inverter sections and/or switching device control circuitry shall not result in a process trip and shall allow for continued operation of the VFD system. In the event of a device or device control failure, the VFD shall annunciate and

identify the specific location of the failed device and allow for continued operation until such time as repairs can be scheduled.

9.4.3.2 The bypass feature shall meet the following requirements:

- Only mechanical bypass is acceptable to improve bypass reliability. If electronic bypass is offered, independent communication between the bypass system and the drive control is required. In case of a fault bypass shall engage within 250 milliseconds or less to avoid process Interruption.

9.4.3.3 With a single power module in bypass system shall maintain as a minimum 83% of output voltage for 4160V system and 90% of output voltage for 6000V and above without extra modules. the VFD shall maintain the required speed. Output voltage shall be optimized when VFD is in bypass without inducing torque pulsations.

9.4.3.4 The feature shall be demonstrated and documented during the factory acceptance testing of the VFD system.

9.4.4 Power Sag Ride-Through

9.4.4.1 The VFD system shall be capable of maintaining continuous operation but with reduced output power up to 34% voltage sag on the input power line. The VFD shall maintain this performance as long as the even exists. If the input medium voltage sags falls below 66% of its rated value, the VFD shall engage power loss ride through control logic.

9.4.5 “Catch-A-Spinning-Load” Capability

9.4.5.1 The VFD system must be able to catch and take control of a spinning load if started while rotating equipment is already spinning in a forward direction. Appropriate safeguards must be included in this operation to prevent damaging torque(s), voltages, or currents from impacting any of the equipment. The user shall have the option of employing this feature or disabling it. This option shall be hard-key or password protected to avoid unwanted changes by unauthorized personnel.

9.4.6 Auto-Restart Capability

9.4.6.1 The VFD system must be capable of automatically restarting in the event of a process or drive trip as long as input MV is present. The VFD system shall provide the user with the choice of automatically restarting or not. The user shall be able to selectively apply this feature to some (but not necessarily all) conditions as determined by the user to be appropriate for the specific application. This option shall be hard-key or password protected to avoid unwanted changes by unauthorized personnel.

9.4.7 Ground Faults

9.4.7.1 In the event of an input or output ground fault, the VFD shall be capable of annunciating the ground fault condition, safely operating, and by user selection, either trip or continue operation.

9.4.7.2 The VFD shall be capable of detecting output ground fault of 10mA to ensure equipment safety. The manufacturer shall provide a valid type test to show that protection and detection works as described.

9.4.7.3 In order to prevent erroneous operation of the site’s ground fault relay protection system, the VFD system shall not contribute more than 0.3 amp input ground fault when operating under normal operation.

9.5 SERVICEABILITY / MAINTAINABILITY

9.5.1 Front Access

9.5.1.1 VFD system should be designed for front access only. VFD manufacturer shall state in their proposal if rear or side access is required. An explanation of reason and specified distance for any required rear or side access shall be given.

9.5.2 Power Component Accessibility

9.5.2.1 All power electronic components in the converter sections shall be designed for rack-out accessibility for ease of maintenance and to minimize repair downtime. Alternate access options must be described in the proposal for purchaser's review and evaluation.

9.5.3 Voltage Isolation

9.5.3.1 All low voltage components, circuits, and wiring shall be separated with physical barriers from any sources of medium voltage and shall be compliant with IEC 61800-5-1.

9.5.4 Remote Diagnostics

9.5.4.1 The VFD system shall be provided with the capability for remote diagnostics via Ethernet link.

9.5.5 Marking/Labelling

9.5.5.1 Self-laminating vinyl labels or other acceptable means of permanent identification shall be applied to power and control wiring. Individual labels shall be provided for all major components of the VFD system. Labels shall match equipment drawings.

9.5.6 Mean Time to Repair (MTTR)

9.5.6.1 In the event of a power electronic failure, removal and replacement should take an average of 20 minutes with spares available on site, after capacitors have discharged and safe working conditions have been established.

9.6 PHYSICAL REQUIREMENTS

9.6.1 Arc Resistant Design and Certification

9.6.1.1 The VFD shall have arc resistant design to help minimize the risks associated with an arc flash event and provides increased protection of customers' personnel and equipment. The equipment is designed to withstand or mitigate the effects of an internal arcing fault as indicated by an appropriate label meeting the test requirements of the VFD standard: IEC 62477-2:2018. Customers will be responsible to provide associated protection as identified on the Internal Arc Classified label located on the VFD.

9.6.1.2 The arc resistant design shall meet the following criteria:

- Accessibility Grade – Type 2B
- Short Circuit Current – 50kA up to 13.8kV
- Time Duration – 100 ms

9.6.2 Environmental Requirements

9.6.2.1 VFD system shall be capable of continuous operation in an average ambient temperature between +5°C and 40°C at an elevation up to 3300 feet (1000 meters) above MSL without de-rating. The VFD system shall also be simultaneously suitable for continuous operation with the humidity between 0 and 95% non-condensing.

9.6.3 Heat Dissipation/Cooling System

9.6.3.1 VFD system shall be forced air-cooled and as an option shall be provided with fan redundancy and automatic switchover in the event of a fan failure for enhanced reliability. If a fan fails, the system must automatically switch to the alternate fan and generate an alarm to notify operator of initial fan system failure. During normal operation, the system must periodically cycle between the redundant fan systems to "exercise" them and prevent drying out of bearings, seals, etc., and to ensure availability of all systems. VFD system manufacturer shall provide heat dissipation data necessary to design all auxiliary HVAC systems.

9.6.3.2 The fans shall be rack-out toward the front of the drive for ease of repair without the use of overhead lifting equipment.

9.6.4 Enclosure

9.6.4.1 All VFD system components, including transformer, shall be mounted and wired by the VFD system manufacturer in a grounded enclosure meeting the following requirements without exception:

- Input filters, transformer, power conversion, and output filters shall be IP-21 design (or NEMA equivalent), or better degree of protection, with gasketed doors/panels. Ventilated enclosure shall have cleanable filter media covering all air inlets. Inlet air filters shall be 100% washable with a corrosion-free media. Filters shall be front replaceable (for cleaning) while the VFD is in operation without exposing maintenance personnel to any of the power components while wearing the proper PPE. Paint procedures and materials shall be manufacturer's system, designed and proven for resistance to chemical attack in industrial power-house environments.
- Microprocessor and control logic boards and their power supplies shall be safely accessible without exposure to high voltages and without drive shutdown. All low voltage wiring shall be fully isolated from medium voltage compartments.
- Cabinets and doors/panels shall be fabricated using heavy gauge formed or structural steel for sturdy construction for dimensional integrity to assure long-term fit and function. All doors/panels shall be gasketed to provide environmental protection and secure fits.
- Enclosures must be designed to avoid harmonic and inductive heating effects.

9.6.5 Installation/Cabling

9.6.5.1 Owner will provide labour to set equipment in place. All VFD system wiring (power, control, and protection) shall be located internally within the VFD system enclosure. All external power conductors (bus or cable) shall be insulated. Power wiring shall be isolated by voltage class. Control and protection wiring shall be isolated from power wiring.

No more than two wires shall be terminated at any terminal point.

9.6.6 Space Limitations - Footprint

9.6.6.1 The VFD system must fit in the space indicated on project drawings.

9.6.7 Auxiliary Power

9.6.7.1 To power the VFD cooling system and control circuits, a 3-phase low-voltage auxiliary power will be provided by the customer. Means for isolation shall be provided to allow for isolation of this power supply source as needed. This auxiliary power voltage shall be determined by the customer and must be indicated at time of order.

9.6.8 Control Power

9.6.8.1 All VFD internal control circuits shall be 230 VAC single phase unless otherwise specified. Other VFD manufacturer shall provide provision for deriving control power from auxiliary power.

9.7 PROTECTIVE DEVICES / DIAGNOSTICS

9.7.1 Drive Short Circuit Protection

9.7.1.1 The VFD with integral transformer shall have built-in short-circuit detection and an equivalent of differential protection. Software shall include protective functions which detect abnormal conditions due to an internal power circuit sub-component failure(s). And as such, VFD will fault if abnormal conditions are present. Protective functions shall include:

- Excessive Input Reactive Current Detection (One Cycle Protection)
- Excessive Drive Losses Protection

9.7.1.2 The manufacturer shall provide a valid type test to show that protection and detection works as described.

9.7.1.3 An upstream trip-able device is required with adequate protection supplied by the customer.

9.7.2 Power Component Protection

9.7.2.1 VFD system shall include distribution class surge arrestors to protect the converter and its input transformer against voltage surges.

9.7.2.2 The VFD system shall include power fuses on the input to the converter devices to protect the secondary of the transformer from any potentially harmful fault currents.

9.7.3 Protective Features and Circuits

9.7.3.1 The controller shall include the following alarms and protective features:

- Static instantaneous over-current and over-voltage trip
- Under-voltage and power loss protection
- Over-temperature protection
- Electronic motor inverse time overload protection
- When power is restored after a complete power outage, the VFD shall be capable - if this function has been enabled - of catching the motor while it is still spinning in a forward direction and restoring it to proper operating speed without the use of an encoder

9.7.3.2 Upon customer request, the VFD shall offer the following advanced features:

- Machine Thermal Protection that includes RTD temperature biasing to account for such things as loss of cooling or unusually high ambient temperature. The thermal protection design shall meet the requirements of IEC 60255-149, Edition 1.0 2013-07 standard
- Inverse Time Overcurrent that offers the range of the standard curves: IEEE, IEC, IAC, ANSI to simplify coordination. If none of these curves meet customer requirements, it offers flexibility of creating their own curve.
- Underpower
- Bearing Temperature RTD
- Mechanical Condition Monitoring
- Current Unbalance, Negative Sequence
- Incomplete Sequence – maximum start time/ maximum stop time
- Power Factor
- Over/Under Frequency
- High Frequency Rate of Change
- Differential protection equivalent to detect such motor internal faults as winding-to-winding, turn-to-ground and turn-to-turn faults in the same winding.
- The following protections shall be configurable for variable protection levels:
  - Thermal
  - Over speed
  - Under speed
  - Undercurrent

- Over frequency
- Under frequency

9.7.3.3 The RTD monitoring will be required for the motors and therefore the temperature feedbacks shall be incorporated into the VFD control. All faults or alarms are stored in the drive event log for a complete reference. All communication is done through the drive control channel to simplify commissioning.

9.7.3.4 The VFD system shall be protected from damage due to the following, without requiring an output contactor:

- Single-phase fault or 3-phase short circuit on VFD system output terminals
- Power device failure to commutate/switch due to severe overload or other conditions
- Loss of input power due to opening of VFD input disconnect device or utility power failure during VFD operation
- Loss of one phase of input power
- Induction motor regeneration due to backspin or loss of VFD input power

9.7.3.5 The VFD shall be able to withstand the following fault conditions without damage to the power circuit components:

- Failure to connect a motor to the VFD output
- VFD output open circuit that may occur during operation
- VFD input or output ground fault
- VFD input or output single-phase

9.7.3.6 The VFD shall be provided with integrated control provisions to operate or trip an incoming power disconnect device.

9.7.4 Data Displays

9.7.4.1 A door-mounted LCD display shall be furnished, capable of displaying the VFD operational status and drive parameters. The digital display must present all diagnostic message and parameter values in plain language/engineering units when accessed, without the use of codes. English is the default language unless noted otherwise.

9.7.4.2 As a minimum, the following door mounted digital indications with a resolution of at least ±0.01% and an accuracy of 1%, shall be supplied:

- Speed demand in percent
- Input current in amperes
- Output current in amperes
- Output frequency in Hertz
- Input voltage
- Output voltage
- Total 3-phase kW output
- Kilowatt hour meter
- Elapsed time running meter

Note: A minimum of four indications must be displayed simultaneously and display indications must be available at the indication panel.

9.7.5 Diagnostics and Fault Recording

9.7.5.1 The control logic section shall be fully digital and not require analogue adjustment pots or fixed selector resistors.

9.7.5.2 Fault log data storage memory shall be stored in non-volatile memory or be supported by a UPS sized to provide a minimum of 48-hour data retention

9.7.5.3 The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.

9.7.5.4 A “FAULT LOG” shall record, store, display, and print upon demand, the following 256 most recent events:

- VFD mode (Auto/Manual)
- Date and time of day
- Type of fault
- Reset mode (Auto/Manual)

9.7.5.5 A “HISTORIC LOG” shall record, store, display, and print upon demand, the following control variables at an adjustable time interval for the 50 intervals immediately preceding a fault trip and 100 intervals following such trip:

- VFD mode (manual/auto/inhibited/tripped/etc.)
- Speed demand
- VFD output frequency
- Demand (output) amps
- Feedback (motor) amps
- VFD output volts
- Type of fault
- Drive inhibit (On/Off)
- The fault log record shall be accessible via an Ethernet port, as well as, line by line on the keypad display

9.7.5.6 With the VFD, a Windows®-based graphical tool suite shall be provided at no additional charge to customer. This graphical PC tool shall be able to plot and display up to 9 different VFD parameters and have the ability to freeze plotting and print hard-copy versions of the plots. Capability to display at least 8 different VFD system parameters is required, and all parameters displayed on the PC tool shall be synchronized with the standard keypad display.

9.8 PROGRAMMING AND COMMUNICATIONS

9.8.1 User Input/Keypad

9.8.1.1 The door/panel of each power unit shall include a mode selector marked “Off-Local-Remote”, start pushbutton, stop pushbutton, and reset pushbutton.

9.8.1.2 A door/panel-mounted touchscreen with integral digital LCD display shall be furnished, capable of controlling the VFD and setting drive parameters. The display must present all diagnostic message and parameter values in standard engineering units when accessed, without the use of codes. The touchscreen shall allow the operator to enter exact numerical settings in standard engineering units. A plain language (English or other language, as noted on the data sheet) user menu (rather than

codes) shall be provided in software as a guide to parameter setting. This device shall be fully compliant with applicable Norms related to enclosures.

9.8.1.3 Drive parameters shall be factory set in non-volatile memory and re-settable in the field through the keypad. A minimum of 6 levels of password security shall be available to protect drive parameters from unauthorized personnel. The stored drive variables must be able to be transferred for programming of new or spare boards.

9.8.1.4 The loss of the keypad or display shall be annunciated as a fault but shall not result in a VFD trip.

9.8.1.5 The VFD system shall have the user selectable option of programming up to 3 speed avoidance bands. This gives the user the ability to block out and prevent operation at any undesirable speed, such as one that may be coincident with a mechanical resonance condition.

9.8.2 Serial Communication/Protocols/Modem or Cable

9.8.2.1 VFD shall be capable of digital communication for setup of parameters, fault diagnostics, trending, and diagnostic log downloading. An Ethernet port shall be door-mounted.

9.8.2.2 The drive shall support duplicate communications channels without the use of protocol bridges. In case of failure, the use of bridges increases maintenance complexity as local expertise is required to reprogram the bridge.

9.8.2.3 The VFD shall be provided with digital communication capability to allow direct control and status communication with a PLC, SCADA, or other control system. Provisions for a redundant channel shall be provided as an option. The control system must be able to communicate with various protocols as determined by the customer.

9.9 COMPONENT REQUIREMENTS

9.9.1 Printed Circuit Boards

9.9.1.1 All printed circuit boards in the VFD power circuit shall be new. They shall be conformal coated for moisture and chemical resistance, in addition to any dielectric coating properties. All control boards must be tested in accordance with Section 10.1.1.

9.9.2 Wiring

9.9.2.1 All control wiring shall be physically separated from the power wiring. Low and high voltage cables shall be physically isolated from each other. The VFD system shall be pre-wired within the enclosure. Spade type connectors are not acceptable. No soldering shall be used in connection with any wiring. Wiring shall be adequately supported to avoid tension on conductors and terminations. All wiring shall be run in surface mounted conduit or wire-ways. Any section of wiring outside of conduit or wire-way shall be securely tied with cable ties at intervals not exceeding 6 inches. No cables shall be tied off to or in any way supported from power busses. Wherever wiring passes metal edges or through holes, suitable guards, grommets, or chamfers shall be provided to prevent cutting or chafing of the insulation.

9.9.2.2 All wiring shall be tagged with permanent labels at each termination, junction box, and device. Labels shall correspond to the schematic and wiring diagrams.

9.9.2.3 Standard corrosion resistant bus pads with NEMA hole patterns are provided for input/output customer connections.

9.9.3 Ground Connection

9.9.3.1 Corrosion resistant, stainless steel ground pads shall be provided in each power cabinet.

9.9.4 Input Isolation Transformer

9.9.4.1 The VFD system must be supplied with a drive isolation transformer to provide common mode voltage protection and phase shifting (for 24 pulse or higher converter bridge, if employed to meet the power

quality requirements of Section 3.1.1.5). VFD systems utilizing input AC line reactors which require motors equipped with special higher voltage rated insulation systems are not acceptable and will not be allowed as an alternate bid.

9.9.4.2 Transformer design to be a rectifier grade isolation type with a K-Factor of 12 for variable torque loads or a K-Factor of 20 for constant torque loads when applied to a SCR converter, in accordance with current EPRI recommendations and ANSI/IEEE Standard C57.110. A K-Factor of 6 is required for diode rectifier converters. Transformers shall have a BIL rating in accordance with the requirements of ANSI/IEEE Standard C57.12.01-2005, C57.110-1998, and IEC 60076-11.

9.9.4.3 The VFD system shall be designed to withstand maximum input rating of 50kA

9.9.4.4 Isolation transformers shall be air-cooled dry type construction with insulation class between 130°C and 220°C with over-temperature protection.

9.9.5 DC Link Inductors

9.9.5.1 DC link inductors, if required, shall be air core to prevent saturation. Separate inductors (split dual winding type) shall be provided in the positive and negative leg of the DC link to minimize stray magnetic fields. Inductors shall be Class H insulation (220°C insulation, 150°C rise) with over-temperature protection. To minimize cabling costs, the inductors shall be integral to the VFD system lineup. If it is not possible to integrate the inductors into the VFD system enclosure, the cabling and connecting must be entirely supplied and/or contracted by the VFD system supplier and approved by the Engineer. Inductors shall be designed to prevent saturation under maximum fault current conditions.

9.9.5.2 The requirements listed in this section shall be considered in conjunction with Section 9.9.3.4, VFD System Efficiency.

9.9.6 DC Link Capacitors

9.9.6.1 Capacitors used in the converter DC link shall be integral to the VFD system lineup to minimize cabling costs.

9.9.6.2 Capacitors used in the converter DC link shall contain discharge resistors and capable of reducing the residual charge to 50 volts or less within 10 minutes after the capacitor is disconnected from the source of supply.

9.9.7 Input Harmonic Filters

9.9.7.1 If, after meeting Section 9.3.1.1.5 above, harmonic filters are still required to meet power factor requirements, stricter local requirements, or telephone interference factor restrictions, the VFD manufacturer must provide the filter, upstream filter isolation, protection, and protection coordination. As harmonic filters are power system dependent, the VFD supplier is responsible for maintaining and providing any required upgrades required for the first 10 years of operation at zero cost to the owner. To minimize cabling costs, the harmonic filter components shall be integral to the VFD system lineup, but isolated from other components, such that they can be disconnected from the power source and accessed for maintenance/repair while the VFD is in operation. If it is not possible to integrate the filters into the VFD system enclosure, the cabling and connecting must be entirely supplied and/or contracted by the VFD system supplier and approved by the customer's engineer. Harmonic filters must be located on the primary side of the input isolation transformer and must be switchable with the VFD, to prevent their remaining on the power line in the event of a VFD trip which could create a damaging leading power factor condition. The complete filter must have independent protection for over-current, phase differential, and ground fault.

9.9.7.2 Capacitors used in any harmonic filter banks shall be provided with a method of shorting the phases to ground once power has been removed and the capacitors have been discharged to a safe voltage

level. Where oil-filled capacitors are required and the total volume of oil exceeds 500 gallons or 2000 litres, the oil sump and containment provisions shall be supplied as part of the VFD system.

9.9.7.3 Any reactors used shall be iron core with 220°C insulation, 130°C rise insulation and over-temperature protection. Reactors shall be designed to prevent saturation under maximum fault current conditions.

9.9.7.4 The requirements listed in this section shall be considered in conjunction with Section 9.3.4, VFD System Efficiency.

9.9.8 Output Filters

9.9.8.1 If an output filter is required to meet the output harmonics requirements of this specification or to meet any special requirements of the application, they must be fully incorporated into the VFD system design and added to overall VFD line-up. Cabling and connection of filter to VFD must be supplied and performed or contracted by the VFD system supplier and approved by the customer's engineer.

9.9.8.2 Where potential exists for self-excitation between the output filter and the motor system, a fully (voltage and current) rated output contactor shall be provided by the VFD supplier as part of the VFD system delivery.

9.9.8.3 Any reactors used shall be iron core with 220°C insulation, 130°C rise insulation and over-temperature protection. Reactors shall be designed to prevent saturation under maximum fault current conditions.

9.9.8.4 The requirements listed in this section shall be considered in conjunction with Section 9.3.4, VFD System Efficiency.

9.9.9 Input / Output Power Terminations

9.9.9.1 The VFD system will be provided with isolated, supported, and plated bus strap connections for the user's medium voltage input and output power connections. Sufficient space shall be provided for termination connections from the top or the bottom of the VFD cabinet. Space provisions shall be provided for application of standard stress cones, and provisions shall be provided for grounding of shielded cabling.

9.10 TESTING

9.10.1 Subassembly Tests

9.10.1.1 Assembled printed circuit boards shall have optical inspection, in circuit testing and complete assemblies must be functionally tested. Bare printed circuit boards must be designed and manufactured for corrosion resistance and long-term reliability. Assembled boards must be tested individually prior to assembly to minimize any impact faulty boards may have on delivery schedules and system reliability. Assembled boards shall have environmental stress screening done for 48 hours, followed by conformal coating. Any board that changes function outside of design parameters shall be replaced with a properly functioning board.

9.10.2 System Level Tests

9.10.2.1 The system shall be given preliminary checks for verification of electrical connections, including ground connections and power and control wiring, and resistance checked point-to-point. E-prom and EE-prom shall be checked for correct revision level. Visual check shall be performed to verify degree of protection for cabinets, input isolation is lockable in the off position, marking of terminals and wiring, space availability for cable termination, accessibility of components, and ease of maintenance and repair. The VFD system shall be fully checked against the approved drawings for compliance and correct physical dimensions.

