Eskom Rotek Industries	Scope of Work (SOW)	Turbo Gen Services

Title: **Scope of Work for 300T Balancing Plant 6.6 kV Switchgear Replacement Project**

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Content

1. INTRODUCTION

The 300T (tonnes) Balancing Plant was commissioned in the 1980s. The 6.6kV Switchgear for the 300T balancing Plant is supplied from ROSHSTEP 88/22/6.6kV Substation. The MV Switchgear provide power supply to 300T Balancing Plant and its auxiliaries, including household loads for the 300T Balancing Plant building. These MV Switchgear has exceeded their expected design life of 30 years. The report seeks to assess these MV switchgear to determine safety and reliability for the remaining life of the 300T Balancing Plant.

Replacing of these MV switchgear will ensure safety to personnel and reliability of the plant.

2. SUPPORTING CLAUSES

2.1 Scope

This document covers the electrical scope for the 300T Balancing Plant 6.6kV Switchgear replacement project. It introduces the entire scope on the MV switchgear specification. Covered in this scope, is the general requirements such as Document management, configuration management as well as training just to name a few.

2.1.1 Purpose

This document covers the scope of work required to manufacture, supply, install , and (cold and hot) commissioning of the 300T Balancing Plant 6.6kV Switchgear and its related equipment.

2.2 Applicability

This document shall apply at Eskom Rotek Industries' 300T Balancing Plant.

2.3 Normative/Informative References

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

2.3.1 Normative

[1] OHS Act Occupational Health and Safety Act 85 of 1993.

[2] ISO 9001 Quality Management Systems.

[3] 240-82332407 Generation Fixed Pattern Gas Insulated Metal-Enclosed Indoor Primary Switchgear and Controlgear Specification for rated Voltages above 1kV up to and including 52kV Standard.

[4] 240-56227443 Generation Requirements for Control and Power Cables for Power Stations Standard.

[5] 240-56997043 Maintenance standard for MV indoor primary switchgear.

[6] 240-56179027 Generation safety measures against the thermal hazard of an electrical arc for metal enclosed switchgear (up to 15kV) standard.

[7] 240-86973501 Engineering Drawing Standard – Common Requirements.

[8] 240-150642762 Generation plant safety regulations.

[9] 240-114967625 Operating regulations for high voltage systems.

[10] 240-143485806 Generation Auxiliary Plant Medium Voltage Protection Standard.

[11] 240-56227589 List of Approved Electronic Devices to be used on Eskom Power Stations.

[12] 240 - 53114248 Thyristor And Switch Mode Chargers AC/DC TO DC/AC Converters And Inverter/uninterruptable Power Supplies Standard.

[13]

2.3.2 Informative

Not applicable.

2.4 Definitions

Definition	Description
Acceptance	The *Employer* accept the condition or design but does not take responsibility from the *Contractor*
Feeder	A section of a switchboard which supplies a load.
Functional unit	A part of metal-enclosed switchgear and controlgear comprising all the components of the main circuits ans auxiliary circuits that contribute to the fulfilment of the single function.
IED	Microprocessor-based device with the protection, control, monitoring and communication functionalities.
Incomer	The incomer is the panel that receive power directly from a transformer.

Definition	Description
Transformer feeder	The transformer feeder refers to a panel that is used to supply power to a transformer.

2.5 Abbreviations

Abbreviation	Explanation
AFLR	Classification for Operator A – Front, Lateral, Rear
BIL	Basic Impulse Level
CT	Current Transformer
GIS	Gas Insulated Switchgear
IED	Intelligent Electronic Device
MV	Medium Voltage
PLC	Programmable Logic Controller
SF_6	Sulphur Hexafluoride
SOW	Scope of Work
T	Tonne
VT	Voltage Transformer
VDSS	Vender Document Subimttal Schedule

3. DESCRIPTION OF THE WORKS

3.1 *Employer*'s Objective and Purpose of the *Works*.

One of the *Employer*'s objectives and purpose of the works is to replace the 6.6kV Switchboards at ERI 300T Balancing Plant. Because of the replacement of the MV switchgear certain associated equipment such as Power and Control cabling, Protection must also be included in the SoW. The following is a record of the replacement/equipment/systems that are required:

a) Replacement of the existing MV switchgear with new MV switchgear. The new MV switchgear must be AFLR internal arc classified for 1 second in accordance with SANS 62271-200 and must have a design life of 30 years.

b) The latest intelligent electronic devices (IED's) protection equipment with designed life of a minimum of 15 years.

c) Power and control cabling, inclusive of installation, testing, joint and termination and commissioning.

d) The switchgear must fit within the available space shown in Drawing 13.25/ABC (Balancing Switchgear Layout).

3.2 Scope of the *Works* for MV Switchgear

The Scope of the Works is for the design, manufacture, factory testing, supply, delivery, off-loading, erection, installation, site testing and commissioning of new Plant and Material forming part of the works.

The Plant includes but is not limited to the following:

a) Metal enclosed gas insulated switchgear and controlgear

b) Power and control cabling

c) Switchgear unit struts for floor levelling

d) Protection schemes to be installed on switchgear panels

e) Interface to the existing control system (PLC).