9.10.2.2 Power circuit and all control circuits shall be HIPOT tested to ground.

9.10.2.3 All control voltage levels are to be checked and verified against stated acceptable levels.

9.10.2.4 A no load test is to be performed on the system. Drive is to be connected to an unloaded motor and feedback signals shall be verified. Output voltage shall be calibrated. All logic and interlocks, including customer logic and instrumentation, shall be tested.

9.10.2.5 Drive shall be given a full power test at rated current and rated voltage (simultaneously) for a minimum of 2 hours on a dynamometer or reactor load. This test shall be performed as an integrated system including all supplied input switchgear (if supplied), input transformer, input filter (if supplied), power section, and output filter (if supplied).

9.10.2.6 The VFD manufacturer shall offer an option for additional system level testing to measure the total system efficiency, power factor, and harmonic distortion, to ensure customer specified limits are met. Total system efficiency shall be measured on both the input and the output of the VFD system. System shall not be shipped unless specified performance criteria are met. Certified test data of all tests conducted shall be provided with final documentation.

9.10.2.7 The VFD manufacturer shall offer an option for testing to be witnessed by customer's representative(s). A projected test schedule and a copy of proposed test procedures shall be provided at least 1 month in advance of test date. Customer shall be given at least 1 week notice or confirmation of actual test date(s).

9.11 DOCUMENTATION

9.11.1 With Proposal

Proposal information shall include, but not be limited to:

9.11.1.1 Certification of compliance with this specification

9.11.1.2 Warranty

9.11.1.3 Preliminary dimensions and weights

9.11.1.4 VFD system continuous current and voltage rating

9.11.1.5 VFD system one minute current rating

9.11.1.6 Efficiency and power factor at 100%, 75%, 50%, and 25% load

9.11.1.7 Input current at 100%, 75%, 50%, and 25% load

9.11.1.8 Current and voltage harmonic distortion calculation with the point of common coupling located at the input connection of each VFD

9.11.1.9 External interconnection one-line wiring diagram showing all power, control, and protection cabling required to complete the VFD system on-site

9.11.2 After Order Submittals

9.11.2.1 Submittals shall be custom prepared by the VFD system manufacturer for this specific application.

9.11.2.2 Submittal information shall include, but not be limited to:

- General arrangement drawings
- Overall outline dimensions and Maintenance Clearances
- Weights and Lifting Drawings
- VFD System Description & Customer Information
- Anchor Bolt Details
- Terminal Block Location and Connections
- Input / Output Power Locations

- Conduit Entrance Space and Locations
- Three-Line diagrams
- Electrical schematics and wiring diagrams
- Cooling system drawings
- Mechanical Interlock Scheme
- Cable locations
- Location of ground pads
- Grounding and Shielding requirements
- Project schedule
- Final O&M manuals

9.11.3 Final Documentation

9.11.3.1 Start-up and commissioning instructions and data

9.11.3.2 Certified as-built drawings of all equipment with information listed above

9.11.3.3 Operation and maintenance manual shall be as follows:

A copy of the Operating and Maintenance Manuals for each equipment type shall be bound in with the Operating and Maintenance Manual for the project. The manual shall be A4 size and properly bound. Drawings larger than A3 size shall be contained in separate plastic pockets. The entire as-built pack should be as follows:

There should be Five hard cover books with glossy pages with the following information:

1) Final design report (civil, mechanical and electrical)
2) Control Narrative of Electrical and Mechanical
3) All electrical, instrumentation schematics and mechanical drawings
4) All certifications test reports , calibration certs etc
5) Pictures of the newly installed equipment

9.11.3.4 Manufacturer's service and repair support during and after warranty

9.11.3.5 Spare parts lists

9.12 DELIVERY

9.12.1 VFD system shall be delivered to the site pre-assembled and wired with all specified interconnecting wiring and cable. Cabling for connection across shipping splits shall be neatly coiled and identified. Exposed sections of equipment shall be fully protected from damage during shipment. All necessary hardware for reconnecting shipping splits shall be provided.

9.12.2 Setting equipment in place, aligning, and anchoring will be done by others. The VFD system manufacturer shall be responsible for all system interconnections across shipping splits at the site.

9.12.3 Complete instructions for handling and storage shall be provided prior to delivery of the equipment.

9.13 WARRANTY

9.13.1 All equipment furnished under this section shall be warranted by the contractor and the equipment manufacturer(s) for a minimum period of 18 months after shipment. Warranty shall include all parts, labour, and expenses to perform necessary work.

9.14 TRAINING

9.14.1 The VFD system supplier shall offer a factory training school for customer's operations, maintenance, and service personnel. The training school shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, software mapping, programming, setup, configuration, control loop tuning, operational indicators, faults, diagnostic tools, troubleshooting, and preventive maintenance. Hands-on training shall be provided on equipment of the same design as that provided. Documentation shall be provided, which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.

9.15 START-UP

9.15.1 VFD system manufacturer shall provide the field services of a technician, as necessary, to supervise/inspect installation, test, and start-up all equipment provided as part of the fixed price proposal. The firm price shall include all travel and living expenses, in addition to, the engineer's time required to complete supervision of the installation, testing, and start-up. All equipment required for testing, start-up, and performance verification shall be provided by the start-up technician.

9.15.1.1 Verification of VFD input harmonic voltage and current distortion limits specified must be verified at rated speed and rated power as part of final startup and acceptance. A recording type Fluke, Multilin PQM, BMI, or equivalent harmonic analyzer displaying individual and total harmonic currents and voltages must be utilized.

9.16 SPARE PARTS

9.16.1 VFD system manufacturer shall make available for purchase an inventory of spare parts to compliment customer's equipment and offer express delivery services to support customer's operations 24/7. Local spare parts stocking and asset management programs, regional warehouses and state-of the-art logistics can supply spare parts to customer without delay. This will allow customer to optimize critical spare parts inventory and costs.

9.17 TECHNICAL SERVICE AGREEMENT

9.17.1 The VFD system manufacturer shall provide a Technical Service Agreement that lets customer bundle the exact services needed in a preventive program that reduces unplanned downtime and operational costs. A Technical Service Agreement will allow customer to select the level of service that best compliments customer's equipment, processes, and existing capabilities, then tailor the program with optional services to meet specific demands.

9.17.2 Under the Technical Service Agreement, VFD system manufacturer shall furnish competent personnel and supervision to perform the services identified in the Agreement. VFD system manufacturer and Customer shall cooperate to coordinate and schedule the delivery of purchased services to ensure their completion before the expiration of the Agreement.

10. ELECTRICAL SPECIFICATION FOR BATTERY CHARGERS AND ASSOCIATED VENTED NICKEL CADMIUM BATTERY BANKS

10.1 SCOPE

10.1.1 This specification details the manufacture, testing, supply and delivery of a DC backup battery and charger unit as specified**;**

10.2 BID INFORMATION

10.2.1 Bidders shall give full technical and descriptive details and submit related literature and drawings for the items offered. Failure to supply full information may render the bid liable to disqualification;

10.3 NORMATIVE REFERENCES

10.3.1 The following standards contain provisions that through reference in the text, constitute requirements of this specification. At time of publication, editions indicated were valid:

10.3.1.1 NRS 026: Battery chargers - Industrial type for rated ac voltages up to and including 525 V - Preferred requirements for application in their organizations by the dc and standby equipment representative user group;

10.3.1.2 SABS 1091 National colour standards for paint;

10.3.1.3 SABS IEC 269-2: Low voltage fuses: Part 2 - Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial applications);

10.3.2 Bidders shall note that, as all standards are subject to revisions, they are encouraged to investigate the possibility of applying the most recent edition of the above standard;

10.4 REQUIREMENTS

10.4.1 General

10.4.1.1 The wall mounted switchgear tripping battery and charger units, shall comply with the requirements of NRS 026 or other equivalent standard, unless otherwise specified below;

10.4.2 AC Supply Details to Charger

10.4.2.1 The unit shall be suitable for supply from a 230 V single phase, 50 Hz, local 16 A UPS type switch socket outlet;

10.4.2.2 Each unit must be provided with 2 m of adequately rated flexible cable, terminated in a 16A, three pin, UPS-type plug, fitted with a red plug top;

10.4.3 DC Tripping Supply from Batteries

10.4.3.1 The tripping supply from the whole unit shall be 110 V dc and be derived from series-connected cells as described under **clause 10.4.6**;

10.4.3.2 The positive and negative outputs shall each be isolated by a fuse-link and holder, complying with SABS IEC 269-2 or other equivalent standard. Termination of the voltage shall be on Klippon spring loaded terminals with pre-insulated lugs;

10.4.4 Duty Requirements

10.4.4.1 The complete unit shall be capable of meeting the following duty requirements:

- Specific duty requirements:
  - AC supply *ON*:
  - Supply a standing load of up to 0,45 A 110 V dc, which may or may not be present; and at the same time;
  - Supply a switchable standing load of 57 mA, which may or may not be present; and at the same time;
  - Supply 6 individual switch tripping coil requirements of 34 A dc for 100 ms each; and at the same time;
  - Maintain cells in a fully charged condition;
  - AC Supply OFF:
  - Supply a standing load of up to 0,45 A at 110 V dc for 15 hours after loss of the ac supply; and thereafter;
  - Supply 6 individual switch tripping coil requirements of 34 A dc for 100 ms each; and thereafter;
  - Retain sufficient battery capacity to continue charging when the ac supply is re-instated after 15 hours, without loss of battery life;

10.4.5 Enclosure

10.4.5.1 The battery and charger shall be housed in a vertical metal enclosure, galvanized to inhibit corrosion. Suitable surface preparation shall be applied prior to the application of two coats of light grey enamel paint colour No. G29 of SABS 1091;

10.4.5.2 The enclosure shall be divided into an upper and lower compartment with the charger housed in the upper compartment and the battery in the lower. The upper compartment shall be fully sealed to prevent ingress of dust and dirt and the products produced during charging of the battery;

10.4.5.3 The charger unit shall be mounted such that all the components are mounted on/in a removable tray/box for quick and easy replacement (of the whole unit), repair and/or inspection. The main input and outgoing circuits shall be terminated on a terminal block (spring loaded Klippon) inside the top chamber within easy access from two 20 mm holes for the attachment of standard conduit or pressure glands for alarms and tripping supplies. These holes shall not be cut out by the bidder but rather by the installation team, therefore ensuring hole placement in the required position to suit each installation;

10.4.5.4 The lower compartment shall contain the battery and shall be ventilated to permit the escape to atmosphere of any gases generated during charging. The battery shall be mounted in such a manner so as to permit adequate clearance space above the upper/back cells so as to allow all aspects of maintenance to be carried out ie, checking the voltage, specific gravity and topping up of water of each individual cell, where applicable, without the removal or disconnection of the whole battery. To enable the enclosure to be transported without the individual cells or the whole battery being displaced, the necessary transport brackets shall be supplied and fitted;

10.4.5.5 The enclosure shall have a front access door, fitted with swivel type latches which may be sealed closed with a conventional lead seal and wire, such that this door fully seals the upper compartment and closes the lower and prevents unauthorised access. If a standard panel lock is also supplied then a key shall be provided with every enclosure. All specified instruments, switches, LEDs, etc. (of the charger unit) shall be visible with the door closed;

10.4.5.6 The 110 V, 220 V charger unit shall have floor mounting lugs so as to facilitate mounting from the outside of the cubicle. The hole dimensions shall be 12 mm;

10.4.6 Cells and Battery

10.4.6.1 Requirements:

- The battery shall be of the nickel-cadmium type, which requires low maintenance, it is advisable to have containers including several cells in series in order to optimise the installation cost. Each block shall have a lid that covers connectors and valves to keep them clean. The battery shall have a minimum capacity of 29 ampere hours and housed in a transparent case. The battery shall be capable of satisfying the duty requirements of section 10.4.4 without reducing the service life of the cells to less than 15 years. The cell connections shall be of a nut and bolt type with easily removable nickel-plated copper connecting straps. The nut and bolt shall be stainless steel (grade 308 or equivalent). The number of cells shall be chosen such that the output voltage is at no time greater than 15% above that specified under clause 10.4.4;
- Vented cells shall be supplied in a transparent plastic case and the cells shall be step mounted in a tray so that the electrolyte levels of all the cells are easily visible;
- The tray shall be galvanised and painted and be deep enough so as to carry all the cells and the full volume of electrolyte from one cell. The tray shall be totally removable with all the cells interconnected;
- Vented cells shall be supplied with transport caps fitted, and plastic fliptop vent caps ready for fitment at the time commissioning the cells;
- Each battery bank shall be supplied with the correct Box/Link spanner set;
- The cells shall be delivered in a fully charged condition suitable for immediate service. The individual cells shall all have been tested to 100% capacity before delivery;
- The battery service life shall preferably be 20 years but not less than 15 years;
- The battery shall have a minimum capacity of 17 ampere-hour;

10.4.7 Charger Unit

10.4.7.1 Requirements:

- The charger unit shall be kept as simple as possible with LEDs and indicators mounted on the front panel of the charger unit;
- The charge unit shall be capable of meeting the following two separate requirements:
  - Supply the continuous switchable standing load; and
  - Maintain the battery at full charge whilst the ac supply remains ON irrespective of whether the standing load is present or not;
- The standing load may be switched off and the charger design shall allow for this;
- The boost voltage shall not exceed that specified by the cell manufacturer;
- The float voltage shall be set to that specified by the cell manufacturer;
- The "ON/OFF" switch, "BATTERY TEST" push-button and "BOOST/FLOAT" manual push-button shall be situated externally on the charger unit but not on the front face (i.e. inside the enclosure when the door is closed);
- The "Alarm Accept/Reset" switch shall be fitted on the front face of the charger unit;
- The manual boost shall not be a switch but a push-button. When the pushbutton is operated, the manual boost shall latch into the "ON" condition for a limited time and then switch “OFF” automatically (ie. trigger an electronic timer circuit). The bidder shall declare this time period which could be used to ascertain the alternative “ON” period for the manual “OFF” pushbutton. Alternatively, the boost condition may be terminated by a manual "OFF" push-button;
- The minimum charge shall be a 110 V dc, 5 ampere unit;
- The unit shall be kept as simple as possible with LED’s and indicators mounted on the front panel of the charger unit. All equipment and components shall be adequately rated with sufficient tolerance to permit continuous operation without overheating or damage or reduction in life of equipment. Underrated components shall not be accepted, IC’s shall be of the plug-in type. All equipment shall be designed to withstand lightning strikes and for surges. All LED’s shall be of the Hi-Brite intensity.
- The charging unit shall be of the constant voltage, controlled current type suitable for pre-selection of the dc float voltage which is to be maintained across the battery to within + 1% for a variation in ac supply voltage of + 10%. The voltage adjusting devices shall be mounted inside the panel and provided with screw-driver slots for adjustments. Each adjustment shall be labelled to indicate its purpose and direction to be related either to raise or lower settings;
- A double pole ac switch and fuse or circuit breakers shall be provided for the incoming AC supply. The outgoing circuits shall be protected by fuses or MCCB’s;
- Chargers shall be provided with surge suppressers for protection against di-ode failure, due to voltage transients;
- The charger shall be provided with static overload protection to ensure that in the event of the charger output being short-circuited, the maximum output current is kept to a value within the continuous rating of the charger components;
- All indicating instalments shall be of flush-mounting, square dial type. An ammeter shall be provided to indicate charger output;

- The unit is to be supplied with 4 outgoing output load circuits, each to be isolated by a fuse and a link or MCB's;
- The recommended charge shall be a 110 V dc, 5 ampere unit;

10.4.8 Wiring and Terminations

10.4.8.1 The wiring of the various components shall be of not less than 1,5 mm² conductor size and shall be terminated in suitably sized anvil-type (Klippon, G-rail type) terminal blocks with pre-insulated lugs. The input and output terminal blocks shall be capable of accepting 2,5mm² conductor. All terminal blocks shall be mounted in such a manner so as to permit easy connection/disconnection from the access doors/covers;

10.4.8.2 The connections to the charger unit shall be of a plug-in type for quick and easy replacement of a faulty charger unit. This plug shall be polarity conscious and no live pins shall protrude from such a plug. The plugs shall be rated to carry the required current and voltage without deterioration of the plug;

10.4.8.3 The connections between the battery bank and the rest of the system shall be of a quick release type and be of sufficient rating so as to carry the total rated trip current for the specified length of time. This shall allow quick replacement of the whole battery bank on a draw out tray. This plug shall also be polarity conscious;

10.4.9 Communications

10.4.9.1 The charger unit will have an output terminal to allow a link to the local RTU for communications to allow the status of the unit to be transmitted onto the fibre network. The following statuses will be available but not limited to:

- Mains healthy;
- Battery output healthy;
- Charger fail;
- Battery test fail;
- Low DC voltage;

10.4.10 Instrumentation

10.4.10.1 The following instruments shall be included:

10.4.10.2 An ammeter of good industrial grade with a scale length of not less than 95 mm to indicate the charging current;

10.4.10.3 A voltmeter (state of charge indicator) matching the instrument in clause **10.4.9.2**, which shall indicate the battery condition when loaded by a resistor switched by a timed push-button mounted inside the top compartment. The indicator shall be clearly marked to indicate whether the battery is fully charged or not when loaded at 1 ampere per ampere hour capacity for approximately 5 seconds;

10.4.10.4 An "ON/OFF" switch mounted on the charger unit such that it is not on the front face and the toggle movement is downwards to switch "on";

10.4.10.5 An indicating lamp/LED coloured red and mounted on the front panel, to indicate when the charger supply is "on" and labelled "MAINS ON";

10.4.11 Auto Battery Test

10.4.11.1 The charger shall have an automatic battery test facility. This facility shall load the bank for a set period of time via a resistor and at set time intervals;

10.4.12 Auxiliaries/Alarms

10.4.12.1 An ac Supply Fail alarm with a delay of 30 s shall illuminate a red LED and at the same time drop off a dedicated relay which closes a pair of voltage free contacts wired to terminal blocks. Refer section **10.4.8**. This LED shall be clearly labelled "AC SUPPLY FAIL" including the contacts on the terminal block;

10.4.12.2 A Low dc Voltage alarm shall illuminate a red LED and at the same time drop off a relay which closes a pair of voltage free contacts wired to terminal blocks. Refer section **10.4.8**. This LED shall be clearly labelled "LOW DC VOLTAGE" including the contacts on the terminal block;

10.4.12.3 A Battery Test Fail alarm shall illuminate a red LED and at the same time operate a relay which closes a pair of voltage free contacts wired to terminal blocks. Refer section **10.4.8**. This LED shall be clearly labelled "BATTERY TEST FAIL" including the contacts on the terminal block;

10.4.12.4 A suitable earth-fault detection system should be supplied, for earth faults above 10 mA. Provision should be made for local and remote indications of positive and negative earth faults for the 110 V systems only;

10.4.13 Equipment and Component Ratings

10.4.13.1 All equipment and components making up the complete unit shall be adequately rated with sufficient tolerance to permit continuous operation without overheating or damage or reduction of the stated service life of the equipment. The tripping unit forms an important part of the unmanned substation and underrated components shall not be accepted. ICs shall be of the plug-in type. **All equipment shall be chosen and designed to withstand lightning strikes and/or surges**. All LEDs shall be of the Hi-Brite intensity;

10.4.14 Spares and Equipment

10.4.14.1 The successful bid shall supply, if required:

10.4.14.2 Complete charger units;

10.4.14.3 Complete assorted spare kits; and

10.4.14.4 Spare battery packs complete with in line clip/coupling compatible with this specification;

10.4.14.5 Bids shall quote separately for the above spares, as the spares are required for maintenance purposes only;

10.5 DOCUMENTATION

10.5.1 The following information shall be included with bid documents:

10.5.1.1 Current/time discharge curves for the battery offered;

10.5.1.2 Battery voltage/time charge and discharge curves;

10.5.1.3 The sensing method of charge control and detection of a full charge condition;

10.5.1.4 Method used to prevent overcharging;

10.5.1.5 Indication method to indicate full charge;

10.5.1.6 Tolerances allowed in component rating;

10.5.2 The following shall be supplied by the successful bidder with the first delivery:

10.5.2.1 Full wiring schematic drawings;

10.5.2.2 Component layout drawings and circuit diagrams;

10.5.2.3 Component list including, name, type of component, source and quantity;

10.5.2.4 Operating manual;

10.5.2.5 Maintenance Manual;

10.5.3 Bidders attach supporting documents with respect to:

10.5.3.1 The service life of the batteries;

10.5.3.2 The equipment design to withstand lightning strikes and/or surges;

10.5.3.3 Where possible the above information should be supplied on a external 4TB hard drive and in Autocad format;

10.6 INSPECTION AND TESTING

10.6.1 Upon receipt each unit will be fully tested and inspected and any units with visible or electric defects will be rejected. These units shall be removed and replaced or repaired by the contractor as soon as possible after being notified. All units shall be fully tested to ensure compliance with the specification and will be accepted only if they meet the requirements of the specification;

10.6.2 It is recommended that if the units are of a type not previously supplied to eThekwini Electricity, a prototype should be submitted for approval prior to manufacture. Liaison with Mr. Lenny Govender, telephone: (031) 311 9639, responsible for the tripping units is strongly recommended;

10.6.3 Each cell/bank shall be supplied with results of type tests carried out in accordance with NRS 026 on the cell by the cell manufacturer;

10.6.4 Each charger shall be supplied with results of type tests carried out in accordance with NRS 026 on the charger by the manufacturer;

10.7 DELIVERY

10.7.1 The required wall mounted switchgear tripping battery and charger units shall be delivered by road, direct to the construction site for the eThekwini Waste Water Treatment Works, Durban, South Africa;

10.7.2 Bidders are requested to offer definite delivery periods which are realistic and attainable;

10.7.3 Delays in delivery in this contract could result in discounting further offers from bidders for future contracts for this equipment;

10.7.4 Units shall be clearly marked "FRAGILE" and "THIS SIDE UP" for transporting and storage;

10.7.5 The units shall be packaged in a light-open slatted wooden crate/frame;

10.7.6 A packed unit shall be clearly marked the following:

10.7.6.1 Stock code number (refer Schedule A for stock code number);

10.7.6.2 Charger unit capacity; and

10.7.6.3 Battery capacity;

10.8 TRAINING

10.8.1 Provision shall be made to train two staff members from eThekwini Waste Water Treatment Works on the construction site;

10.8.2 Training shall include fault finding down to component level utilising the drawings to be provided under the training section of this specification;

10.9 SAMPLES

10.9.1 Samples will not be required for this tender;

10.10 HEALTH, SAFETY, AND ENVIRONMENTAL ISSUES

10.10.1 Bidders shall provide the following information in respect of each product offered;

10.10.2 A list of all materials used in the product, including packaging, and associated chemical data sheets;

10.10.3 Whether the product poses any health or safety risks to persons handling the product. In addition, if there are risks, the protective gear required to handle the product, e.g. leather gloves, masks, etc.;

10.10.4 How the product should be disposed at the end of its useful life or in the event of failure of the product;

10.10.5 Whether any toxic by-products are produced (whether in gaseous, solid or liquid form) in the event of the product being exposed fire or heated to elevated temperatures;

10.10.6 Any other pertinent and relevant information relating to health, safety, and environmental issues; and

10.10.7 What percentage of the product can be recycled;

10.10.8 The bidder shall complete an Acceptance of undertaking in terms of the Occupational Health and Safety Act (Act 85 of 1993);

10.10.9 The successful bidder's installation team shall undergo eThekwini Water and Sanitation 's Safety Rules course and a subsequent test, after which these persons would be deemed Specifically Trained Persons and issued with a contractor's identity card.

11. EARTHING SPECIFICATION

11.1 General

11.1.1 The Earthing and Bonding of the substation electrical installation and extraneous conductive parts shall be in accordance with the latest regulations of the Code of Practice of the Wiring of Premises SANS 10142-1.

11.1.2 Should tenderers wish to offer alternative layouts, a full set of Detail Drawings shall be submitted with their tender for evaluation.

11.1.3 The main earth bars and substation earth mats shall be installed before any of the substation equipment is brought in for installation.

11.2 Soil Resistivity

11.2.1 Soil Resistivity measurements shall be taken of the soils into which the proposed earth mats will be installed. Typically, a Wenner four pin method is to be applied, making use of four electrodes driven into the soil to equal depth and equally apart. A suitable megger is connected to the electrodes in a predetermined sequence, the current is injected into the soil and resulting potential difference is measured.

11.3 Earth Mats

11.3.1 Substation earth mats are to be installed as shown on the Earth Diagrams and Layout Drawings. Substation main earth bars (wall mounted) shall be bonded with the earth mat by means of 95mm² stranded copper conduit Cu PVC insulated cable.

The earth mats systems shall conform with the following:

11.3.1.1 Material:

Main earth mat	95mm² stranded copper
Secondary earth mat	70mm² stranded copper
Branch connectors	95mm² stranded copper PVC insulated cable

The earth rod system shall consist of 'copper welded' extensible (2m x 16mm) earth electrodes interconnected by 70mm² stranded copper conductor.

Depth of Installation	1000mm below finished ground level
Method of Installation	Direct in the ground

11.4 Earth Conductor Joints, Intersection Bonding and Terminal Connectors

11.4.1 All joints shall be Exoweld connectors using Exothermic-welding powder. The powder is available from Exoweld, but any other type or supplier may be chosen provided full details are submitted to the Engineer for his approval.

11.4.2 Before the metals are brazed, both surfaces shall be sand papered clean and shall be heated to the required temperature sufficient to enable the brazing material to flow between the surfaces and so ensure, through adhesion a complete metallic bond is required.

11.5 Terminal Connections

11.5.1 Earth Terminal lugs shall be a Torque-controlled, shear-head bolt type (IEC61218-1) suitable for 95mm² 1-core Cu PVC insulated and sheathed (SANS 1507-3) cables. Each bolted connection shall also include two bronze clamping bolts and nuts with flat and spring washers.

11.6 Substation Earth bars

11.6.1 Each substation shall be fitted with a wall mounted (fixed on insulators) copper earth bar: 1000mm x 60mm x 12mm.

11.6.2 Medium and low voltage switchgear, transformers as well as the MV cable earth shall be connected to the main earth bar as the main earth bar connected to the substation equipment.

11.6.3 Earth bars shall be constructed with the Test links to isolate local earth mats from the earthing systems.

11.7 Recording of Earth System Resistance

11.7.1 The substation earth resistance shall be measured immediately upon completion of the earthing installation BEFORE the substation equipment is installed.

Final reading shall be taken upon completion of the substation, when fully installed the earth resistance shall not exceed 1 Ohm. The final resistance measurement shall be with MV supply cables disconnected from the earth mat.

PARTICULAR SPECIFICATION – MEDIUM VOLTAGE

Contents

PARTICULAR SPECIFICATION – MEDIUM VOLTAGE

1. INTELLECTUAL PROPERTY

1.1. All rights of intellectual property, including copyright in the Tender Documents, drawings, data and technical and other pictorial and written information supplied to the Tenderer by the eThekwini Water & Sanitation (EWS) or any person or body for or on behalf of EWS, shall be and at all times remain the property of EWS;

1.2. EWS may, in its sole discretion and at any stage before or after completion of the Tender process, require that all written information (whether confidential or otherwise and without regard to the type of media on which such information was provided to any Tenderer including all copies of such information) be:

1.2.1. Returned to EWS, in which case the Tenderer must promptly return all such information to the address identified by EWS; or

1.2.2. Destroyed by the Tenderer, in which case the Tenderer must promptly destroy all such information;

1.2.3. Without affecting any intellectual property rights which may exist in a Tender, all Tenders submitted in relation to the Invitation to Tender shall be the property of the EWS;

2. OVERVIEW

2.1. The Contractor will be responsible for the Medium Voltage, associated Low Voltage and minor mechanical and civil upgrade to the eThekwini Southern Wastewater Treatment Works which is a fully functional and operating plant. The existing electrical installation is to have an extensive modernisation programme involving replacing the Main Substation MV switchgear, metering panels, battery units, selected transformers, VSD motor starters, ring main units, cabling, and earthing.

2.2. The contractor will also ensure continuity of supply for outages for critical processes as directed by the Works Area Manager by means of supplying a prime rated generator for 72hours. All change overs must be planned with permission being sought for all power outages. The disconnecting and removing of redundant equipment and cabling after affecting all necessary changeovers.

3. REDUNDANT EQUIPMENT

3.1. Certain parts of the existing plant are to be made redundant after commissioning of the new plant and the Contractor shall be responsible for disconnecting and removing redundant electrical equipment and cables where possible and as directed by the Engineer. In summary, existing plant to be removed will be the existing main substation MV switchgear, MV cabling, Auto Transformers, transformers, ring main units, metering panels, battery charging units etc;

3.2. All redundant equipment shall be removed off site to the eThekwini Electricity Reclamation Site in Springfield, which is approximately 30 km away from the site. Ownership of redundant equipment shall always reside in EWS and no equipment may be removed off site without prior authorization from the Engineer;

3.3. The removal of the redundant plant and equipment to the eThekwini Electricity Reclamation Site shall be arranged in conjunction with the EWS Area Engineer to ensure that proper procedures are followed;

3.4. Equipment to be removed shall be identified and physically tagged by the Contractor. Identification of cables shall include the origin and destination of each cable and authorization for removal shall be given after the tagged equipment has been inspected by the Engineer in the presence of the Contractor;

3.5. The contractor shall deliver the old equipment to our reclamation stores in Springfield via a GFD form which will be authorized by the engineer in charge;

4. SCOPE OF WORK

4.1. The scope of work includes the design, engineering, manufacture, supply, delivery, installation, risk assessment, testing, commissioning, quality control and guarantee of all new equipment for the substation buildings as summarised below, including all ancillary equipment medium voltage, low voltage, fibre cabling and connections required to provide a fully functioning and maintainable installation in terms of good engineering practice. Also included in the scope is the factory acceptance test at the OEM of **all equipment**, the on-site training of the Employer's operating staff and the supply of as-built drawings, operating and maintenance manuals;

4.2. It needs to be noted that the maximum electrical capacity that can be obtained from eThekwini Electricity is 6 MVA. Therefore, all sizing of cabling must be done to accommodate this supply of 6 MVA at 11kV. All MV cables needs to be XLPE (copper) and LV cables copper. All transformers shall have copper windings;

5. SUMMARISED SCOPE OF WORK: MV SWITCHGEAR, RING MAIN UNITS, MV MOTOR STARTERS, AND TRANSFORMERS

5.1. All MV installation work shall be carried out strictly in accordance with SANS 10142-2;

5.2. To be read in conjunction with clause 5.4.12 Competency Requirements of the Standard Specification**;**

5.3. The contractor working on the 11,000-volt system and equipment must be deemed competent and authorised by the eThekwini Electricity Department regarding safety rules, systems operating regulations, underground mains cabling and substation maintenance. These competencies must be current, and the contractor shall hold a valid contractor's card issued by eThekwini Electricity;

5.4. All switching activities of the EWS 11kV equipment during the contract period shall be the full responsibility of the contractor. All MV switching shall be done by the authorised appointed person from the contractor in the presence of the eThekwini (EWS) authorised official. Any planned power outages together with the risk assessment reports shall be planned at least one week in advance with the EWS Mechanical and Electrical Branches and a 48-hour written notice period shall be given to the nominated staff;

5.5. eThekwini Electricity has existing contracts in place for the manufacture, supply, and delivery of MV switchgear and mini substations. To ensure standards for switchgear are maintained within the Municipality, it is a requirement that similar equipment be installed at the Southern Wastewater Treatment Works. The standard technical specifications in the Standard Specifications section of this document must be adhered to where applicable;

5.6. The contractor will be responsible for submitting all application forms to the eThekwini Electricity for the change-over from the old MV equipment to the new MV equipment and submit all drawings required by the Municipality. It is the contractor's responsibility to coordinate with the eThekwini Electricity for the change-over of the equipment and the outages required. Outages must also be arranged with the plant superintendent;

5.7. The existing substation equipment and reticulated underground MV cabling and ancillary equipment shall be decommissioned and stripped out where possible and with the direction of the Engineer in accordance with an approved shutdown programme and transported to the Springfield Municipal Stores;

5.8. A new 11kV network consisting of new mini- substations interlinked with a new underground medium voltage and fibre optic cables shall replace the existing 11kV system. New MV equipment and cabling shall be supplied, delivered to site, installed, and commissioned at the new main substation, Veolia Sub Station, the Medium voltage ring, and Low-Level Pump station;

5.9. The contractor shall employ the services of a specialised cable tracing agency to assist in identifying locations of MV, LV cables and other buried services; this service coupled to careful hand dug

inspection trenches will help the Contractor in verifying the position of existing services that may impact on planned final cable routes.

5.10. A new main Substation building is to be built to house the supply authority's switchgear, the metering equipment as well as new consumer's MV switchgear for the Southern Wastewater and Veolia Water: This substation will be built under a different contract to this.

5.11. The new MV switchgear for the EWS switch room shall consist of a 11kV Electricity Incomer and two feeder circuit breakers – with voltage transformer and measuring class (0,2) current transformers wired for overcurrent, auto-reclosing functionality and internal arc detection protection for Southern Wastewater Treatment Works and for Veolia Water. The Southern Wastewater Treatment Works switchboard will consist of three Feeder circuit breakers – with protection (PX class) current transformers wired for overcurrent, earth fault protection, sensitive earth fault protection, auto-reclosing functionality and internal arc detection protection. 11KV, 630A, 25 kA. The switchgear shall be provided with a Remote Terminal Unit for the monitoring of the switchgear statuses and a remote switching device for safe local operation. A new 110v or suitably rated battery charger unit will be required and shall be manufactured in accordance with the standard specification attached for battery chargers. (with a 5 % factor of safety);

5.12. The Veolia Water switchboard housed in the adjacent room will consist of three Feeder circuit breakers – with protection (PX class) current transformers wired for overcurrent, earth fault protection, sensitive earth fault protection, auto-reclosing functionality, and internal arc detection protection. 11kV, 630A, 25 kA. The switchgear shall be provided with a Remote Terminal Unit for the monitoring of the switchgear statuses and a remote switching device for safe local operation. A new 110v or suitably rated battery charger unit will be required and shall be manufactured in accordance with the standard specification attached for battery chargers. (with a 5% factor of safety);

5.13. The 11kV bulk metering panel (one each for Southern Wastewater Treatment Works and for Veolia Water) shall be manufactured to eThekwini Electricity requirements. Municipal energy meters shall be mounted on a wall mounted panel manufactured to eThekwini Electricity requirements in the Councils meter room next door. All cabling racking consumables and other material necessary shall be provided;

5.14. All protection relays are to be monitored: Each relay is to be connected to the Remote Terminal Unit and for transmission and communication via fibre optic cable;

5.15. The new miniature substations (6 off) shall contain SMART READY motorised, 3 Way RING MAIN UNITs with suitable relays, e/f indicator with CT and a Remote Terminal Unit for the 500kVA (5 off) and 1000 kVA (1 off) transformers with an LV switchboard;

5.16. The new mini substations for the Aeration MCC shall be fed from the main Veolia MV panel a 1000 kVA transformer with an LV switchboard;

5.17. IEC 61850 Communications Networks and Systems in Substations must be complied with;

5.18. All substation MV equipment and protection relays are to be connected via ethernet to the switch box for remote monitoring by SCADA which will be installed at a later stage;

5.19. All SMART READY MINI Substations shall be connected via optic fibre cabling and brought to the main substation termination box for connection to SCADA which will be installed at a later stage;

5.20. The SCADA system will monitor all information available from the MV switchgear and relays. This will be installed at a later stage;

5.21. In the interim an allowance has been made to procure and install a Panel PC in the main intake substation that will monitor the status of the medium voltage installation: The contractor will employ the services of a specialist sub-contractor to design and programme the platform on which this will operate;

5.22. Cable boxes on the new switchgear shall have a minimum height of 600mm;

5.23. Various parameters for each circuit breaker would be hard wired to terminals. This will be wired to the SCADA at a later stage for monitoring and communication to the central control room. These shall include but not limited to for each circuit breaker:

5.23.1. Circuit breaker open, circuit breaker closed, circuit breaker tripped on fault, load drawn by main incoming breaker in kW and Amps (Remote Terminal Unit);

5.24. For the ring main units:

5.24.1. Each ring main unit shall have motorised breaker or switch units with mimic display ring main unit switch open, ring main unit switch closed, cable fault, load drawn by each substation in kW and Amps. The RMU shall also be provided with voltage indicator lamps for each phase and have an internal arc withstand capability of the tank of 25 kA for 1,0 second;

5.25. The Low Level 11 kV transformer switchboard housed in the newly built Low-Level Electrical Substation shall consist of FIVE Feeder Circuit Breakers as well as TWO Incomer Circuit Breakers fed from the new MV ring. The feeder circuit breakers will be provided with protection (PX class) current transformers wired for cable differential protection, overcurrent, earth fault protection, sensitive earth fault protection, auto-reclosing functionality, transformer protection and internal arc detection protection,11KV, 630A, 25 kA.

5.26. The switchgear shall be provided with a Remote Terminal Unit for the monitoring of the switchgear statuses and a remote switching device for safe local operation. A new 110v or suitably rated battery charger unit will be required and shall be manufactured in accordance with the standard specification attached for battery chargers (with a 5% factor of safety).

5.27. One 200kVA 11kV / 420 V distribution transformer shall be installed in the newly built Low-Level Substation fed from the medium voltage switchboard with all ancillary transformer protection cabling and earth cables as described in the standard specification by a medium voltage XLPE cable 95mm2 3 Core: This in turn will be connected to a Low Voltage MCC.

5.28. On the new Low Level 11kV switchboard, four of the feeder circuit breakers will provide power and protection to four 3.3kV 140-amp variable frequency drives (VFDs) motor starters as per specifications. These VFDs will be controlled by the new low voltage Motor Control Centre (MCC) described elsewhere in the tender document.

5.29. The Low Level 11kV switchboard shall be provided with a Remote Terminal Unit with a remote switching device for safe local operation. A new 110v or suitably rated battery charger unit will be required and shall be manufactured in accordance with the standard specification attached for battery chargers. (this can be common to both but rated appropriately with a 5% factor of safety);

5.30. All protection relays are to be able to be monitored by the SCADA system, once installed. Each relay is to be connected to the Remote Terminal Unit and linked via fibre optic cable back to the main substation;

5.31. All suitably rated MV motor cables, earth cables and ancillary motor protection cables shall be connected to the new motors. This includes cable ladders, trays, stop stations, all fixings and consumables;

5.32. Concrete plinths are to be supplied with each mini substation as per general specification. A concrete screed is to be installed in the cable holes of the base after cable installation to prevent moisture rising into the unit;

5.33. All new 11kV cables laid in the ground or in substation ducts for the new MV ring shall be 150 mm² 3 core copper: XPLE, copper taped screened, galvanised steel wire armoured 6,6/11kV cable.

5.34. A 70 mm² insulated/bare copper earth wire is to be run with all new MV cabling;

5.35. ALL SWITCHGEAR IS TO BE CONGIGURED AS PER SINGLE LINE DRAWING PROVIDED;

6. COMPULSORY DATA PACK

6.1. A detailed design pack will be submitted, including, but not limited to a CAD drawing of all cable routes including fibre and medium voltage, a single line drawing indicating the layout of the equipment, a design report with all table's, guidelines, standards etc all as per the IEC codes is to be provided on three hard copy format and on soft copy format (native file and PDF) on a 4TB hard drive. Any other reports, calculations, and narrative to comply with the scope of work and the discussions held on site;

7. PROCESS CONDITIONS

7.1. The contractor is to take full cognisance of the following:

7.1.1. It is assumed that the atmosphere within all sumps and chambers is toxic and will not support life and is to be treated as explosive;

7.1.2. No sump or chamber may be entered unless under the direct supervision of the eThekwini Wastewater Treatment Works Management Staff;

7.1.3. Before undertaking any work in sumps and chambers, a full risk assessment is to be undertaken and submitted to the eThekwini Wastewater Treatment Works Management Staff for approval prior to initiating any of this type of work;

7.1.4. All work undertaken at the pump station shall at all times be supervised by a registered installation electrician, who has experience in sewage pumping installations;

8. DIVISION OF WORK

8.1. No assistance by way of materials, labour or machinery will be provided by the eThekwini Wastewater Treatment Works Management Staff;

9. CONTRACTOR TO DESIGN AND ENGINEER

9.1. It is the contractor's responsibility to design and engineer the installation in accordance with the specification and good engineering practice;

9.2. The design shall be undertaken by personnel who are able to demonstrate experience in the field of wastewater management. The design drawings and as-built drawings shall be signed by a person or persons under the employ of the Contractor and shall be registered with the Engineering Council of South Africa;

9.3. The engineer will review all drawings for conformance with the design concept but will not confer formal approval for construction;

9.4. Attached is a preliminary design report for the Medium Voltage Upgrade as per the Single Line Diagram. It is the contractor's responsibility to provide a detailed final design report consisting of but not limited to the following:

9.4.1. Design calculations:

9.4.1.1. Cable sizing; MV, LV and fibre;
9.4.1.2. Load calculations;
9.4.1.3. Cable lengths;
9.4.1.4. Volt drop calculations;
9.4.1.5. Fault level calculations on Medium Voltage ring;
9.4.1.6. Fault Level for Motor Starters (entire Low Level MV);
9.4.1.7. New LV cable sizes and lengths with volt drop calculations from the mini subs and transformers;
9.4.1.8. Earth cable sizes LV and MV;
9.4.1.9. Selection of the open point;

9.4.1.10. Grading of the protection relays (Main MV reticulation);
9.4.1.11. Grading of the protections relay – Low Level Pumps;
9.4.1.12. Medium Voltage (MV) Switchgear; motor starters. Select the FLA of each;
9.4.1.13. Protection relays; (Earth Fault, Overload, sensitive earth faults and cable differential);
9.4.1.14. Protection relays for motor starters (Overload, Earth Fault, thermal, etc).