The *Contractor* performs the mounting of protection equipment, the wiring of the relays and control circuits on the MV switchgear. The *Employer* provides the typical functional protection and interface block diagrams.

The *Contractor* performs the detailed design of the protection and control circuits as well as interfacing. The *Contractor*'s designs are submitted to the *Employer* for review and acceptance.

Disconnection and removal of the existing power and control cabling from the MV switchgear and the removal of switchgear from the respective substations will be carried out by the *Contractor*. The *Contractor* submits proposals for re-positioning of the power and control cables to suit the new switchgear, for Project Manager's acceptance.

The re-connection of the power and control cables once the medium voltage switchgear is in position is performed by the *Contractor*.

The *Contractor* designs the schematic diagrams using provided old schematic diagrams and Protection Function (*PA1200 and *PA1000) & Interface IO Block Diagrams(X07) in Appendix I supplied by the *Employer*, Refer to 0.52/30476 and 052/30483.

The *Contractor* designs the C&I interface to the newly installed Control System provided by Others.

The *Contractor* is responsible for the marking of the substation floor for additional cable entry holes.

The *Contractor* provides engineering, operating and maintenance training on the Plant (as detailed in this SoW. The documentation requirements cover the various stages, from the engineering stage through to installation and commissioning and most importantly for the operating, maintenance, and training stage of the project.

The *Contractor* completes the Technical Schedule and A & B for MV switchgear and describes any deviations from this Scope of Work in the deviation section of the respective Technical Schedule and A & B.

3.3 Management and Start Up

3.3.1 Configuration and Document Management

Information Requirements

The *Employer* requires drawings, documentation, plans, information, and data (collectively "Information") from the *Contractor* for various fundamental purposes including but not limited to the following:

a) Management and execution of the *works*

b) Installation and commissioning of the *works*

c) Technical support for the *works* during its entire operational phase until decommissioning and disposal

d) Operation and maintenance

The *Contractor* supplies, during the progress of and upon Completion of the *works*, the information called for in the Contract and or Works Information and all such information as may usually be supplied in connection with work similar in nature to the *works* and the interface and required integration of the *works* with the Plant provided and Material by Others including but not limited to all information necessary or useful for:

a) Design reviews and the interface management of the *works* with the overall project.

b) Quality assurance and control, construction, commissioning, testing, and setting to work of the *works*.

c) The operation, maintenance, support, inspection, integrity management, training, and technical optimization of the *works*, over the lifecycle thereof.

Same as otherwise provided for in the contract, information is supplied in such numbers and dispatched by such means as may be required by the *Employer*.

The *Contractor* makes available to the *Project Manager* as and when required, information necessary to enable the *Employer* to make and fit replacement parts.

3.4 Document Requirements

3.4.1 General

The *Contractor* complies with the requirements of the *Employer's* standard 240-83561037 Reporting Data Requirements Specification *Contractor*s, which forms part of these requirements, and the *Contractor* is deemed to be familiar with this document to understand the *Employer's* requirements.

These are the minimum requirements to be met.

Areas where details are not specified, they are proposed by the *Contractor* and subject to the *Project Manager's* acceptance.

3.4.2 Documentation Management

The documentation requirements cover the various engineering stages, from the design stage through fabrication, installation, testing and commissioning and most importantly for the operating, maintenance, and training stage of the *works*.

The *Contractor* is responsible for the compilation and the supply of the documentation for all systems during the various project stages in accordance with the VDSS. The VDSS documentation and drawings are programmed in the project schedule for delivery to align with the Key Dates.

The *Contractor* implements a document management system in compliance with ISO 9001:2008: Quality Management System-Requirements. In addition to ISO 9001:2008 the *Contractor* takes note of the *Employer's* Document and Record Management Procedure 240-53114186, compliance to this procedure is mandatory. The *Contractor's* document management system is implemented to ensure that:

- Correct document's metadata is captured.
- All documents can be traced and be accounted for.
- The documents are uniquely identified and their consistency with the physical configuration and design requirements maintained.
- The changes and modifications of the plant configuration conform to the documentation.
- Documents are periodically reviewed to confirm their continued suitability.
- The latest approved or appropriate, revisions of documents are used.
- Documents are properly stored to ensure easy accessibility and retrievability.

3.4.3 Formatting Requirements

a) Contract Documents

The *Contractor's* documents comply with the requirements of Technical Document and Record Management Work Instruction (240-76992014).

To portray a consistent image, it is important that all documents developed for the project follow the same standards of layout, style, and formatting.