10. PREFERRED EQUIPMENT

10.1. The tenderer shall base his main tender price on the equipment listed in the schedule of preferred equipment. The tenderer may however offer alternative equipment, but in this event:

10.2. The proposal shall be offered in a separate covering letter indicating the influence on the main tender price;

10.3. The Contractor shall submit sufficient documentation at the time of tender to allow the engineer to evaluate the equipment;

10.4. The Contractor shall make himself available during the tender adjudication period for one or more discussions on the detail of the equipment and its operation in a system;

10.5. The decision as to final choice of equipment shall rest with the Engineer but this shall not relieve the contractor of his contractual obligations in terms of the specification and functional operation of the equipment;

11. MATERIAL OF CONSTRUCTION

11.1. The cable ladders, accessories and equipment mounting brackets shall be manufactured from 3CR12 sheet metal or ‘dressed’ flat bar;

11.2. All fixings and brackets within the confines of the wet sump shall be 304 stainless steel;

11.3. All fixings, bolts, nuts and washers other than those used within the MCC, shall be of grade 304 stainless steel;

12. EARTHING AND LIGHTNING PROTECTION

12.1. The earthing and lightning protection installations at the existing buildings are to be inspected and tested for compliance with the standard specifications SANS 10313 and SANS 62305 1-4. Soil resistivity surveys are to be carried out at each building with a Wenner and fall of potential method. Reports with test results, drawings, recommendations and quotations to ensure compliance with the standards are to be submitted to the engineer. A provisional sum has been allowed in the document for the upgrading or installing new earthing and lightning protection to the existing buildings. Both earthing and lightning protection of building structures shall be carried out by a Specialist Earthing Contractor. Suitable earth bar based on the results shall be installed in the trench for the connection of all earths. The earth bar shall have a minimum of 20 holes 12mm in diameter;

13. SITE OF WORKS AND ACCESS

13.1. The site of the works is at the Southern Wastewater Treatment Works in Durban, KwaZulu. The Pump Station is classed as a factory in terms of the Occupational Health and Safety Act and the Contractor’s labour is to keep within the bounds of the site during working hours;

14. CONTRACT PERIOD AND CONSTRUCTION PROGRAMME

14.1. The contract period is **24 Months (104 weeks)** (including public holidays). Tenderers are required to submit a preliminary programme for the works with their tender. The programme shall clearly indicate separately and in bar chart form the proposed activities and their time spans for the various stages of the job. Also, to be indicated in the programme is an appropriate commissioning period and the critical path;

15. WATER, LIGHT AND POWER

15.1. Water lights and power will be made available to the Contractor on site; however, the contractor will be responsible for the supply of all temporary extension cables and hoses etc., required by him to supply water and power to the point of demand. The contractor will not be charged for reasonable use of water and power but must bear all the cost related to conveying the water and power to the point of demand. The contractor shall liaise with the M&E staff with regard to making his arrangements for water, lights and power

15.2. It is also the Tenderer's responsibility to determine the sufficiency of the water and power supplies to suit his requirements. Further, uninterrupted supplies are not guaranteed;

16. SANITARY FACILITIES

16.1. The Contractor shall not be permitted to use the employer's sanitary facilities. The contractor will make their own arrangements for these facilities: An allowance has been made in the BOQ;

17. STORAGE OF PLANT AND EQUIPMENT

17.1. Storage space for plant and equipment will be available on site: The contractor shall arrange storage at their own expense within the contractor's compound. The cost of this facility should be included in their tender price including the need for any additional security and lighting; It should be noted that site security cannot be guaranteed;

18. INTERFERENCE WITH OPERATION OF THE TREATMENT PLANT

18.1. The Treatment Works is operational 24 hours a day: Interruptions to the operation are only permissible if prior arrangements have been made with the EWS Project Engineer and Works Area Manager with a notice period of at least 3 days;

18.2. All operations necessary for the execution of the contract shall be carried out with minimum inconvenience to running of the Treatment plant. This will require close liaison with the Works Branch staff. This liaison must always be maintained whilst work is being carried out on this site;

18.3. Access for EWS staff to all parts of the Treatment Plant must be maintained at all times and the Contractor's work must be programmed accordingly;

19. GUARANTEE

19.1. The Contractor shall guarantee all workmanship and materials supplied by him and installed under this contract for a **period of TWELVE MONTHS from the date of acceptance and handover of the plant to EWS.** The guarantee shall include any latent defects in the workmanship, materials and installation thereof and any labour or other costs inherent in repairing any defect and ensuring that the plant, equipment and fittings remain free of defects and in good working order to the satisfaction of the Engineer;

19.2. Fair wear and tear shall not be considered as requiring any action by the Contractor under the requirements of the contractual guarantee;

19.3. Inspection of the plant shall be made by the Contractor in the presence of the Council's Staff, at suitable intervals, to confirm that the plant is operating in a satisfactory manner;

19.4. Provision, as required, shall be made in the contract rates, or elsewhere, for any additional cost incurred in providing this contractual guarantee;

20. MAINTENANCE

20.1. The Contractor shall be responsible for the initial routine maintenance, until such time as the plant and equipment has been accepted and handed over to EWS and is capable of fulfilling its' specified operational duties. Once the plant and equipment has been successfully commissioned and

accepted, the Council's site staff will undertake the operations of the plant and equipment and its routine maintenance in accordance with operating instructions and routine maintenance requirements;

20.2. The normal operational maintenance, in accordance with the manufacturer's recommendations, will be undertaken by Council staff at no charge to the Contract. The Contractor will be instructed to attend to maintenance of a non-routine nature. If the Contractor fails to respond to such an instruction within period of twenty-four (24) hours, then such maintenance may be carried out by the Council at the risk of the Contractor. All costs incurred by the Council under these circumstances will be deducted from the contract sum;

20.3. The maintenance period in terms of Clause 11,1 (FIDIC Defects Liability) shall commence concurrent with the guarantee period as defined in Clause PS.10 (Guarantee);

20.4. Details of tests and work to be performed at the end of the maintenance period are given in the specification;

21. DEFINITION OF HAND-OVER

21.1. The maintenance and guarantee period will commence on the date of hand-over which shall be the date of certification of completion of the works. Hand-over will not occur until:

21.1.1. The testing and commissioning report has been submitted and approved;

21.1.2. The operating and maintenance manuals have been handed to the Engineer;

22. INSPECTION ON ARRIVAL AT SITE

22.1. On delivery direct to the erection positions or to the storage area, the plant and equipment shall be inspected by the Engineer's representative and the Contractor's agent. The Engineer shall be at liberty to carry out any tests he may deem fit before acceptance;

23. REPAIRS TO DAMAGE

23.1. Damage or defects of any kind which became apparent on inspection or delivery shall be repaired by the supplier of such items to the satisfaction of the Engineer immediately upon detection. Where damage is such that, in the opinion of the Engineer, satisfactory repairs are not practicable, the damaged article shall be replaced at no cost to EWS which shall accept no responsibility for any loss or damage which may be suffered as a result of delays in obtaining the necessary replacements;

24. INSPECTION AND TESTING (FACTORY AND SITE)

24.1. The successful tenderer shall arrange at his own expense, for the two Project Engineers and three representatives of EWS to carry-out a pre-delivery inspection, at the manufacture's factory. The tenderer needs to point out the entire manufacturing process for the switchgear and equipment. At this time, the switchgear and equipment must be tested as per the design criteria and quoted standards;

24.2. The site test shall consist of recognised and approved tests as per the OEM. All test equipment shall have valid test certificates not older than 6 months and the equipment must be approved by the OEM;

25. CONTRACT'S STAFF DURING INSTALLATION AND COMMISSIONING

25.1. During the period of installation and commissioning of the works, the Contractor shall retain, within the region of the eThekwini Municipality, one or more persons who are fully conversant with the equipment and who can be brought on to site at short notice and for such periods as the Engineer shall consider necessary. Such person(s) shall be proficient and fluent in the English language and shall be employed to act on behalf of the Contractor;

26. APPOINTMENT OF RESPONSIBLE PERSON

26.1. The contractor shall cause all work to be carried out under the general supervision of a responsible

person appointed by the Contractor in writing in accordance with the provisions of the General Safety Regulations made in terms of the Occupational Health and Safety Act:

26.1.1. A copy of the letter of appointment and of the appointee's written acceptance thereof, shall be lodged with the Engineer;

26.1.2. Work on site shall not commence until the documents referred to in sub-clause 25.1.1 have been received by the Engineer;

26.1.3. Due cognisance shall be taken by the Contractor of the regulation/s relating to, "Work in confined spaces", of the O.H.S.A. Regulations and further to this no clearance shall be given by this Department;

26.1.4. Precaution shall be taken to avoid safety and health hazards to workmen. The Contractor shall be responsible for supplying protective clothing, etc. for use of workmen;

27. ANCILLARY EQUIPMENT

27.1. The Contractor will be responsible for the supply, delivery to site and erection of all ancillary equipment, including scaffolding, lifting equipment, cranes, hand tools welding machines, portable generators and any other equipment or tools necessary to do the work necessary to complete the contract;

27.2. All brackets, cleats, clamps, hangars, ties, "U" bolts etc. are to be grade 316 stainless steel securely and neatly fixed in accordance with good engineering practice, and to the satisfaction of the Engineer;

27.3. All costs involved in the provision and installation of such ancillary equipment must be included in the Tender Prices;

28. TESTING OF PLANT AND EQUIPMENT

28.1. Prior to the commissioning and handover, the Contractor shall carry out his own tests on the plant and equipment to verify that the plant is operating correctly;

28.2. When these tests meet the Specification, the Contractor shall notify the Engineer, giving him a minimum of 48 hours' notice, that he is ready to commence commissioning and the performance test;

28.3. No plant or equipment shall be commissioned without the Engineer or his appointed representative being present;

28.4. The Contractor will be responsible for all costs incurred by other parties in attending tests on plant and equipment which has not been adequately tested by the Contractor before it is presented to the Engineer for testing and commissioning;

28.5. Prior to and during commissioning the Contractor shall maintain a record of each test which shall be countersigned by the Engineer or his representative immediately after it has been successfully performed;

28.6. After commissioning and testing of all plant has been completed, 3 copies of this record shall be supplied to the Engineer;

29. COMMISSIONING AND COMPLETION CERTIFICATE

29.1. The commissioning period shall be over a suitable period (to be agreed by all parties) of plant operation during which period the plant and equipment must operate and meet performance requirements under operational conditions without any breakdowns or stoppages due to malfunctioning of any part of the plant or equipment;

29.2. During the commissioning period the Contractor shall be responsible for providing all labour and materials and shall carry out all servicing and any adjustment of plant required ensuring it operates as specified;

29.3. Commissioning of the plant shall include for operating and testing under all conditions as guaranteed and required in the Contract;

29.4. The completion certificate will only be issued on successful commissioning of the plant and will also be subject to EWS having received the operating and maintenance manuals before the plant is first run;

30. PLANT AND EQUIPMENT NOT MEETING GUARANTEED PERFORMANCE

30.1. In the event of the plant not being accepted, the Contractor will be afforded an opportunity to effect refinements or adjustments within a reasonable limited period in order to overcome the deficiencies of the plant, which shall be subject to the same conditions in regard to tests and guarantee as herein specified. In the event that the remedial action still prevents the plant from operating as per specification EWS reserves the right to cancel the contract and recover from the contractor all interim payments made for the contract (if applicable) as well as any other costs related to the cancellation of the contract;

31. TESTS AND WORK TO BE PERFORMED AT END OF MAINTENANCE PERIOD

31.1. At the end of the maintenance period the Contractor shall, at his cost:

31.1.1. If there is due cause to suspect that equipment supplied is faulty the Contract shall dismantle the equipment where required to allow the wearing internal parts to be inspected by the Engineer to ensure that there is no excessive wear and reassemble the equipment after inspection;

31.1.2. Inspect the equipment supplied;

32. STAINLESS STEEL AND 3CR12 MATERIALS AND FABRICATION (IF APPLICABLE TO THIS CONTRACT)

32.1. Great care shall be taken not to contaminate the stainless steel 3CR12 items with iron or mild steel particles. Stainless steel/3CR12 parts shall be kept physically separated from any mild steel fabrication in the manufacturer workshop such that grinding particles and the like cannot contaminate the stainless steel/3CR12 items;

32.2. Tools and grinding wheels used shall be kept separate from those used for mild steel fabrications. Brushing shall be with stainless steel brushes only. All tools used for cutting, grinding, brushing or machinery of the stainless steel/3CR12 shall be dedicated to use on stainless steel/3CR12 only;

32.3. Any parts that have been machined shall be passivated;

32.4. Before commencing welding of stainless steel/3CR12 items the Contract shall notify the Engineer, in writing, of the type of electrode or welding rod he proposes to use. The Engineer's written approval of the same shall be obtained before welding commences;

32.5. Standard stainless steel welding practices, as recommended by SASSDA, shall be employed. Finish welds shall be thoroughly cleaned and passivated;

33. BOLTS, NUTS AND WASHERS

33.1. Bolts, nuts and washers shall be of grade 316 stainless steel and shall comply generally with S.A.B.S. 136-1972 for ISO metric precision hexagon - head bolts, screws and nuts. High tensile steel stud bolts are required at the drive end mounting flange;

PARTICULAR SPECIFICATION – LOW VOLTAGE

1.1 SCOPE LOW VOLTAGE ELECTRICAL INSTALLATION IN PUMPSTATION

This section of the specification includes the low voltage (230/400V) electrical installation within the pumpstation and excludes the MV 11kV switchgear and MV Variable Speed Drives mentioned in the section above.

The contract covers the related design, supply, delivery, installation, putting into satisfactory operation, testing and maintenance during the defects liability period of the electrical installation for the Works, comprising MCCs/switchboards, control gear, cables and all electrical equipment necessary to complete the installation in full working order. Electric motors must be provided as part of the relevant driven equipment in Section 5 (Mechanical Installation) of this project specification.

All equipment and work carried out must generally be in accordance with the Ethekwini Standard Specification for Waste-Water Pump Station, unless stated otherwise in this project specification as well as other standard specifications for specialised work as described under the relevant sections. The Contractor is required to have a person in employ to fulfil the requirements of SANS 10142 - Part 2 in terms of a registered person and to sign off the Certificate of Compliance.

The Scope of Works comprises in short:

a) New MCC and LV Distribution Board for control of four new main pumps fitted with MV motors, in the new pump station at the ETHEKWINI Municipality (ETHEKWINI) Southern Waste Water Treatment Works, 6 sump pumps and electrical supplies to HVAC equipment, crane, lights, small power and instruments.

b) The electrical installation work associated with the four main pump-sets, 6 sump pumps, HVAC, crane, lights, plugs and instruments including all control equipment, metering and instrumentation.

Note that information pertaining to the existing installation, has been obtained from different sources and old records. It could not all be verified on site against the actual installation for correctness. As such, it can be used for tender purposes, but it is a requisite of this contract that for purposes of construction, such information be verified on site by the Contractor.

1.2 ELECTRICAL SUPPLY AND EARTH CONNECTION

The supply to the pump station building domestic power will be 3-phase 400 V/230 V nominal, and to the pumps 3.3kV nominal, all at 50 Hz. The supply authority is the ETHEKWINI at Southern.

- The 400 V point of supply will be from the normal/standby sections of the existing normal/standby power distribution board in the substation in close proximity of the new pump station.

  Two 30 A, 10 kA three pole supply circuit breakers must be supplied and installed on each in the normal and standby sections of the distribution board, to be confirmed with the Engineer before construction.

  The supply cable from the connection point to the pump station building must be supplied and connected at both ends, under this contract.

- The 3.3kV point of supply and connection to the new pumpsets will be the existing 3.3kV switchboard for the existing pump station, to be extended under this contract.

The cable requirements are specified under clause 3.6.1.

It will be the responsibility of the Contractor to make the necessary arrangements for the electrical connections timeously with the supply authority. No connection fees are payable. Once connected the Contractor must ensure that the supply i.r.o voltage and earthing is in order before switching power onto his equipment. Claims for damage arising from non compliance, will not be accepted.

1.3 SWITCHBOARDS, PFC CABINETS AND VALVE CONTROL PANELS

The scope of work under this section covers the extension and upgrade of the existing 3.3kV switchboard, the provision of power factor correction equipment and a LV switchboard for the new pump station and pump control consoles.

The medium voltage installation must comply with the standard specification PD: Medium Voltage Indoor Circuit Breakers, in part C3.2 of this document. Low voltage (LV) MCCs/switchboards must comply with the standard specifications PMA in part C3.2 of this document. Any deviations in terms of propriety equipment offered must be fully qualified in the schedule for deviation from the specification, for evaluation. Brochures of the MV switchgear and starters offered must be submitted with the tender.

1.3.1 Existing Switchboard and Switchgear configuration

The switchboard panels inside the pumpstation are all to be removed after the new electrical installation is ready to be commissioned.

Allowance shall be made to safely isolate the switchgear and remove from site and arrange for recycling of the materials or safe disposal.

1.3.1.1 Protection relays

The existing panels 1-3 motor protection relays must be upgraded to the corresponding relays as provided for the existing starter no 4 and the other panels to the corresponding relays provided for the new incomer, as applicable. The particulars are shown on the equipment schedule on the single line diagram included under Part 3.6.

1.3.2 Pump Station LV Switchboard Assembly

Supply and install a new indoor type wall mounted switchboard within the pump-house, in the position shown on the drawings. The switchboard must be constructed in two separated enclosed modules for normal power and standby power respectively, each module divided in sections (panels) with own door for each section and individual drives.

The switchboard and switchgear fault rating must be 10 kA (minimum). Each section must be supplied from the relevant normal power and standby power sections of the distribution board in the substation. A 40 A 10 kA 3 pole circuit breaker must be installed in each section as supply.

The switchboard must comprise the following (**the normal/standby split will be confirmed before construction starts**):

1.3.2.1 Incoming section one each for the normal and standby power sections, equipped with:

a) 30 A 3P main circuit breaker.

b) Voltmeter with 6 position selector switch.

c) Phase fail protection.

d) Lighting surge suppressors in conformance with the SANS 10142-1 guidelines, Class 2 minimum, installed in a PVC enclosure inside the switchboard.

1.3.2.2 Control section equipped with

a) Ultrasonic level sensor control unit.

b) DC power supply for instrumentation.

c) Buffer relays for interfacing digital inputs such as the suction float level switch and any other control equipment as required, to the pumpset PLCs.

1.3.2.3 Outgoing section for extraction fans (5 No.) equipped for each with:

a) All control devices and equipment necessary to ensure operation as specified in clause 3.4.7.

b) DOL starter (1,5 kW), in accordance with PMA.3.3.

1.3.2.4 Outgoing section for drainage pump equipped with:

a) All control devices and equipment necessary to ensure operation as specified in clause 3.4.8.

b) DOL starter (1,5 kW), in accordance with PMA.3.3.

1.3.2.5 Section for distribution and local power one each for the normal and standby power sections, equipped with:

a) 30 A earth leakage relay and 3 x 15 A 1P circuit breakers for switched socket outlets.

b) 10 A SP x 3 circuit breakers for local lighting.

c) 15 A SP circuit breaker for pump no 1 control console.

d) 15 A SP circuit breaker for pump no 2 control console.

e) 15 A SP circuit breaker for pump no 3 control console.

f) 15 A SP circuit breaker for pump no 4 control console.

g) 10 A 3P circuit breaker for pump no 1 delivery valve supply.

h) 10 A 3P circuit breaker for pump no 2 delivery valve supply.

i) 10 A 3P circuit breaker for pump no 3 delivery valve supply.

j) 10 A 3P circuit breaker for pump no 4 delivery valve supply.

k) 10 A SP circuit breaker for ultrasonic level sensor supply.

l) 10 A SP circuit breaker for a flow meter supply.

m) 10 A 3P circuit breaker for supply to the electric hoist.

1.3.3 Pump Control Valve panel

Supply and install four new pedestal mounted control panels adjacent to each pump control valve. The panel must be manufactured from 1,6 mm 3CR-12 sheet-steel, generally constructed in accordance with the standard specification PMA, fitted with a hinged door. The whole assembly must be rated at IP 55.

The panel and switchgear fault rating must be 6 kA (minimum).

The panel must comprise the following:

a) 10 A 2P door interlock padlockable isolator.

b) All control devices and equipment necessary to ensure operation as specified in clause 3.4.2.1.

c) DOL starter (1,5 kW), in accordance with PMA.4.3.1.

d) Phase fail protection.

1.3.3.1 Substation existing normal/standby power switchboard

There is a possibility that the substation existing normal/standby power switchboard will have to be upgraded and a provisional sum has been allowed for in the price schedule.

1.4 PLANT CONTROL

1.4.1 General System

The pump station comprises four pumps (three duty and one standby) pumping from the adjacent two sumps to the sea outfall pipeline. The pumps are manually operated only, via a HMI interface on a control console at each pump, independently from each other. The control incorporating pumpset protection, interlocking etc., is executed by means of a PLC in each control console communicating with the relevant MV starter panel PLC via an ethernet network.

The plant status will be monitored by an existing SCADA system (local at the purification works), to be extended under this contract to incorporate this new plant and associated equipment.

1.4.2 Pumpset Control

1.4.2.1 Starting and stopping

The pumpsets must be individually started and stopped by means of a green and red START and STOP touch screen pushbuttons on the HMI screen.

Each pump is fitted with a pump control valve. The pump may only start and stop against a closed valve. Starting the pump must automatically open the valve and stopping the pump must automatically close the valve, as described under 3.4.3. I.e. the valve closed status is the pump effective stop signal. The valve is also fitted with an analogue position monitor, that the OPEN and CLOSED conditions could be changed to pre-programmed intermediate positions, should operational conditions necessitate this.

Should the valve not open or close after a predetermined time after starting the pump, or receiving the stop (close) signal, the pump must stop irrespective. The pump no flow protection must be

coordinated with the valve opening and closing time.

Note that the pump suction and delivery manually operated isolation valves are also fitted with position detectors (proximity sensors), two per valve, for the OPEN and CLOSED position respectively. Both valves must be in the fully open position before the pump is enabled to start.

1.4.2.2 Suction control

The pump may only run if there is sufficient water in the sewerage sump, as detected by means of an ultrasonic level sensors, If the water level is too low, the pump must stop, to be manually restarted, once the level has risen above a predetermined high (reset) level. The levels must be adjustable via programmable switching relays on the ultrasonic sensor.

At the low level a SUCTION LOW LEVEL status must be displayed on the HMI, to reset automatically at the reset level.

1.4.2.3 Pumpset protection

The pump set must be protected against damage, for the conditions described below.

Protection devices must have manual resets on the HMI, unless specified to the contrary elsewhere. The motor may only restart once the protection device has been reset.

a) **Motor**

Motor protection must be provided by means of the comprehensive motor protection (MPR) relay in the MV starter panel, as well as discrete protection devices for facilities not provided by the MPR.

- Overload
- Underload
- Over/under voltage and phase loss
- Phase rotation
- Earth fault
- Overheat by means of temperature sensors (PT 100 sensors; two per phase). Each phase must be provided with an adjustable alarm and trip setting, adjustable via HMI.
- Start limit: to limit the number of consecutive starts per hour to a preset number (set on HMI).
- Restart delay: to prevent consecutive starting within a preset time (set on the HMI).
- Bearing over temperature (PT 100, both for the drive end and non drive end). Each bearing must be provided with an adjustable alarm and trip setting, adjustable via HMI.
- Bearing vibration (vibration sensor with analogue output and programmable alarm and trip limits)
- Motor shaft induced voltages (refer to clause 3.9.1 of the motor specification).
- Surge protection (ZORC suppressors fitted in the motor terminal box)

b) **Pump**

- Pump running dry by means of a flow switch in the delivery line of each pump. Timers must be provided to override this switch during start up and short time

disturbances. Note: that the timers must be co-ordinated with the control valve opening and closing times.

- Suction low level by means of a float level switch in the sewerage sump.
- Bearing temperature high (PT 100, both for the drive end and non drive end).
- Bearing vibration (vibration sensor with analogue output and programmable alarm and trip limits)
- Shaft induced voltages originating from motor shaft induced voltage.

1.4.2.4 Alarm and status indication facilities

Alarm and status indication facilities must be provided in accordance with Clause PMA 4.2.8. These requirements are also applicable to the HMI status display. All of the statuses below must be displayed on HMI and the SCADA system.

Note that the colour coding of status indication as set out in the abovementioned clause will be subject to the ETHEKWINI standards, to be coordinated with the Engineer prior to construction.

a) **Pumpset status display (4 No)**

- 3.3kV SUPPLY AVAILABLE
- 3.3kV CIRCUIT BREAKER RACKED IN
- 3.3kV CIRCUIT BREAKER OPEN/CLOSED
- 3.3kV CIRCUIT BREAKER TRIPPED
- 3.3kV CIRCUIT BREAKER ANTI PUMP LOCKOUT
- MOTOR RUN
- MOTOR STOPPED
- MOTOR TRIP; MPR individual statuses as per 3.4.3 (a)
- EARTH FAULT
- MOTOR OVERHEAT (alarm and trip per phase as per 3.4.3 (a), as well as the analogue value per phase).
- MOTOR AND PUMP BEARING HIGH TEMPERATURE (alarm and trip per bearing as per 3.4.3 (a), (b) as well as the analogue value).
- MOTOR AND PUMP BEARING VIBRATION (alarm and trip per bearing as per 3.4.3 (a), (b), as well as the analogue value).
- PUMP NO FLOW
- PUMP NO FLOW
- PUMP SUCTION LOW LEVEL
- PUMP SUCTION EXTRA LOW LEVEL
- PUMP SUCTION LOW PRESSURE
- PUMP DELIVERY HIGH PRESSURE
- PUMP DELIVERY LOW PRESSURE
- VALVE OPENING (running status)
- VALVE CLOSING (running status)

- DELIVERY VALVE OPEN
- DELIVERY VALVE CLOSED
- DELIVERY VALVE FAULT
- DELIVERY VALVE ANALOGUE POSITION
- EMERGENCY STOP ON (console, pumpset local, MV switchboard)
- START LIMIT FAULT
- START DELAY ON
- Power parameters from the MV starter power module to include voltage, line and phase current (all phases), kW, kVA, kVAr and power factor.

b) **System analogue parameter display**

- SEWER SUMP LEVEL (ultrasonic level sensor)
- COMMON SUCTION LINE PRESSURE (pressure sensor)
- COMMON DELIVERY LINE PRESSURE (pressure sensor)
- DELIVERY FLOW (electromagnetic flow meter)

Note 1: That alarm/protection devices with a device reset, need not be latched within the PLC with HMI reset; only unlatched equipment such as flow switches, level alarms, etc.

2: That the summary above is for the convenience of the Tenderer; the complete specification must be scrutinised to ensure that all indication is provided as specified in all sections.

1.4.3 Pumpset Delivery Valve Control

The delivery valve is specified under the mechanical section 2. It is of the ball type with counterbalance weighted arm, hydraulically operated and electrically controlled. To open the valve, the electric motor driving the hydraulic pump must start and the solenoid closing the cylinder pressure relief port pilot valve, must be energised. The delivery valve is opened by hydraulic action until it is in the fully open position (or intermediate programmed position). To close the valve, the actuating cylinder pressure is released by de-energising the solenoid and the weighted arm closes the valve by gravity force. The pump starter must be fitted in a valve control panel adjacent to the valve complete with all operator interface.

The valve must be fitted with two position detectors, to provide the relevant OPEN/CLOSED status signal to the PLC, as well as an analogue position detector with 4-20 mA output proportional to the valve percentage opening. At approximately 30% (adjustable) of travel, the valve will be regarded as open. The valve must be in the fully closed position, for the position detector to indicate the closed position.

Indication lights must be provided on the valve control panel to indicate the VALVE OPEN, CLOSED and two intermediate programmable status positions, and must be displayed correspondingly on the HMI.

It should be noted that a diaphragm type hydraulically operated electric solenoid controlled valve is specified as an option in the mechanical section. The control of the valve is analogous to the ball valve, except solenoids are switched for the valve opening/closing. Should this option be implemented, the provision specified below must be amended to suit.

1.4.3.1 Mode selection

The valve must be operated both automatically via the PLC in conjunction with the pump start and stop control (from the HMI) and manually (remote from the HMI and local at the valve control panel), by means of a three position selector switch on the local control panel, labelled REMOTE/OFF/LOCAL. It shall not be possible to operate the valve in the OFF position; an operating valve motor must STOP when switched to OFF and the valve must CLOSE.

a) **Remote mode**

This operational mode must only be functional with the valve local control station mode selector switch in the REMOTE position.

The valve must be operated both manually and automatically, by means of an on screen selector switch on the HMI, labelled AUTO (NORMAL)/MANUAL (MAINTENANCE).

In the manual mode, the valve can be opened and closed by means of on screen OPEN and

CLOSE pushbuttons for test and maintenance purposes.

In AUTO (normal) mode, the valve must operate automatically in conjunction with the pumps manual starting and stopping. Starting the pump must OPEN the valve. Stopping the pump must CLOSE the valve. The valve must also be fitted with an analogue valve position indicator with 4-20 mA analogue output signal proportional to valve travel (percentage opening).

Provision must be made that the OPEN/CLOSED positions for the start stop control, be programmed to any other two intermediate positions should this become necessary due to operational considerations.

Should the valve not open or close after a predetermined time after starting the pump, or receiving the stop (close) signal, the pump must stop irrespective, with VALVE FAULT indication on the control panel and HMI, with manual reset.

The pump no flow protection must be coordinated with the valve opening and closing time.

b) **Local mode**

The valve must be opened and closed manually at the valve by means of OPEN and CLOSE pushbuttons on the control station.

1.4.3.2 Hydraulic pumpset protection

The pumpset must be must be protected against damage, for the conditions described below.

Protection devices must have manual resets on the HMI, unless specified to the contrary elsewhere. The motor may only restart once the protection device has been reset.

a) **Motor**

- Overload by means of a thermal overload relay.

b) **Pump**

- Overpressure in the hydraulic delivery line by means of a pressure switch.

1.4.3.3 Alarm and status indication facilities

Alarm and status indication facilities must be provided in accordance with Clause PMA 4.2.8. These requirements are also applicable to the HMI status display. All statuses must be displayed on the HMI and SCADA system. Indication lights must be provided on the valve control panel as stated below.

Note that the colour coding of status indication as set out in the abovementioned clause will be subject to the ETHEKWINI standards, to be coordinated with the Engineer prior to construction.

a) **Motor**

- RUN
- TRIP

b) **Pump**

- OVERPRESSURE

c) **Valve**

- OPEN
- CLOSED
- VALVE FAULT
- VALVE OPENING (running status)
- VALVE CLOSING (running status)
- VALVE ANALOGUE position

1.4.4 Control Console

A control console in accordance with the drawing included in section C3.6 must be provided on the control gallery for each pumpset.

This console and equipment must closely match the existing pump station equivalent console and equipment in appearance and equipment manufacture, for purposes of standardization of spares, maintenance and importantly function, since the two pump stations are adjacent to each other and it is the same operators that will operate both pump stations.

The console must be manufactured from 1,6 mm (min) 3CR12 sheet-steel, with hinged front door and two rear doors. All doors must be fitted with square key locking mechanisms. and the rear doors must in addition be padlockable. This console must conform to the general switchboard construction requirements as per standard specification clause PMA 4.2.5.

The console must be equipped as follows:

a) Door interlock 15 A, 6 kA two pole circuit breaker. (Supply from LV switchboard).

b) Lightning surge arrestors.

c) Two pole circuit breakers for the following DC supplies:

- PLC
- HMI
- Ethernet module
- Ethernet switch

d) PLC for control and communication modules

e) HMI to serve as operator interface.

f) Emergency stop with red indication light (e-stop activated). The e-stop must be hard wired directly to the MV starter panel circuit breaker trip, as well as the PLC, to close the control valve simultaneously. This operation must be confirmed with the Engineer before construction.

g) General alarm light stack as per 3.4.4(e) above.

h) 24V regulated DC supply rated at 150% of the maximum load requirement.

i) 16A switched socket outlet fitted to the side of the console.

j) RJ-45 external communication port for communication with the PLC via laptop.

Note that the abovementioned equipment schedule is nominal and the Tenderer must provide for all ancillaries and equipment not listed above, to suit his specific design and configuration.

1.4.4.1 PLC

Schneider, Siemens or similar approved PLCs may be offered.

The PLC, hardware and software must be equal and similar to the abovementioned, complete with all ancillary equipment to communicate with the associated MV starter panel equipment, field equipment and HMI, on an ethernet/ modbus network.

The PLC must be provided with digital and analogue input and output modules for the corresponding devices. All I/O must be surge protected. Digital inputs must be galvanically isolated and both digital inputs and digital outputs must be fitted with buffer interface relays.

Communication with field devices must be via the ethernet network and discrete digital and analogue I/O only used where devices are not equipped with serial communication capabilities.

Note: Control equipment common to multiple independently controlled equipment (such as the float level switch for suction control of the four pumpsets) must be configured that the unavailability of any of the downstream controlled equipment will not affect the operation of the others. I.e., such a control signal must be multi dropped to the controlled equipment and not series linked.

a) In case of a single analogue device, an analogue to ethernet convertor must be used with ethernet multi drop ports to the relevant controlled equipment (either by integral ethernet multiport switch or separate ethernet multiport switch). This convertor (and ethernet switch) must be powered from the same source as the control device and not from one of the controlled equipment.

b) In case of a single digital device, the source signal must switch separate buffer relays with potential free contacts, one relay each per controlled item. The control voltage for relays must be powered from the same source as the control device and not from one of the controlled equipment. E.g. the pumpsets suction low level float switch must be powered from the local MCC and switch four separate buffer relays (within the local MCC) with potential free contacts, one relay each per pumpset PLC.

1.4.4.2 HMI

The HMI must be similar and equal to the Magelis XBTG 10,4 inch (minimum) multi function graphic touch sensitive screen.

The graphic displays must be configured similar to the existing pump station HMI for the benefit of the operators and it will be the responsibility of the successful tenderer to establish the detail of this. Minimum guidelines are given below and allowance must be made within the tender price for liaison with the client and Engineer in this regard. Refer to clause 3.8 in respect of the system integrator. It will be regarded in accordance with clause 3.8, that the system integrator is familiar with the ETHEKWINI standards and software configuration and no claims for additional payment in this regard will be entertained.

The following graphic screen layouts must be provided:

a) **Screen 1 : Main menu**

This is the HMI default opening screen, displaying the listing of screens below, for selection. Each listed screen must have an alarm flag to indicate if there is an active alarm on the relevant screen. It must be possible to return to the main menu from any other screen.

An on screen LAMP TEST pushbutton must be provided which will energise the control console main status stack lights for four seconds.

b) **Screen 2: Pump station overview**

This screen displays:

- A schematic line diagram of the pumpsets main status as per 3.4.2.4(a).
- Valves status as (OPEN, CLOSED, FAULT)
- MV supply status (supply ON/OFF TRIPPED)
- System analogue status as per 3.4.2.4.(b)
- Emergency stop active.

c) **Screens 3, 4, 5 and 6: Pumpsets 1, 2, 3 and 4 detail status**

This screen gives a graphic representation of the pumpset and associated equipment with detailed status indication as per 3.4.2.4 (a), as well as the required on screen control facilities.

The pump START pushbutton must be grey when the all the interlocking conditions are not met (or the pump is running) turning to bright green when the pump is ready to run (i.e. available). The STOP pushbutton must be grey when the pump is not running, turning bright red when the pump is running. Both start and stop pushbuttons must be depressed for a minimum of four seconds before the command will be validated to prevent inadvertent starting/stopping.

The number of consecutive starts per hour must be set on screen, and the remaining start for the hour must be displayed. This counter must reset every hour.

The minimum period between consecutive starts must be set on screen and the countdown to restart displayed on screen.

From each of these screens sub-screens must be accessible for:

- Motor and pump bearing vibration analysis.
- Motor and pump bearing temperature analysis.
- Motor winding temperature analysis.
- Motor power parameter analyses, such as current (per phase), kW, kVA, KVAr, Power factor.

These screens must display the monitored parameters in a scaled bar chart format with the instantaneous values displayed digitally.

From each of these sub-screens, further trend sub-screens must be accessible for real time/historical trending and alarm and trip value settings.

d) **MV distribution**

This screen gives a schematic line diagram with switchgear status, both 11kV as well as 3.3kV and transformer trip status.

e) **Alarm page**

This screen must display current alarms and historical alarms.

f) **Event log**

This screen must log and time and date stamp main events.

g) **Alarm page**

This screen must display current alarms and historical alarms.

1.4.4.3 Motor Control Center Status Indication Lights

a) **Light stack**

Four general status indication lights in a stacked configuration must be fitted on top of each console, with the following colours and status, as follows, starting from the bottom:

- WHITE: Pumpset ready to run (available)
- GREEN: Pumpset run
- AMBER: Pumpset alarm
- RED: Pumpset tripped; the light must flash until the alarm accept on screen pushbutton on the HMI has been operated, after which it must stay on, until the alarm/fault condition has been reset.

b) **Emergency stop**

- A red indication light labelled EMERGENCY STOP ON, must be fitted above the HMI to indicate the pumpset emergency stops active status (remote MV panel, local control station and control console e-stops).

1.4.5 Network Topology

The network topology is ethernet/modbus as shown diagrammatically on the drawing included under part C3.6 of this document.

1.4.6 Extraction Fans Control

There are three (4) extraction fans for ventilation of the building. They must each be controlled as follows:

1.4.6.1 Mode Selection

The fans must be operated both manually and automatically, by means of a three position selector switch for each fan on the switchboard, labelled AUTO/OFF/MANUAL. It shall not be possible to start a fan in the OFF position and a running fan shall STOP when switched to OFF.

a) **MANUAL Mode**

The fan must be started and stopped by means of START and STOP pushbuttons on the switchboard.

b) **AUTO Mode**

The fan must be started and stopped automatically, by means of a manually adjustable thermostat, with hysteresis. If the temperature exceeds the setting, the fan must start and stop when the temperature has dropped to the lower (differential) reset value.

1.4.6.2 Protection

The fans must be protected in all control modes against damage from the conditions stated below.

Protection devices must have manual resets, unless specified to the contrary elsewhere. The motor may only restart after the protection device has been reset.

a) Overload by means of an overload protection relay.

b) Under voltage and phase imbalance, by means of a phase fail relay with time delayed (up to 5 min adjustable) auto reset.

1.4.6.3 Alarm and status indication

Alarm and status indication must be provided in accordance with Clause PMA.4.2.8.

- RUN
- OVERLOAD TRIP

1.4.6.4 HMI and SCADA

The pump and chamber status must be displayed on the pumpsets HMI and SCADA in accordance with Clause 3.3.3.

1.4.7 EXTRACTION FANS

Five fans are provided in the pump station. The control is provided from the LV switchboard and identical for all.

1.4.7.1 Mode Selection

The fans must be operated both automatically and manually, by means of a three position selector switch on the MCC for each fan labelled AUTO/OFF/MAN. In the OFF position it shall not be possible to start a fan and a running fan shall STOP when switched OFF.

a) **MANUAL mode**

The fans must be started and stopped by means of START and STOP pushbuttons on the switchboard for each fan.

b) **AUTOMATIC mode**

The fans must be started and stopped automatically by means of a thermostatic switch.

1.4.7.2 Protection

Each fan must be protected in all control modes against damage due to the conditions described below. The motor must STOP and a corresponding fault indication light must switch ON.

a) Motor

- Overload

1.4.7.3 Alarm and status indication facilities

Alarm and status indication must be provided in accordance with PMA.4.2.8 as listed below:

a) Fan Panel

- RUN
- TRIP

1.4.7.4 HMI and SCADA

The fan operational status must be displayed on the pumpsets HMI and SCADA in accordance with Clause 3.3.3.

1.5 DRAINAGE PUMP

The valve chamber is fitted with a drainage pump, which must be controlled as follows provided for on the LV switchboard:

1.5.1.1 Mode selection

The pump must be operated both manually and automatically, by means of a three position selector switch on the switchboard, labelled AUTO/OFF/MANUAL. It shall not be possible to start the pump in the OFF position and a running pump shall STOP when switched to OFF.

a) **MANUAL Mode**

The pump must be started and stopped by means of START and STOP pushbuttons on the switchboard.

b) **AUTO Mode**

The pump must be started and stopped automatically, by means of two float level switches. At a high level the pump must START and STOP at a low (empty) level.

1.5.1.2 High level alarm

A high level alarm float level switch must be fitted in the pump with corresponding indication light on the switchboard and manual reset.

1.5.1.3 Protection

The pump must be protected in all control modes against damage from the conditions stated below.

Protection devices must have manual resets, unless specified to the contrary elsewhere. The motor may only restart after the protection device has been reset.

- Overload by means of an overload protection relay.
- Earth leakage protection (250 mA).
- Under voltage and phase imbalance, by means of a phase fail relay with time delayed (up to 5 min adjustable) auto reset.

1.5.1.4 Alarm and status indication

Alarm and status indication must be provided in accordance with Clause PMA.4.2.8.

- RUN
- EARTH LEAKAGE
- OVERLOAD TRIP
- VALVE CHAMBER HIGH LEVEL ALARM

1.5.1.5 HMI and SCADA

The pump and chamber status must be displayed on the pumpsets HMI and SCADA in accordance with Clause 3.3.3.

1.6 CONTROL EQUIPMENT

1.6.1 Level Sensing

1.6.1.1 Ultrasonic level sensor

Ultrasonic level sensors must be equal and similar to the Endress & Hauser manufacture, type FMU 90, with 4-20 mA analogue output proportional to level and four programmable level switching relays.

The sensor must be mounted on a sturdy stainless steel bracket of not less than 3 mm thickness, fitted higher than the structure overflow level. The bracket must be fixed to the holding structure soffit with stainless steel or brass fasteners, to suit the structure, in an easily accessible position but not where it can be damaged by removal of equipment or interference (echo) from nearby equipment and/or structures.

The control unit must be installed within the controlled equipment MCC behind a Perspex see through window, or as otherwise specified elsewhere.

Two (2 no) ultrasonic level sensors must be provided as follows:

a) **Southern sewerage sump**

One unit must be installed in close proximity of the position indicated on the drawings, the final position to be determined on site. The controller must be installed in the pump station local MCC for control and connected to the HMIs for level display and the pumps suction control.

Note that the analogue loop connection must be configured that failure of, or switching a pumpset PLC off, will not affect the signal to the other pumpset PLCs.

b) **Olifantskop remote reservoir**

One unit must be installed in the reservoir for monitoring the reservoir level at the ETHEKWINI central station at Linton Grange, via the radio telemetry outstation provided under the SCADA section.

The controller must be installed within the telemetry outstation enclosure.

1.6.1.2 Float level switches

Float level switches must be of the magnetic reed switch type, operated on 24V DC.

The level switches must be mounted on a sturdy stainless steel bracket of not less than 3 mm thickness, fixed to the holding structure soffit with stainless steel or brass fasteners, to suit the structure, in an easily accessible position but not where it can be damaged by removal of equipment or interfere with the operation of other equipment such as ultrasonic level sensors. The level switch

cable must be secured to this bracket by means of compression glands and identified as to its function at the mounting point, by means of plastic cable markers e.g. labelled HIGH ALARM.

The float switches must be tied to a h.d.g. chain or weighted down nylon rope.

Note that float switches used for LOW LEVEL protection and alarm purposes must be wired failsafe, i.e. with the float switch in the hanging position, the contact must be open.

One (1 no) float level switch must be provided in the Southern SEWER SUMP for the pumps suction low level protection:

The 24V DC must be sourced in the local MCC and switch four buffer relays, one each for the input to each pumpset PLC.

a) **Southern sewerage sump**

One unit must be installed in close proximity of the position indicated on the drawings, the final position to be determined on site. The controller must be installed in the pump station switchboard.

1.6.2 FLOW SENSING

1.6.2.1 Flow switches

Flow switches must be of the weatherproof non intrusive type, operating on the calorimetric principle, similar and equal to the Weber manufacture, provided for the pumps no flow protection (4 No.). Flow switches must operate on 24V DC, sourced from each pumpset control console power supply.

1.6.2.2 Electromagnetic flow meters

Electromagnetic flow meters must be similar and equal to Endress & Hauser Promag 53W installed in the pumps common delivery line as indicated on the drawings, for flow rate and volume recordal and any control function as specified in the project specification.

The meter must conform to the following requirements:

Type : Electromagnetic Flow-meter

Sensor diameter : to suit 1 000 mm pipe diameter

Flanges : PN16 to SANS 1123 table 1600/3

Lining : Suitable for potable water

Flow speed measuring range : 0,01 – 10 m/s

Flow rate operational range : 200 – 1600 ℓ/s

Accuracy (maximum measured error) :

- Pulse output : ± 0,4 % (max) of reading at 0,8 m/s; 0,2 % (max) of reading 2 m/s – 10 m/s
- Current output : ± 5 µa

Repeatability : 0,1 % of reading max

Alarm signal : Current output fail

Pulse / frequency fail

Relay output de-energised by fault or power supply failure

Switching output : 60V / 0,1A DC configurable for:

Error messages

Empty pipe detection

Flow direction

Limit values

Low flow cut-off : Selectable switch point

Water temp (max) : 40°C

Enclosure : IP 67

Electrodes : Stainless steel

Transmitter : Remote mounted

Enclosure : IP 67

Power supply : 9 - 32 VDC

Display : 4 Line “Touch Control” display

Output : Current:

4 - 20 mA proportional to flow; full scale value selectable

Pulse/frequency:
Potential free contact 24V DC/25 mA (250 mA max for 20 ms)

Frequency output:
Full scale 2 – 10 kHZ; on/off ratio 1:1; pulse width max 10s

Pulse output :
Pulse value and polarity adjustable; pulse width (0,05 ms – 2000 ms)

All outputs must be separately adjustable for forward
and reverse flow

Fieldbus interface : Profibus DP

One (1 no) meter must be provided for pump station outgoing flow.

The meter must be fitted with a remote display, installed in the local MCC control panel of the switchboard. It must be fieldbus connected to the HMIs.

Low and high flow alarm setpoints in relation to the number of pumps running must be provided on the HMI for possible supply sump low level and high flow for possible pipe break / run away condition,

1.6.3 PRESSURE SENSING

1.6.3.1 Pressure switches

Pressure switches must be provided for the pumps suction and delivery pipes. The pressure switches must be of the mechanical dial display type with adjustable switch point, equivalent to the SAUTER or WIKA Manufacture. The pressure switch ranges must be selected to detect a low suction and high delivery condition, to protect the pumps against insufficient supply high delivery pressure (closed valve).

Eight (8 no) pressure switches must be provided as follows:

a) Pumpset suction lines for low pressure protection (total no 4)

b) Pumpset delivery lines for high pressure alarm (total no 4)

3.1.1.1 **Pressure sensor**

Pressure sensors must be equivalent to the Endress & Hauser type Cerebar PMC 41, conforming to the following:

- Measuring range : 40 bar (nominal 10 bar)
- Overpressure : 60 bar
- Type : Capacitive measuring cell with ceramic diaphragm
- Output : 4-20 mA proportional to pressure, with adjustable scale value
- Fieldbus interface : Profibus DP
- Accuracy : ± 0,2 % of set span
- Power supply : 12 to 45V DC
- Ambient temperature : -40 to 50°C

The sensor must be provided with analogue LCD display with the following functions (Profibus option):

- 4 digit pressure display
- Bar graph displaying current pressure value relative to the measuring range
- Error code

Two (2 no) sensors must be provided as follows:

a) **Pumpsets common suction line for pressure monitoring (total no 1)**

- Range : 0 – 1 Bar
- Overpressure : 10 Bar
- Nominal setting : 0,08 Bar

b) **Pumpsets common delivery line for high and low pressure monitoring (total no 1)**

- Range : 0 – 16 Bar
- Overpressure : 40 Bar
- Low pressure : to be confirmed
- Nominal setting : 11,8 Bar

Both instruments power supply must be sourced from the local MCC and the outputs connected to the pumpsets PLCs for display on the HMI.

Note the general requirement of connection configuration.

Pressure alarm setpoints must be provided on the HMI for suction low pressure, delivery low pressure (possible pipe break / run away condition) and delivery high pressure (possible closed valve). Switch points as set out are provisional and allowance must be made for adjustment on site in accordance with the actual site conditions.

The sensors may not be rigidly mounted to pipe work, but on a separate mounting plate with shut off valve and flexible connection to the pipe-work.

3.1.2 **Bearing Overtemperature Sensors**

The pump and motor bearings must be fitted at each end with PT100 temperature sensors connected to the relevant PLC and displayed on the HMI.

3.1.3 **Bearing Vibration Sensors**

The pump and motor bearings must be fitted at each end with vibration sensors connected to the relevant PLC and displayed on the HMI.

3.1.4 **Control Cable**

Instrumentation cable must be installed within galvanised steel conduit, for mechanical and UV protection. The last section at the instrument may be installed in PVC flexible conduit.

In cases where the cable cannot be installed in a continuous run between the instrument and the switchboard, a junction may be made within a PRATLEY cable junction box. From the box the cable must be extended with the same type, or 1,5 mm² PVC SWA PVC multi-core cable if instrumentation cable is not a requirement.

1.7 GENERAL ELECTRICAL INSTALLATION

1.7.1 Cables, Trenching and Ducts

Tenderers must allow for the supply and installation of all necessary cables of appropriate size to all the electrical equipment specified in accordance with the standard specification PMA.4.9 in part C3.2 of this document.

NOTE:

All power and control cable necessary to provide a fully operational system as specified, must be provided. Cable sizes and lengths are given in the price schedule, but any cable not scheduled and required for full operation, must be qualified by the Tenderer in the cable schedule; if not it will be considered as included in the price and the contractor will have no additional claim.

Cables with long runs and or provisional routes, subject to change, are measured per meter. Such cable is remeasureable and remuneration for will be for the installed length as measured from point to point, allowing 1.5m for cable ends (each), against the tendered unit rates. Tenderers must allow for slack and wastage in the rates. Cable lengths in the price schedule must be verified on site before ordering. Cables, within the same building and/or fixed routes with short runs to the equipment served, are not measured individually and will not re-measured. Only in a case where the layout has changed substantially affecting cable lengths, will adjustment be considered.

Cable sizes where specified, are for purposes of tender only. Tenderers must verify these sizes against the requirements of their equipment offered and must qualify their tender accordingly. No claims in this regard will be accepted after appointment, for cables that are not suitable, which must then be rectified at the Contractor's cost.

Cable sizes given in the price schedule and not qualified, must be confirmed with the Engineer before ordering

Where so indicated in the price schedule, the Tenderer must fill in the type and quantity of instrumentation and network communication cable, in accordance with his specific communication network design.

1.7.1.1 Cables in trenches

Trenching and backfilling must be provided under this contract.

MV and LV cable must be installed at a depth of 1000 mm and 750 mm below ground level respectively, with danger tape 300 mm above the cable, on a 150 mm sand bedding with a 150 mm sand cover on top, for excavation other than soil. Cable may be installed in the same trench as a water line, but separated with at least 400 mm and not on top of the water line. The mechanical

contractor must liaise with the civil contractor in this regard.

Road crossing excavation, sleeves and reinstatement will be done under the civil contract. All other excavation, including the LV supply from the minisubstation to the new pump station, must be done under this contract.

1.7.1.2 Cables within buildings

Cables within buildings must be installed on cable rack (ladder or wired tray, but not perforated steel tray) fixed to the walls, or bottom (and sides if space is limited) of constructed cable ducts. Sleeves must be cast in floor slabs of new buildings for equipment away from the walls, if not serviced by a cable duct. In existing buildings without sleeves or ducts, the racking must be installed on the wall to a point where the racking can be installed on the floor to equipment. In case of pump stations, underneath the pipe work to the pump motor.

Single core cable must be installed in Trefoil formation and special care must be taken that all parallel cables are exactly the same length. Unarmoured cable must be protected by concrete slabs.

a) **MV substation**

Cable must be installed within the existing cable ducts to the outside of the building and underground to the new pump station.

b) **New Pump Station**

Cable ducts are provided, but the Contractor must verify his requirements in terms of the duct positions and dimensions, as well as any sleeves to be cast into the floor, timeously for construction by the civil contractor. The cost for remedial work if this information is not provided timeously, will be for the mechanical contractor's account.

Any equipment not served by these ducts and sleeves, must be served by cable rack as described above, included in the tender price.

1.7.1.3 Instrumentation / control / communication network cable

The cable from instrumentation / control switches must be terminated in a Pratley cable box and extended with instrumentation cable or 1,5 mm^2 multi-core PVC SWA PVC cable to the switchboard as required, in the case of discrete wiring. In the case of fieldbus communication networks, the cabling must be provided to the requirements of the system design. **Note the stipulation in 3.6.1 with regard to the cable schedule.**

All external surface mounted cable must be installed within galvanised steel conduit, with flexible PVC conduit from the end of the steel conduit to the cable termination / entry point. The installation of cable outside and inside buildings is covered under 3.6.1.1 and 3.6.1.2 above.

The communication between the pump station PLCs, substation MV switchgear and local SCADA central station, must be done via fibre optic cable. The link between the new pump station and substation must be provided as part of this contract. The link between the substation and SCADA central station is existing, and the new system must be connected to this link in the substation. The new link between the pump station and substation must be done in a 75 mm dia sleeve, supplied and installed under this contract.

The schedule item [2] in cable schedule B must be based upon the route lengths given. This cable will only be re-measured on completion if the route length has changed with more than 5% and in case of final installed position of equipment other than indicated on the tender drawings.

1.7.1.4 MV cable

The 3.3kV supply cable will be of the XLPE insulated type, with copper conductors in accordance with SANS 1339 and must carry the SABS mark.

Cables must be rated for high earth fault current and wire armoured. Wire armouring for multicore cables must be galvanised steel wire and may be aluminium wire for single core cable.

Cable must be of the following sizes:

a) Pump motor feeder : 50 mm² three core.

b) Pump motor capacitor : 25 mm² three core.

1.7.1.5 LV cable

LV cable must be PVC SWA PVC with copper Conductors.

1.7.2 Earthing

Earthing of equipment shall be done strictly in accordance with the standard specification PMA.4.11 in Part C3.6 of this document. All extraneous metal parts and pipe-work up to the pump station wall shall be bonded to earth.

A 50 mm x 10 mm earth bar must be installed in the cable duct midpoint between the pumpsets. A 70 mm^2 b.c.e.c. must be installed from each MV motor terminal box to this earth bar and extended to the the MV substation earth bar. An additional 1,0 m x 1,0 m with 100 mm x 100 mm x 70 mm^2 b.c.e.c. grid Cadwelded earth mat must also be provided outside the pump station, connected to this earth bar. The measured earth resistance may not exceed 1Ω. Supplementary 1,8 m earth rods must be used to obtain this reading if necessary. On completion, the Contractor must certify that the earthing complies with SANS 10142-2, with specific reference to Clause 7.1.

1.7.3 Building Electrical Installation

The new building power and lighting installation must be provided as shown on the building general power and lighting layout under section 3.6.

All conduits shall be PVC with stainless steel or plastic screws and covers mounted with hospital type saddles in neat and professional manner. Any materials found to be rusting during the 12 months defects liability period to be replaced.

1.7.4 Light Fittings

The existing light fittings in the pumpstation shall be replaced with energy efficiency LED light fittings. Due to the corrosive nature of the gases at the waste-water treatment plant and close proximity to the sea all light fittings shall be polycarbonate with plastic clips or suitably treated to prevent corrosion with IP65 rating. Efficiency of all light fittings shall be greater than 140 lumen/ watt. Colour temperature to be cool white 4000K with colour rendering index >80 with long service life over 60 000 hours L70B10. The following types:

Type A: Indoor wall mount high impact polycarbonate LED Vaporproof 5ft with plastic clips, 45W/56W, 5282 luminaire output, IP66 with integrated movement and daylight sensor.

Type A(E): Indoor wall mount high impact polycarbonate LED Vaporproof 5ft with plastic clips, 45W/56W, 5282 luminaire output, IP66 with integrated movement and daylight sensor emergency version with battery backup for 1 hour.

Type B: Outdoor floodlight LED 81W IP66, 8257 lumen output, marine grade high pressure die cast aluminium with motion sensor.

Type C: Indoor corrosion proof round bulkhead LED 15W IP65, 1868 lumen, marine grade high pressure die cast aluminium with high impact acrylic diffuser and UV stabilised polypropylene black trim ring with motion sensor.

Type C(E): Indoor corrosion proof round bulkhead LED 15W IP65, 1868 lumen, marine grade high pressure die cast aluminium with high impact acrylic diffuser and UV stabilised polypropylene black trim ring, helicoil anti-corrosion with battery backup for 1 hour.

1.7.5 Local Control

Wall mounted local control stations manufactured from 3CR12 must be provided at each pump, equipped with a push lock emergency stop.

The extraction fans and drainage pumps must each be fitted with a wall-mounted isolator.

1.7.6 Connection of Equipment

All electrical equipment supplied under this contract whether specified under the mechanical or electrical section of this document, or specified as supplied by others, must be connected and tested under this contract.

1.7.7 Sundry Equipment

This item in the price schedule covers the supply and installation of sundry items specified under other relevant installation headings such as cable rack, conduit, cable boxes, brackets, earthing, etc, not covered by specific schedule items and/or compliance with SANS 10142-1.

1.8 SCADA INSTALLATION

1.8.1 Southern Local SCADA

1.8.1.1 Existing system

There is an existing local SCADA system, at the Southern Waste Water purification works building, comprising a PC and SCADA software. Communication between the PC and plant must be provided via fibre optic link between the PC, MV substation and pump station.

1.8.1.2 System extension

This system must be extended with the new pump station, substation 3.3kV MV switchgear extension and upgrade as well as the 11kV installation, as described elsewhere. The central station software must be reconfigured to incorporate the new plant status display in accordance with the existing SCADA standards.

The new switchgear must be fitted with PLCs compatible with the pumpsets PLCs. All I/O and protection relays must be connected to the main ethernet bus via the PLCs and related communication equipment, connected to the existing fibre optic link to the central station. The new pump station must be linked with a new fibre optic cable.

The SCADA graphic screens must be configured for status monitoring only, in accordance with the existing format and standards. The status is essentially a duplicate as displayed on the HMI graphic screens, but without control facilities. Allowance must be made to extend the existing screen layouts, such as the menu and alarm screens to navigate to the new addition screens and tenderers must allow in their tender price to acquaint themselves with the existing system, before tendering.

Note that this is a specialist installation, to be carried out by the system integrator also responsible for the pumping plant PLCs programming, HMI and communication network. Refer to 2.9 below.

.

DC sub-circuits.

1.9 SYSTEM INTEGRATOR

The PLC control, HMI and SCADA forms an integrated system and must be executed by the system integrator.

The system integrator must comply with the following requirements, and the necessary substantiating information must be submitted with the tender. **Tenders submitted without this information will be considered incomplete and severely compromised**.

The system integrator:

a) permanent operational base must be local, i.e. Durban;

b) must have proven capabilities in this field and have a track record of work previously done for the ETHEKWINI, similar to the work covered by this project. A summary of such work done for the ETHEKWINI must be included with the tender with contactable references. Refer to the data sheets.

The system integrator must be present at the factory simulation testing of the MCC control system as well as the on-site commissioning and final acceptance testing. This party will be considered an employee of the Contractor and no cost claims in addition to the normal contractual claims to which the Contractor is entitled, will be entertained.

For purposes of factory and site testing, the HMI and SCADA will be considered an integral part of the system, tested and inspected at the same time as the MCC. The SCADA graphic displays and control must be set up at the factory test of the MCC that a full functional simulation in terms of control and monitoring can be done.

1.10 MV MOTORS

1.10.1 Detailed Specification

The pump motors are specified in detail in Section 5, Mechanical Specification.

1.10.2 Induced Shaft Voltages

The motors must be supplied with measures to prevent damage to both the motor and pump bearings due to shaft induced voltages from variable speed drives, by any one or combination of the following methods:

a) Break or insulate the shaft or bearing current path (open the closed current loop through shaft and bearings (insulated bearings and couplings);

b) Divert the shaft or bearing current (to earth), via a suitable shaft brush.

Note that the preventative measures must be stated briefly in the data sheets, with supplementary information in a covering letter submitted with the tender.

1.11 TESTING

The electrical MCCs shall be tested in the factory by the Engineer and all equipment necessary to test the performance and operation of the panels must be provided.

1.11.1 Test Reports

The Contractor must submit his own test reports, on the forms bound in Part 10 of this document, to the Engineer before calling on the Engineer to test equipment.

1.11.2 Factory Test

Switchboards must be inspected and tested by the Contractor before installation. Tenderers must make provision for all equipment necessary to test the operation of the boards for compliance with the

specification, inclusive of all protection devices.

Once the Contractor is satisfied that the switchboard is to specification, the Engineer must be notified in writing and he will then inspect and test the switchboards. Should the switchboard fail due to non compliance with the specification, the cost of the re-inspection, including travelling cost of the Engineer from Cape Town, will be for the account of the Contractor, in accordance with SACPE rates.

1.11.3 Acceptance Test

On completion of the installation and putting into proper operating of the works, the Contractor will be required to make suitable arrangements for the testing of the plant and equipment supplied under this contract, in the presence of the Engineer or his representative, to demonstrate whether they are in compliance with the guaranteed figures submitted by the Contractor, and the test results submitted after commissioning. Refer C3.1 to Section 1 Clause 11 and PMA Section 5 Clause.5.3 on testing. A competent person must be present to carry out the electrical testing.

The Contractor shall be responsible for all the costs incurred in testing, including the supply and the use of all calibrated instruments.

PARTICULAR SPECIFICATION – OCCUPATIONAL HEALTH AND SAFETY

(Read with SANS 1921 - 1: 2004 clause 4.14)

1.12 GENERAL STATEMENT

1.1.1. It is a requirement of this contract that the Contractor shall provide a safe and healthy working environment and to direct all his activities in such a manner that his employees and any other persons, who may be directly affected by his activities, are not exposed to hazards to their health and safety. To this end the Contractor shall assume full responsibility to conform to all the provisions of the Occupational Health and Safety Act No 85 and Amendment Act No 181 of 1993, and the OHSA 1993 Construction Regulations 2003 issued on 18 July 2003 by the Department of Labour;

1.1.2. For the purpose of this contract the Contractor is required to confirm his status as mandatory and employer in his own right for the execution of the contract by entering into an agreement with the Employer in terms of the Occupational Health and Safety Act by executing the Agreement form C1.2.4 included in Section C1: Agreements and Contract Data;

1.13 HEALTH AND SAFETY SPECIFICATIONS AND PLANS TO BE SUBMITTED AT TENDER STAGE

1.1.3. Employer's Health and Safety Specification:

1.1.3.1. The Employer's Health and Safety Specification will be included in the tender documents as part of the Project Specifications;

1.1.4. Tenderer's Health and Safety Plan:

1.1.4.1. The Tenderer shall submit with his tender his own documented Health and Safety Plan he proposes to implement for the execution of the work under the contract. His Health and Safety Plan must at least cover the following:

1.1.4.1.1. A proper risk assessment of the works, risk items, work methods and procedures in terms of Regulations 7 to 28;

1.1.4.1.2. Pro-active identification of potential hazards and unsafe working conditions;

1.1.4.1.3. Provision of a safe working environment and equipment;

1.1.4.1.4. Statements of methods to ensure the health and safety of subcontractors, employees and visitors to the site, including safety training in hazards and risk areas (*Regulation 5)*;

1.1.4.1.5. Monitoring health and safety on the site of works on a regular basis, and keeping of records and registers as provided for in the Construction Regulations;

1.1.4.1.6. Details of the Construction Supervisor, the Construction Safety Officers and other competent persons he intends to appoint for the construction works in terms of Regulation 6 and other applicable regulations;

1.1.4.1.7. Details of methods to ensure that his Health and Safety Plan is carried out effectively in accordance with the Construction Regulations 2003;

1.1.4.2. The Contractor's Health and Safety Plan will be subject to approval by the Employer, or amendment if necessary, before commencement of construction work. The Contractor will not be allowed to commence work, or his work will be suspended if he had already commenced work, before he has obtained the Employer's written approval of his Health and Safety Plan;

1.1.4.3. Time lost due to delayed commencement or suspension of the work as a result of the Contractor's failure to obtain approval for his safety plan, shall not be used as a reason to claim for extension of time or standing time and related costs;

1.14 COST OF COMPLIANCE WITH THE OHSA CONSTRUCTION REGULATIONS

1.1.5. The rates and prices tendered by the Contractor shall be deemed to include all costs for conforming to the requirements of the Act, the Construction Regulations and the Employer's Health and Safety Specification as applicable to this contract. Should the Contractor fail to comply with the provisions of the Construction Regulations, he will be liable for penalties as provided in the Construction Regulations and in the Employer's Health and Safety Specification;

1.1.6. Items that may qualify for remuneration will be specified in the Safety Specifications included or in the Project specifications;

1.15 ACCIDENTS INVOLVING CONTRACTOR STAFF

1.1.7. Should any accidents or incidents occur involving the Contractor's staff, it shall be the Contractor's responsibility to take the necessary action to see to the care and well-being of those staff. However, in an emergency situation the Employer shall provide assistance but reserves the right to recover the costs of such assistance from the Contractor;

1.16 PERMIT TO WORK SYSTEM IN PLACE AT WASTEWATER TREATMENT WORKS

1.1.8. A Permit to Work System (Procedure 2.1 of the Wastewater Safety Procedures Manual) is in place in all Works Branch facilities and certain sewage pump stations and it is incumbent on all persons carrying out work at these facilities to adhere to the requirements of the Procedure;

1.1.9. Where contractors are likely to be engaged in potentially hazardous work such as:

1.1.9.1. Confined Space Entry;

1.1.9.2. Hot Work;

1.1.9.3. Rigging;

1.1.9.4. Excavation;

1.1.9.5. Building;

1.1.9.6. Hazardous Substances;

1.1.10. The contractor or tenderers attention must be drawn to eThekwini Wastewater Services Safety Procedures;

1.1.11. Responsibilities:

1.1.11.1. Project Engineer - It is the responsibility of the Project Engineer or Engineer responsible for issuing a tender document or specification to ensure that the requirements of this procedure are met, and that tenderers and contractors are provided with Wastewater Safety requirements and made aware of those requirements. It is also the responsibility of the Project Engineer to arrange a meeting, on site, with the Contractor at handover to specify any additional safety precautions required by the Project Work to be entered on the Permit to Work;

1.1.11.2. Tenderer or Contractor - It is the responsibility of the Tenderer or Contractor to meet all requirements of eThekwini Wastewater Safety Procedures and the requirements of the Occupational Health and Safety Act (OHSA);

1.1.11.3. Authorized Person - It is the responsibility of the Authorized Person (usually the Superintendent or Works Area Engineer) to issue a Permit to Work (PTW) and stipulate the safety procedures to be followed by the Contractor. This applies specifically to hazards associated with

Wastewater processing and in no way absolves the Contractor of his responsibilities to follow safe working practices;

1.1.12. Permit to Work:

1.1.12.1. This permit will be issued to the Contractor (the "Receiver") upon arrival at the Works, by the Superintendent or Works Area Engineer (the "Authorized Person");

1.1.12.2. The Authorized Person shall, in consultation with the Contractor, stipulate the safety precautions, personal protective equipment (PPE) and conditions governing the work to be undertaken;

1.1.12.3. The permit shall be issued for a stipulated period at the end of which, or on conclusion of the works, the Contractor shall return the permit to the Authorized Person. This will assist in the handover process, ensuring the area and equipment are left by the contractor, in a safe condition;

1.1.13. Instruction to Contractors and Tenderers:

1.1.13.1. Prior to Arrival on Site:

1.1.13.1.1. The basic plant safety requirement is that contractors (and staff) wear boots and overalls while carrying out their tasks, or alternatively, personal protective equipment (PPE) such as gumboots, waders, etc, where specified;

1.1.13.1.2. In addition, contractors shall issue their staff with PPE appropriate to the work to be carried out, as required by the OHS Act;

1.1.13.2. On Arrival on Site:

1.1.13.2.1. The Responsible person, appointed by the Contractor to supervise the Works, shall meet with the Superintendent and/or Works Area Engineer (the Authorized Person) for a handover meeting;

1.1.13.2.2. The **Permit to Work** shall clearly state the Contractor's details, details of the work to be carried out, safety precautions and PPE to be used and the permit shall be countersigned by the Project Engineer and Supervisor of Machinery. It is a requirement that the Project Engineer make a comment on the Permit to Work that precautions specific to the Work have been stipulated;

1.1.13.2.3. The Permit to Work is intended as a handover document whereby the Authorized Person verifies that it is safe to commence work, and the Contractor (or "Receiver") accepts the area and equipment as safe. It is the responsibility of <u>both</u> parties to verify that the situation is safe;

1.1.13.3. During Work in Progress:

1.1.13.3.1. The stipulations of the Permit to Work shall be adhered to at all times. Should the conditions or circumstances change the nature or extent of the hazards, the Receiver shall revert to the Authorized Person for further instructions or the use of a new Permit to Work. The Project Engineer shall be required to make regular inspections of the work to ensure that there is compliance with the Permit to Work on the part of the Contractor;

1.1.13.3.2. It is the responsibility of the Contractor to ensure, at all times, that unskilled or semi-skilled labors are supervised by a properly trained and experienced supervisor;

1.1.13.4. On Completion of Work:

1.1.13.4.1. On completion of work the area is to be tidied, made safe and fully restored in terms of the Contract;

1.1.13.4.2. The Contractor shall return the Permit to Work to the Authorized Person who shall, once he is satisfied that the area is safe and in an acceptable condition, sign off and retain the PTW as acceptance. It must be stressed that this in an acceptance in safety terms and in no way affects the Contractor's contractual obligations or liabilities.

1.17 GENERAL SAFETY GUIDELINES FOR WASTEWATER FACILITIES

1.1.14. This safety information relates to the General Duties of Employers to their Employees (Section 8 of the OHS ACT), which is critical to safe working by contractors unfamiliar with this particular wastewater treatment works site. It is not meant to be comprehensive, and you are still required to exercise the care that is expected by a person of your particular qualifications and experience. You are responsible for the conduct of all the staff that you bring on site;

1.1.15. **Dangerous Gases**: A significant potential danger on the works is the presence of gases such Hydrogen Sulphide (toxic at low concentrations with a characteristic rotten egg smell) and Methane (explosive in the range approximately 5% to 15% methane in the air), which arise from the decomposition of sewage or sewage sludge. As a result, you should not enter any confined space without seeking the permission of the Superintendent. The requirements of General Safety Regulation 5 of the OHS Act and Safety Procedure 2.2 apply to such spaces. Unless prior arrangements are made, the Superintendent will not issue a gas clearance certificate. The definition of a "Confined Space" is attached hereto;

1.1.16. **No Smoking:** Contractors must not smoke, use naked flames, or cause any other form of spark emission where there are no smoking signs**;**

1.1.17. **Chlorine:** Chlorine is used to treat the final effluent. This gas is heavier than air and toxic. Work within the chlorine installations must only be undertaken after the permission of the Superintendent has been obtained. Workers operating in the vicinity of chlorine installations must be aware of the dangers of inhaling chlorine and, if necessary, evacuate their work site and move to high point before giving the alarm or on receipt of an alarm message. Permit to Work is required;

1.1.18. **Electricity:** High Voltage supply and distribution of electricity are provided on site. Care must be exercised to avoid damaging cables when excavating or contact with exposed conductors with tools or ladders made from steel or aluminium;

1.1.19. **Empty Tanks:** In some instance's tanks are empty. Although efforts are made to prevent persons falling in, all persons must exercise care when working in the vicinity of such tanks. There is a general need to prevent persons who suffer from epileptic fits or fainting spells for whatever reason from working on the site without direct supervision;

1.1.20. **Sewerage:** Many of the tanks and channels are full of sewage and are deep. There is a danger of drowning if a person falls in and cannot swim. Handrails have been provided except where they would interfere with operation of the machinery associated with the tank. In the aeration tanks the aeration system reduces the buoyancy of the liquid and persons falling in being at a particular risk from this as well as injury from contact with the moving machinery;

1.1.21. **Personal Hygiene:** Personal hygiene is essential as the sewage received contains a range of pathogenic organisms. All open wounds must be adequately protected by a waterproof dressing. Where contact is unavoidable gloves must be worn. Scratches, abrasions and other injuries sustained in contact with sewage must receive immediate medical treatment;

1.1.22. **Personal Protective Equipment (PPE):** EWS will NOT provide any personal protective equipment or safety equipment to the contractor or his staff. The contractor is responsible for this as well as ensuring that his staff are instructed in its use and do make use of it;

1.1.23. **Drinking Water:** Purified effluent is available on some sites and contractors must exercise caution if they want to drink. Staff on the works can give guidance as to which taps deliver potable (drinking) water;

1.1.24. **Moving Machinery:** Some of the mechanical equipment starts automatically and some equipment like sedimentation tank bridges move slowly. Contractors must avoid placing objects where they could be struck by either of the above types of machinery;

1.1.25. **eThekwini Tools:** Metro tools and equipment are NOT to be used by the contractor;

1.1.26. **Supervision of Labour:** The Employee or Contractor shall ensure that unskilled or semi-skilled labour are supervised by a properly trained supervisor;

1.1.27. **Earth Leakage**: All portable electrical equipment shall be operated on independent and portable earth leakage units;

1.1.28. **Permits to Work:** Are required for most maintenance and construction activities. The relevant Superintendent must be consulted before work is undertaken, and a permit obtained**;**

1.1.29. **Confined Space** means an enclosed, restricted or limited space in which, because of its construction, location or contents, or any work carried out therein, a hazardous substance may accumulate, or an oxygen deficient atmosphere may occur, and includes any chamber, tunnel, pipe, pit, sewer, container, valve, pump, sump, or similar construction, equipment, machinery or object in which a dangerous liquid or a dangerous concentration of gas, dust or fumes may be present.

ANNEXURES – TECHNICAL DATA SHEETS

2 Contents

1.1. SCHEDULE OF PROPOSED MEDIUM VOLTAGE SWITCHGEAR

Item	Description	Main Sub 11kV Board	EWS Sub 11kV Board	Veolia Sub 11kV Board	Low Level 11kV Board	Mini Subs
1	New Main Substation to include Veolia Switchgear					
2	New Low-Level Substation to Include MV, LV Switchgear and Local Transformer.					
3	Incoming circuit breaker - with voltage transformer and protection class (5P20) current transformers, measuring class (0,2) current transformers wired for overcurrent, auto-reclosing functionality and internal arc detection protection. 11kV, 630A, 25kA	1	1	1		
4	Feeder circuit breaker - with voltage transformer and protection class (5P20) current transformers, wired for overcurrent, earth fault protection, sensitive earth fault protection, auto-reclosing functionality and internal arc detection protection. 11kV, 630A, 25kA		2	1		
5	Feeder circuit breaker – with protection (class X) current transformers wired for overcurrent, earth fault protection, auto-reclosing functionality and internal arc detection protection. 11kV, 630A, 25kA	2				
6	Feeder circuit breaker – with protection (class X) current transformers wired for overcurrent, earth fault protection, sensitive earth fault protection, transformer protection, auto-reclosing functionality and internal arc detection protection11kV, 630A, 25kA			1		
7	Compact Switchgear: Incomer circuit breaker – with protection (class X) current transformers wired for overcurrent, earth fault protection, sensitive earth fault protection and internal arc detection protection complete s11kV, 630A, 25kA				2	
8	Compact Switchgear: Feeder circuit breaker – with protection (class X) current transformers wired for overcurrent, earth fault protection, sensitive earth fault protection, transformer protection and internal arc detection protection suitable for feeds to connect to VSD motor starter panels and local transformer 11kV, 630A, 25kA				5	
9	Bus section breaker with riser panel, internal arc proof with arc protection 11kV, 630A, 25kA					
10	11kV/0.4kV, 500 kVA 630A mini substations with circuit breaker protection for transformer (3-way RMU) with LV panel					5
11	11kV/0.4kV, 1000 kVA 630A mini substation with circuit breaker protection for transformer (3-way RMU) with LV panel					1
12	11kV/0.4kV, 1000 kVA 630A mini substation with LV panel					1
13	11kV/3.3kV VSD Motor Starters to specification				4	

1.2. REQUIREMENTS FOR SWITCHGEAR: GENERAL

1.2.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part:

No	Technical Details	EWS	Tenderer's Offer
1	Name of manufacturer		
2	Place of manufacturer		
3	Manufacture reference number		
4	Overall dimensions of each panel:		
4.1	Incoming panel	Height × 600 × 1500	mm × mm ×
4.2	Incoming panel with voltage transformer	Height × 600 × 1500	mm × mm ×
4.2	Distributor panel	Height × 600 × 1500	mm × mm ×
4.3	Bus section/riser panel	Height × 600 × 1500	mm × mm ×
5	Weight of each panel:		
5.1	Incoming panel		kg
5.2	Incoming panel with voltage transformer		kg
5.2	Distributor panel		kg
5.3	Bus section breaker		kg
6	Type of provision for lifting		
7	Type tests:		
7.1	Type test certificate summary supplied, including test authority	Yes	*Yes/No
7.2	Name of test authority		
7.2	Internal arc test requirements:		
7.2.1	Current rating	25 kA	kA
7.2.2	Voltage rating	12 kV	kV
7.2.3	Duration	1s	s
7.2.4	Accessibility	Type A	
7.2.5	Arc classification	IAC AF/RL	

No	Technical Details	EWS	Tenderer's Offer
8	Labelling:		
8.1	EWS retraction numbers	As per **clause 5.10.3**	
8.2	Particular of circuit designation label requirements	Labels are to be removable and left blank	
8.3	Are rating plates in accordance with **Clause 5.9.2**	Yes	*Yes/No
8.4	Are ON, OFF and EARTH labels in accordance with **clause 12.3.8**	Yes	*Yes/No
8	Labels for instruments and protection relays to read as follows:		
8.1	Alarm on/off switch	ON OFF	
8.2	Sensitive earth fault on/off switch	ON OFF	
8.3	Auto-reclose	ON OFF	
8.4	Cable differential and/or Sensitive earth fault test block	CABLE DIFF and/or SEF TEST BLOCK	
8.5	Overcurrent and earth fault test block	O/C and E/F TEST BLOCK	
8.6	Cable differential relay	CABLE DIFF RELAY	
8.7	Overcurrent and earth fault relay	O/C and E/F RELAY	
8.8	Sensitive earth fault relay	SEF RELAY	

***Delete that which is not applicable. Please note that preference will be given to the most compact switchgear in terms of dimensions.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.3. REQUIREMENTS FOR SWITCHGEAR: CIRCUIT BREAKER

1.3.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part:

No	Technical Details	EWS Requirement	Tenderer's Offer
1	Type of circuit breaker	Fixed	
1.1	Arc interrupting medium	SF6	
1.2	Secondary insulation	Solidly Screened Separable Insulation	
2	Frequency	50 Hz	Hz
3	Rated voltage	12 kV	kV
4	Rated 1 min power frequency withstand voltage (rms value)		
3.1	To earth, between poles and across opening switching devices	28 kV	kV
3.2	Across isolating distances	32 kV	kV
4	Rated lightning impulse withstand voltage (peak value)		
4.1	To earth, between poles and across opening switching devices	75 kV	kV
4.2	Across isolating distances	85 kV	kV
5	Rated short-time withstand current	25kA	kA
6	Rated current	630 A	A
7	Rated peak withstand current	50 kA	kA
8	Short circuit withstand time	3 seconds	
9	Circuit earthing facilities	Integral of the panel	
10	Busbar earthing facilities		
11	Cable Test Facility	Details to be supplied with bid	
12	Number of spare auxiliary contacts required on each circuit-breaker "a" contacts, "b" contacts	"a"-5 "b"-5	
13	Type of trip indication required on switchgear	Mechanical indication	
14	Charging device for circuit breaker		
14.1	Circuit breaker to have automatic charging device	Yes	*Yes/No
14.2	Power requirements of automatic charging device	< 1,5 kW	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.4. REQUIREMENTS FOR SWITCHGEAR: CABLE TERMINATION COMPARTMENT

1.4.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part.

No	Technical Details	EWS Requirement	Tenderer's Offer
1	Specification to which cable termination compartment complies	NRS 012	
2	Cable compartment suitable for terminations in air	Yes	*Yes/No
3	Cable compartment to be naturally ventilated for air circulation	Yes	*Yes/No
4	Method of terminating cable	Screened Separable Connectors	
5	Are cable cleats required	Yes	*Yes/No
6	Method of supporting cable	Cable cleats	
7	Cable entering each panel	One 3-core XLPE cable between 95 and 300 mm^2	
8	Cable entry point	vertically from bottom	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.5. REQUIREMENTS FOR SWITCHGEAR: CURRENT TRANSFORMER REQUIREMENTS

1.5.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part.

No	Technical Details	EWS Requirement	Tenderer's Offer
1	Specification to which CTs complies	SANS IEC 60044-1	
2	Type of CTs	Encapsulated Screened	
2	Encapsulation material		
3	Detailed CT rating plate accordancein with **Clause 15.10.2.4**	Yes	*Yes/No
4	O/C and E/F CTs:		
4.1	Number of CTs	3	
4.2	Class	5P20	
4.2	Burden	10 VA	VA
4.3	Tap ratios	400/1	
4.4	Knee-point voltage (V_k)		V
4.5	Secondary resistance		Ω
4.6	Excitation current at V_k		mA
5	Differential protection CTs:		
5.1	Number of CTs	3	
5.2	Class	PX	
5.2	Burden	10 VA	
5.3	Tap ratios	400/5	
5.4	Knee-point voltage (V_k)	<75 V	V
5.5	Secondary resistance	<0,15 Ω	Ω
5.6	Excitation current at V_k	100 mA (<140 mA)	mA
6	Metering CTs:		
6.1	Number of CTs	3 (if specified on order)	
6.2	Class	0,2	
6.2	Burden	7,5 VA	VA
6.3	Tap ratios	400/200/1	
6.4	Knee-point voltage (V_k)		V
6.5	Secondary resistance		Ω
6.6	Excitation current at V_k		mA

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.6. REQUIREMENTS FOR SWITCHGEAR: VOLTAGE TRANSFORMER REQUIREMENTS

1.6.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part:

No	Technical Details	EWS Requirement	Tenderer's Offer
1	Specification to which VT complies	SANS IEC 60044-2	
2	Name of VT manufacturer		
2	Type of voltage transformers offered	Fixed	
3	Number of phases	3 phase	
4	VT ratios	11 kV/110 V	kV/ V
5	VT class requirements	0,2/0,5 according to SANS IEC 60044-2	
6	VT burden	50 VA/100 VA per phase	VA
7	VT factor	1,2 continuous 1,9 for 30 seconds	
8	VT connection	star/star	
8	Location of VT fuses	Suitably accessible	
9	Location and type of VT test blocks	With the VT	
10	HV VT fuses required	Not Required	
10	Method of connecting busbar/cable VT primaries to be indicated	To be connected to the circuit side	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.7. REQUIREMENTS FOR SWITCHGEAR: PROTECTION AND INSTRUMENTATION REQUIREMENTS

1.7.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part: (Tenderers are encouraged to submit various alternatives for each type of protection relay)

1.7.2. General:

No	Technical Details	EWS Requirement	Tenderer's Offer
1	Functionality of protection relay:		
1.1	Protection functions		
1.1.1	Non-directional overcurrent protection, 3 stage	Yes	*Yes / No
1.1.2	Non-directional earth fault protection, 3 stage	Yes	*Yes / No
1.1.2	Sensitive earth fault, with definite time	Yes	*Yes / No
1.1.3	Power arc detection	Yes	*Yes / No
1.1.4	Auto-reclose function, 4 shots	Yes	*Yes / No
1.1.5	Three phase overload	Yes	*Yes / No
1.1.6	Circuit breaker failure	Yes	*Yes / No
1.2	Measurement functions		
1.2.1	Phase currents	Yes	*Yes / No
1.2.2	Neutral currents	Yes	*Yes / No
1.2.2	Three phase voltage	Yes	*Yes / No
1.2.3	Three phase power (active)	Yes	*Yes / No
1.2.4	Three phase power (reactive)	Yes	*Yes / No
1.2.5	Three phase energy	Yes	*Yes / No
1.2.6	Three phase kilowatt hours	Yes	*Yes / No
1.2.7	Frequency	Yes	*Yes / No
1.2.8	Load profiles over a 7 day period (minimum)	advantageous	
1.2	Condition Monitoring Functions		
1.2.1	Circuit breaker contact wear (I^2t)	Yes	*Yes / No
1.2.2	Breaker travel time	Yes	*Yes / No
1.2.2	Gas density	(Not Allowed)	*Yes / No
1.2.3	Scheduled maintenance	Yes	*Yes / No
1.2.4	Trip circuit supervision	Yes	*Yes / No

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.7.3. This Schedule shall be completed, signed and returned with tender documents of which it forms part: (Tenderers are encouraged to submit various alternatives for each type of protection relay)

1.7.4. Overcurrent, earth fault and sensitive earth fault protection:

No	Technical Details	EWS Requirement	Tenderer's Offer
2	**Overcurrent, earth fault and sensitive earth fault protection**		
2.1	Relay name and model		
2.2	Type of relay		
2.2	Specification to which relay complies	IEC 60255	
2.3	Communication specification for relay	IEC 61850	
2.4	Auxiliary voltage	110 V dc	V dc
2.5	CT secondary rating	1 A	A
2.6	Frequency rating	50 Hz	Hz
2.7	Burden of the relay	<15 VA	VA
2.8	Thermal current rating	2,4 × In	A
2.9	Does it have standard inverse characteristic referred to in IEC 255	Yes	*Yes/No
2.10	Number of tripping contacts	minimum 2	
2.11	Number of annunciating contacts	minimum 2	
2.10	Tripping contact rating	Making - 1 000 VA Tripping - 30 VA	VA VA
2.12	Dimensions of relays to be supplied	Height × width × depth	mm× mm× mm

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.7.5. This Schedule shall be completed, signed and returned with tender documents of which it forms part: (Tenderers are encouraged to submit various alternatives for each type of protection relay)

1.7.6. Cable Differential Protection:

No	Technical Details	EWS Requirements	Tenderer's Offer
2	Cable differential protection		
2.1	Relay name and model		
2.2	Type of relay		
2.2	Specification to which relay complies	IEC60255	
2.3	Auxiliary voltage	110 V dc	V dc
2.4	CT secondary rating	5 A	A
2.5	Frequency rating	50 Hz	Hz
2.6	Burden of the relay	<15 VA	VA
2.7	Thermal current rating	2 × In	
2.8	Number of tripping contacts	minimum 2	
2.8	Number of annunciating contacts	minimum 2	
2.9	Tripping contact rating	Making - 1 000 VA Tripping - 30 VA	VA VA
2.10	Dimensions of relays to be supplied	Height × width × depth	mm× mm× mm
3	**Instrumentation**		
3.1	Details of all instruments and transducers required	One combined ammeter/thermal maximum demand indicator for distributor and incoming panels	
3.2	Instruments name and model		
3.2	Type of instrument		
3.3	Thermal maximum demand ammeters required	As per **Clause 5.2**	
3.4	Dimensions of instruments to be supplied	Height × width × depth	mm× mm× mm
3.5	Ammeter scale	400/1	

Name:_____ Date:_____

Company:_____ Sign: _____

1.7.7. This Schedule shall be completed, signed and returned with tender documents of which it forms part: (Tenderers are encouraged to submit various alternatives for each type of protection relay)

1.7.8. Arc Detection Protection:

No	Technical Details	EWS Requirement	Tenderer's Offer
1	Name of manufacturer		
2	Place of manufacturer		
2	Manufacture reference number		
3	Light sensors and cabling		
3.1	Manufacture and type	Specify	
3.2	State approval by a Standard Authority	Specify	
3.2	Automatic/manual light reference	Specify	
3.3	State any length limitations of the comms cable	Specify	
4	Voltage Supplies		
4.1	Rated voltage range	110V DC	
4.2	Operating voltage range	(88-132)V	
5	Indication circuits and Alarm		
5.1	Power supply LED	Green	
5.2	All LEDs	Red	
6	Self-Monitoring/Self-supervision	Yes	*Yes/ No
7	Analogue / Digital		
7.1	Digital inputs	8	*More/Less
7.2	Analogue inputs	5	*Yes/No
7.2	Digital output programmable	Yes	*Yes/No
8	Communication Ports		
8.1	Engineering access	RS485/RS232	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.8. REQUIREMENTS FOR SWITCHGEAR: PRECOMMISSIONING CHECK SHEET

1.8.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part:

1.8.2. This check and inspection shall be carried out by the manufacturer prior to the switchgear being dispatched to eThekwini Municipality. Each item on the list shall be checked and if found to be satisfactory a tick (□) shall be used, or if found to be unsatisfactory a cross (X) shall be used. The letters **NA** shall be inserted against items which are not applicable. Where an item is marked with a cross (X), reasons shall be stated in the **Remarks and comments** section:

No	Description	EWS Number of Panel							
1.0 General Checks on each Switchgear Panel									
1.1	Circuit designation on front and rear of panel								
1.2	The same EWS number on panel and truck								
1.2	Cable box and gland in order and ready for terminating								
1.3	Paint work on switchgear satisfactory								
1.4	Front door of panel latch operational								
1.5	CT information and rating plates inside relay compartment								
1.6	Manufacturer's rating plate affixed with information								
2	**Mechanical Checks on each Switchgear Panel**								
2.1	Panel bolted down								
2.2	Position selector easily manipulated								
2.2	"OFF" position clearly displayed								
2.3	Close by mechanical lever or push-button								
2.4	Can only close with interlock in "LOCKED" position								
2.5	Cannot close with interlock in "FREE" position								
2.6	"ON" position clearly displayed								
2.7	Cannot be isolated when closed								
2.8	Open by mechanical lever or push-button								
2.8	Circuit earth position easily selected and indicated								
2.9	CB can be locked off in circuit earth position								
2.10	Close by mechanical lever or push-button								
2.10	Open by mechanical lever or push-button								

No	Remarks and comments

No	Description	EWS Number of Panel							
3	**Electrical tests on each Switchgear Panel**								
3.1	Circuit breaker open								
3.2	Circuit breaker close								

4	**Ductor test**				
	EWS Number of Panel		**Results** (*u* ohms)		
	From	**To**	**Red phase**	**White phase**	**Blue phase**
4.1					
4.2					
4.2					
4.3					
4.4					
4.5					
4.6					
4.7					
4.8					
4.8					

5	**Power frequency voltage withstand test - Test voltage 24 kV, duration 1 minute**		
	EWS Number of each panel making up the complete switchboard		
	From	**To**	**Leakage current (mA)**
5.1	red phase	earth	
5.2	white phase	earth	
5.2	blue phase	earth	
5.3	across open point		
5.4	across other point		

No	Remarks and comments

6	**Primary injection test**							
	Overcurrent and earth fault protection							
	Current transformer (CT) ratio:				**Primary current:**			
	EWS Number of Panel	**Circuit Designation**	**Results**					
			Secondary current (A)			**Spill current** (mA)		**Single point CT earthing**
			Red φ	**White φ**	**Blue φ**	**Red/White**	**Red/Blue**	
6.1								*Yes/No
6.2								*Yes/No
6.2								*Yes/No
6.3								*Yes/No
6.4								*Yes/No
6.5								*Yes/No
6.6								*Yes/No
6.7								*Yes/No
6.8								*Yes/No
6.8								*Yes/No

7	**Primary injection test**							
	Cable differential protection							
	Current transformer (CT) ratio:				**Primary current:**			
	EWS Number of Panel	**Circuit Designation**	**Results**					
			Secondary current (A)			**Spill current** (mA)		**Single point CT earthing**
			Red φ	**White φ**	**Blue φ**	**Red/White**	**Red/Blue**	
7.1								*Yes/No
7.2								*Yes/No
7.2								*Yes/No
7.3								*Yes/No
7.4								*Yes/No
7.5								*Yes/No
7.6								*Yes/No
7.7								*Yes/No
7.8								*Yes/No
7.8								*Yes/No

8	**Primary injection test**							
	Metering							
	Current transformer ratio:				**Primary current:**			
	EWS Number of Panel	**Circuit Designation**	**Results**					
			Secondary current (A)			**Spill current** (mA)		**Single point CT earthing**
			Red φ	**White φ**	**Blue φ**	**Red/White**	**Red/Blue**	
8.1								*Yes/No
8.2								*Yes/No
8.2								*Yes/No
8.3								*Yes/No
8.4								*Yes/No

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.9. REQUIREMENTS FOR MINI-SUBSTATIONS (VACUUM/SOLID "SMART" RMU)

Ref No.	Technical details	EWS Requirement	Bidder's offer
1	**General requirements of mini substation**		
1.1	Name of manufacturer		
1.2	Place of manufacture		
1.3	Manufacturer's identification reference		
1.4	Rated output	500 kVA	kVA
1.5	Nominal secondary voltage	415 V/240 V	V
1.6	Nominal primary voltage of system	11 kV	kV
1.7	Does the mini-substation comply with SANS 1029?	Yes	*Yes/No
1.8	Corrosion protection of the base	Hot-dip galvanised and coated with black epoxy tar paint	
1.9	Is the ring main unit, enclosure and all other components protected against the environmental conditions as in **clause 6.2.2**?	Yes	*Yes/No
1.10	Details of the corrosion protection applied to the ring main unit, transformer and enclosure supplied with the bid documents	Yes	*Yes/No
1.11	Material of enclosure	3CR12	
1.12	Colour of mini-substation	C37 light stone to SANS 1091: 2012	
1.13	Dimensions of mini-substation	Height × width × depth	x x
1.14	Mass of mini-substation		kg
1.15	Material of fasteners and door hinges	Marine grade stainless steel	
1.16	Three point locking mechanism fitted to doors	Yes	*Yes/No
1.17	Doors fitted with padlock protection facility to accommodate 50 mm high security lock with 10 mm diameter shackle	Yes	*Yes/No

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
1.18	Left LV door drilled with 5 mm diameter holes to accommodate label (see **clause 6.2.8**)	Yes	*Yes/No
1.19	Door contacts fitted to all doors and wired to the IED	Yes	*Yes/No
1.20	Drawings and details of the concrete plinth supplied with the bid documents	Yes	*Yes/No
1.21	IAC of the mini substation	A-B FLR	
1.22	Warranty of complete mini substation (with all associated components)	Minimum 2 years	
1.23	Warranty of complete mini-substation against corrosion and leaks	Minimum 5 years	
2	**Transformers**		
2.1	Do the transformers comply with SANS 780?	Yes	*Yes/No
2.2	Design detail submitted with the bid documents	Yes	*Yes/No
2.3	Rated power	500 kVA	kVA
2.4	Nominal primary voltage	11 kV	
2.5	Nominal secondary voltage	420 V/242 V	V
2.6	Vector group and symbol	Dyn11	
2.7	Tap change switch	Rotary off load, externally operated, lockable in any position	
2.8	MV tappings: single ratio	± 2,5% & ± 5% at 11 kV	a)
2.9	Guaranteed impedance voltage	4,5% to 5,5%	%
2.10	Method used to ensure that terminals are suitable for both copper and aluminium conductors	Tinning or silver plating of terminals	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
2.11	Bushing: a) MV b) LV	a) Type C Epoxy Resin b) Porcelain	a) b)
2.12	Transformer fitted with a bolted tank lid	Yes	*Yes/No
2.13	Oil gauge and tap change switch easily visible and readily accessible	Yes	*Yes/No
2.14	Temperature rise at rated voltage and power of: (i) Windings (ii) Top oil	65 ºC 60ºC	ºC ºC
2.15	Temperature sensing system fitted as in clause 4.5.15?	Yes	*Yes/No
	Transformer 500kVA Single Ratio Transformer		
2.16	Name of manufacturer		
2.17	Place of manufacture		
2.18	Manufacture's reference number		
2.19	Dimensions of transformer	Height × width × depth	x x
2.20	Mass of core and windings		kg
2.21	Mass of complete transformer		kg
2.22	Oil capacity		litres
2.23	Guaranteed upper limit of no-load losses at rated voltage and frequency	850 W	W
2.24	Guaranteed upper limit of load-losses at rated voltage and frequency	5 000 W	W

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
3	**"Smart" Ring main unit and ring main unit compartment**		
3.1	Name of manufacturer		
3.2	Place of manufacture		
3.3	Manufacturer's identification reference		
3.4	Does the ring main unit comply with SANS 1874?	Yes	*Yes/No
3.5	Interruption medium	SF6	
3.6	Rated frequency	50 Hz	Hz
3.7	Rated voltage	12 kV	kV
3.8	Rated short-time withstand current	25 kA (3 s)	kA s
3.9	Rated peak withstand current	50 kA (3 s)	kA s
3.10	Rated current	630 A	A
3.11	Rated 1 min power frequency withstand voltage	28 kV	kV
3.12	Rated lightning impulse withstand voltage	75 kV	kV

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
3.13	Material of bushing		
3.14	Bushing type	Type C	
3.15	One Earth Fault Indicator fitted and compliant to spec	Yes	*Yes/No
3.16	Minimum earth fault current indication	50 A	A
3.17	Minimum response time for indication	50 ms	ms
3.18	Is EFI immune to current spikes and magnetizing inrush current?	Yes	*Yes/No
3.19	Mechanical flag indication on ICU and LED indication on RIU of EFI	Yes	*Yes/No
3.20	Method of resetting	Reset automatically with 230 V, 50 Hz supply	
3.21	Test facility fitted to confirm functionality of the EFI via a 6,35 mm female jack plug	Yes	*Yes/No
3.22	HR VDS fitted with test and indication	Yes	*Yes/No
3.23	M16 brass stud, spring washer, flat washer and nut fitted to all bushings	Yes	*Yes/No
3.24	Centre switch function of ring main unit connected to and labelled 'LOCAL TRANSFORMER' with Circuit breaker protection	Yes	*Yes/No
3.25	Centre leg of ring main unit is a tee-off circuit breaker?	Yes	*Yes/No
3.26	Current rating of tee-off circuit breaker	200A	A
3.27	Ring main unit and transformer connected via single-core screened copper cables with Type 4 connectors	Yes	*Yes/No
3.28	Ring main unit compartment fitted with socket outlet and lamp as per specification	Yes	*Yes/No
3.29	Circuit earthing facility	Integral earthing through ring main unit	
3.30	Cable test facility	Details supplied with bid	
3.31	Type of switch position indication	Mechanical via a mimic indication system	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
3.32	Type of SF6 pressure indication fitted	SF6 pressure gauge	
3.33	Is the ring main unit and enclosure protected against the environmental conditions as per specification	Yes	*Yes/No
3.34	Details of the corrosion protection applied to the ring main unit and enclosure supplied with the bid documents?	Yes	*Yes/No
3.33	Warranty on complete ring main units (with all associated components)	Minimum 2 years	
3.34	Warranty of ring main unit against corrosion	Minimum 5 years	
3.35	Warranty of ring main unit against SF6 leaks	Minimum 20 years	
4	**Low voltage switchboard**		
4.1	Name of manufacturer		
4.2	Place of manufacture		
4.3	Manufacturer's identification reference		
4.4	Busbars manufactured from aluminium	Yes	*Yes/No
4.5	Phase busbars current rating	800 A	
4.6	Neutral busbar current rating	400 A	
4.7	1 × 800 A incoming switch disconnector fitted	Yes	*Yes/No
4.8	3 × 400 A switch fuse disconnectors fitted	Yes	*Yes/No
4.9	Earth bar in accordance with **clause 6.2.20.3**	Yes	*Yes/No
4.10	Neutral earth link included	Yes	*Yes/No

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
4.11	3 × spare M10 nuts and bolts fitted to earth and neutral busbars as per specification	Yes	*Yes/No
4.12	Short circuit strength – 18,0 kA for 0,5 s	Yes	*Yes/No
4.13	Creepage and clearances distances (min)	19 mm	mm
4.14	Personnel protection: IP XXB under all conditions as per specification	Yes	*Yes/No
4.15	Short-circuit withstand strength type test report/certificate submitted as per specification	Yes	*Yes/No
4.16	Incoming switch disconnector test report/certificate submitted as per specification	Yes	*Yes/No
4.17	Outgoing fuse-switch disconnector test report/certificate submitted as per specification	Yes	*Yes/No
4.18	Resistance to abnormal heat type test report/certificate submitted as per specification	Yes	*Yes/No
4.19	LV interconnecting cables adequately rated?	Yes	*Yes/No
4.20	Supporting documents and calculations for cable rating provided with bid document	Yes	*Yes/No
4.21	Socket outlet, lamp and IED fitted as per specification	Yes	*Yes/No
4.22	Name of IED manufacturer		
4.23	IED manufacturer's identification reference		
4.24	Door switches and EFI operation wired to IED	Yes	*Yes/No
4.25	Mounting space allocated for mounting of modem	Yes	*Yes/No
5	**Incoming switch disconnector**		
5.1	Name of manufacturer		
5.2	Place of manufacture		
5.3	Manufacturer's identification reference		

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
5.4	Complies with SANS 60947-3	Yes	*Yes/No
5.5	Current rating	800 A	
5.6	Three phase pole operated and suitable for single phase operation	Yes	*Yes/No
5.7	Contact pressure does not rely on springs in normal service	Yes	*Yes/No
5.8	Operating pole has interlocks to ensure correct operation	Yes	*Yes/No
5.9	Visible break	Yes	*Yes/No
5.10	Test probe access	Yes	*Yes/No
5.11	Current transformer incorporated in switch disconnector and resin encapsulated	Yes	*Yes/No
5.12	Current transformers comply with SANS 61869-2	Yes	*Yes/No
5.13	Current transformer: ratio 800/5, 5 VA, Class 5	Yes	*Yes/No
5.14	Padlocking in the open position	Yes	*Yes/No
5.15	Cleat provided to support and locate incoming cables	Yes	*Yes/No
5.16	Terminals suitable for torque sheer lugs	Yes	*Yes/No
6	**Outgoing distributor unit**		
6.1	Manufacturer		
6.2	Place of manufacture		
6.3	Manufacturer's reference number		
6.4	Comply with SANS 60947-3?	Yes	*Yes/No

Delete that which is not applicable.

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
6.5	Current rating	400 A	A
6.6	Three phase fuse switch disconnector suitable for single pole operations	Yes	*Yes/No
6.7	Double visible break	Yes	*Yes/No
6.8	Suitable for type gG, Size 2 fuse links to SANS 60269-2	Yes	*Yes/No
6.9	Test probe access	Yes	*Yes/No
6.10	Padlocking with fuse carriers removed	Yes	*Yes/No
6.11	Provision for connection of 1 × 4-core 240 mm² cable	Yes	*Yes/No
6.12	Terminals suitable for torque sheer lugs	Yes	*Yes/No
6.13	General performance characteristic: AC-22B, U_e = 400 V	Yes	*Yes/No
6.14	Operational performance characteristic: AC-22B, U_e = 400 V	Yes	*Yes/No
6.15	Conditional short circuit current: 50 kA, U_e = 400 V	Yes	*Yes/No
6.16	Overload performance capability: Test Sequence V of SANS 60947-3	Yes	*Yes/No

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
7	**General requirements of RTUs (for SF6 RMU)**		
7.1	RTU fitted in a lockable cabinet as per specification		
7.2	Dimensions of RTU cabinet in millimetres: a) Indoor ring main unit b) Outdoor ring main unit	Height × width × depth Height × width × depth	x x x x
7.3	Are all monitoring and automation functions as per clauses	Yes	*Yes/No
7.4	RTU fitted with battery and charger unit?	Yes	*Yes/No
7.5	Is the d.c. supply for the modem supplied as Per specification?	Yes	*Yes/No
7.6	Standby duration of RTU and modem on battery power (minimum)	12 hours	
7.7	Number of switch operations on battery power (min)	8 operations	
7.8	Battery voltage and rating		V Ah
7.9	Number of additional I/Os on RTU (for indoor units only)	24 digital inputs, 8 analogue inputs	
7.10	Can I/Os be extended?	Yes	*Yes/No
7.11	Modem mounting plate provided to accommodate modem of size 300 mm × 250 mm × 100 mm within the cabinet?	Yes	*Yes/No
7.12	Pre-cut hole drilled and grommeted to RTU cabinet as per specification?	Yes	*Yes/No
7.13	RTU cabinet fitted with trunking and terminal block wired to inputs on the RTU as per clause 6.13 (for indoor units only) ?	Yes	*Yes/No
7.14	All wiring from the RTU fitted with plug connectors as per specification	Yes	*Yes/No
7.15	RTU capable of communicating via DNP3.0 over TCP/IP?	Yes	*Yes/No
7.16	RTU fitted with a 10/100 Ethernet port?	Yes	*Yes/No
7.17	RTU configurable through a web browser?	Yes	*Yes/No
7.18	RTU configuration file workable when offline?	Yes	*Yes/No
7.19	Wiring marked with clip-on labels as per specification	Yes	*Yes/No
7.20	Wiring diagrams supplied with bid documents?	Yes	*Yes/No

• Delete whichever is not applicable

Name:_____ Date:_____

Company:_____ Sign:_____

1.10. REQUIREMENTS FOR MV VSD MOTOR STARTERS SWITCHGEAR

1.10.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part:

Ref No.	Technical details	EWS Requirement	Bidder's offer
1	Name of manufacturer		
2	Place of manufacturer		
3	Manufacture reference number		
4	**Overall dimensions of each panel**		
4.1	Motor Starter Panel	Height × mm × mm	x x
5	**Weight of each panel**		
5.1	Motor Starter Panel		kg
6	Type of provision for lifting		
7	**Type tests**		
7.1	Type test certificate summary supplied, including test authority	Yes	*Yes/No
7.2	Name of test authority		
7.2.1	Installation	Indoor	
7.2.2	Maximum Rated Voltage	11kV/3.3kV	
7.2.3	Rated Insulation Level: Impulse withstand voltage (1.2/50)µs, peak value	60	
7.2.4	Rated Insulation Level: Power Frequency withstand Voltage (1Min)	20	
7.2.5	kA Rating of Busbars and time		
7.2.6	Rated Frequency	50 Hz	
7.2.7	Maximum Busbars rating		
7.2.8	Degree of Protection: Enclosure	IP3X, IP4X, IPX1, IPX2	
7.2.9	Degree of Protection: Between Compartments	IP2XC 200/400 A, IP2X 450 A	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
7.2.10	Contactor		
7.2.11	Rated Operational Current		
7.2.12	kA Rating for HRC fuses		
7.2.13	Rated Switching Frequency	1200 Hour	
7.2.14	Category of Use	AC3	
7.2.15	Type of HRC Co-ordination	C	
7.2.16	Mechanism	Mechanically latched & Electrically held	
7.2.17	Internal Arc		
7.2.18	Protection Relay	Multi-Functional	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.11. REQUIREMENTS OF 200 KVA, SINGLE RATIO, 3 PHASE, 11 000 V/420/242 V TRANSFORMER

1.11.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part:

Ref No.	Technical details	EWS Requirement	Bidder's offer
1	Name of Manufacturer		
2	Place of Manufacture		
3	Manufacture's reference number		
4	Rated Power	200 kVA	kVA
5	Rated primary no load voltage	11 kV	kV
6	Rated secondary no load voltage	420 V/242 V	V/ V
7	Insulation level	75 kV	kV
8	Vector group	Dyn11	
9	Overall dimensions: (i) Length (ii) Depth (iii) Height	1 900 mm (maximum) 1 650 mm (maximum) 2 050 mm (maximum)	mm mm mm
10	Primary voltage tappings	±2,5% and ± 5%	
11	Tap change switch	**Rotary** off-load, externally operated, lockable in any position	
12	Material of windings: (i) Primary (ii) Secondary	Copper/Aluminium Copper/Aluminium	
13	Mass of core and windings		kg
14	Mass of complete transformer		kg
15	Oil capacity		litre
16	Guaranteed impedance voltage	4,5 to 5,5 %	%

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
17	Guaranteed upper limit of no-load losses at rated voltage and frequency:		W
18	Guaranteed upper limit of load losses at rated voltage and frequency:		W
19	Temperature rise at rated voltage and power of: (i) Windings (ii) Top oil	65 ºC 60□ºC	ºC ºC
20	Method used to ensure that terminals suitable for both copper and aluminium conductors	Tinning or silver plating of terminals	
21	Bushing: MV LV	Type C-Epoxy Resin Porcelain	
22	Creepage distance of MV bushings	31 mm/kV	
23	Colour	No. G 35 of SANS 1091	
24	Corrosion protection: In accordance with in Eskom Standard: 240-56030674 for new units for protection in C5-M (Very High Marine) environments	Yes	*Yes/No
25	Warranty period	36 months	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.12. REQUIREMENTS OF 1000 KVA, SINGLE RATIO, 3 PHASE, 11 000 V/420/242 V

TRANSFORMER

1.12.1. This Schedule shall be completed, signed and returned with tender documents of which it forms part:

Ref No.	Technical details	EWS Requirement	Bidder's offer
1	Name of Manufacturer		
2	Place of Manufacture		
3	Manufacture's reference number		
4	Rated Power	1000 kVA	kVA
5	Rated primary no load voltage	11 kV	kV
6	Rated secondary no load voltage	420 V/242 V	V/ V
7	Insulation level	75 kV	kV
8	Vector group	Dyn11	
9	Overall dimensions: (iv) Length (v) Depth (vi) Height	 1 900 mm (maximum) 3 650 mm (maximum) 4 050 mm (maximum)	 mm mm mm
10	Primary voltage tappings	±2,5% and ± 5%	
11	Tap change switch	**Rotary** off-load, externally operated, lockable in any position	
12	Material of windings: (iii) Primary (iv) Secondary	 Copper/Aluminium Copper/Aluminium	
13	Mass of core and windings		kg
14	Mass of complete transformer		kg
15	Oil capacity		litre
16	Guaranteed impedance voltage	4,5 to 5,5 %	%

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

Ref No.	Technical details	EWS Requirement	Bidder's offer
17	Guaranteed upper limit of no-load losses at rated voltage and frequency:		W
18	Guaranteed upper limit of load losses at rated voltage and frequency:		W
19	Temperature rise at rated voltage and power of: (iii) Windings (iv) Top oil	 65 ºC 60 ºC	 ºC ºC
20	Method used to ensure that terminals suitable for both copper and aluminium conductors	Tinning or silver plating of terminals	
21	Bushing: MV LV	Type C-Epoxy Resin Porcelain	
22	Creepage distance of MV bushings	31 mm/kV	
23	Colour	No. G 35 of SANS 1091	
24	Corrosion protection: In accordance with in Eskom Standard: 240-56030674 for new units for protection in C5-M (Very High Marine) environments	Yes	*Yes/No
25	Warranty period	36 months	

***Delete that which is not applicable.**

Name:_____ Date:_____

Company:_____ Sign: _____

1.13. PROPOSED PROJECT STAFF AND ARTISANS

1.13.1. The following table is to be populated with the proposed senior staff and artisans for the project:

NO.	POSITION/ROLE	NAME	QUALIFICATION
1	Project Manager		
2	Engineer		
3	Master Electrician		
4	Artisan		
5	Artisan		
6	Other		
7	Other		
8	Other		

1.14. COMPULSORY DATA PACK

1.14.1. Drawings 3 sets;

1.14.2. Factory Routine Test Certificates (SANS 1473-1);

1.14.3. Site Test Certificates;

1.14.4. Certificate of Compliance;

1.14.5. Maintenance Manual;

1.14.6. Technical Specifications;

1.14.7. All Electronic and Electrical Manuals;

1.14.8. Partial Type test certificates for MVC over 10kA;

1.14.9. Paint Thickness certificate;

1.14.10. All programmable parameters of all protection shall be supplied;

1.14.11. An electronic copy of each PLC program installed in the plant;

1.14.12. A schematic of all cable routes and joints of all cables. This should show the position of all cable markers installed;

1.14.13. A life cycle letter from the manufactures of all electrical and electronic equipment. (Soft Starter/VSD);

1.14.14. Contact details of all agents/ sole suppliers of all electrical and electronic equipment for after sales service and back up;

1.14.15. All of the above to be supplied on a suitable external hard drive;

1.15. SCHEDULE OF RECOMMENDED EQUIPMENT

(THE TENDER MAY HOWEVER, OFFER ALTERNATIVE)

1.15.1. Siemens Metal-Enclosed MV Switchgear;

1.15.2. ABB;

1.15.3. Schneider:

1.15.4. MICOM relay;

1.15.5. ABB relays;

1.15.6. Siemens Relay.