- Layout and Typography

Every document complies with the following font specifications as per the Electronic Corporate Identity Manual on Eskom Intranet:

- Colour Specification: Black
- Main Headings Font Type: Arial, Bold, Capital Letters
- Main Heading Font Size: 12pt
- Sub Headings Font Type: Arial, Bold, Title Case
- Sub Headings Font Size: 11pt
- Body Font Type: Arial, Sentence Case i.e., only the first letter of the first word is a capital letter.
- Body Text Font size: 11pt
- Line Spacing: 1.5 line spacing
- Margins: standard (about 1 inch)
- Alignment: full justification to be used.
- Paragraphing: one line skip between paragraphs
- Pagination: centred page numbers (about 0.5 inches from bottom)
- Indentations: standard tab for all paragraphs (about 0.4 to 0.5 inches)

b) Data

The *Contractor* supplies the descriptive data including but not limited to equipment list, price schedules, and speciality item lists in MSExcel compatible to the *Employer's* latest version. Compliance to this requirement does not constitute compensation event. The aforementioned lists contain the following fields for each item as a minimum:

- functional location
- tag ID (consistent with customer specifications)
- description
- associated drawing and document names (that contain references to this item)

c) Drawings

The creation, issuing and control of Engineering Drawings is in accordance with the latest revision of engineering drawing Standard – Common Requirement (240-86973501).

The *Contractor* submits as minimum of one hardcopy and an electronic copy to the *Project Manager*.

The *Contractor* submits editable electronic drawings in MicroStation (DGN) format, and scanned drawings in PDF format. Drawings issued to the *Project Manager* must not be "Right Protected" or encrypted as the *Employer* must mdo the necessary configuration management on these documents upon receipt.

Electronic drawings must have a water mark indicating the approval phase of a drawing and hardcopies must be stamped to indicate the phase.

Any drawing requested by the *Project Manager*, which forms part of the works, does not constitute a compensation event.

d) Documentation Submission and Recording

The *Employer* provides a list of documentation to be submitted by the *Contractor*. The *Contractor* can only add to the list after agreement from the *Employer* is obtained.

Based on the list referred above, the *Contractor* develops a documentation deliverable schedule that is in line with the Key Dates.

The *Contractor* submits to the *Project Manager* a documentation deliverable Schedule for acceptance within one month of Contract Date. As a minimum, the Documentation deliverable schedule includes list of drawings and must have the following information:

a) Date of submission

b) Document description

c) Document Type

d) Revision number

e) Document Status

The schedule is updated and submitted to the *Project Manager* for review and acceptance as and when changes are effected.

After being informed of the decision to accept or reject the schedule, the *Contractor* revises and submits the updated schedule within 48hrs after being informed of the *Project Manager's* decision.

3.4.4 Minimum Requirements

The *Contractor* delivers all data, drawings, and documents generated in the *Contractor's* designed system of choice to the Project Manager in the following public domain formats:

a) Data:

The *Contractor* supplies the descriptive data such as equipment list, switchgear schedules, price schedules, speciality item lists and the like in Excel (MS Office 2003 or later compatible format) spreadsheets. All lists will contain the following fields for each item in the lists as a minimum, functional location/tag ID (consistent with customer specifications), description, associated drawing, and document names (that contain references to this item) and a minimum of 10 additional fields of data as directed by the Project Manager.

b) Drawings:

Drawings are delivered by the *Contractor* in digital format in DGN (version eight or later). These drawings contain sufficient graphical detail and engineering intelligence and are of proper configuration to allow the lists specified in the data deliverables to be digitally extracted. In addition, drawing lists are delivered in Excel format that contains the following fields: drawing named, drawing type, drawing description (consistent with customers checked by and up to five additional fields as per customer request.

c) Documents:

The *Contractor* delivers documents in electronic format (MS Office 2003 compatible or Adobe Acrobat pdf files). In addition, a document list is delivered by the *Contractor* in Excel format that contains the following fields: Document name, Document type, Version number, Date created, Created by.

The *Contractor* submits a soft copy in PDF format and 1 copy in native file format (for applicable design software) as per the VDSS. All design documentation is submitted before the commencement of construction. Red line drawings and documentation is also submitted prior to pre-commissioning to enable the *Employer* to perform the pre-commissioning design review as per the *Employer*'s design review procedure 240-53113685.

3.4.5 Digital Plant Data Drawings

Plant data and drawings in electronic (digital) format are supplied by the *Contractor* in the XMpLant format (an advanced XML based exchange format based on ISO 15926).

The *Contractor* delivers all data, drawings, and documents generated in the *Contractor*'s 3-D design system of choice to the *Project Manager* in the public domain format XMpLant. This deliverable contains sufficient graphical detail and engineering intelligence, are of proper configuration to be imported into the *Employer's* target PDS, retaining the full fidelity and intelligence found in the *Contractor's* design system.

3.4.6 Drawings Standard

The *Contractor* ensures that submitted drawings comply with the requirements of Engineering Drawing Standard – Common Requirement (240-86973501).

Drawing practice, formats, title blocks, and numbering conforms to the standards applicable for the Project and are to be agreed between the *Contractor* and the *Project Manager* during a kick-off meeting. Proposals are submitted to the *Project Manager* for review and acceptance.

3.4.7 Configuration Management

The *Contractor* employs a comprehensive configuration management program according to ISO 10007 to ensure that plant structures, components and computer software conform to approved design requirements.

As a minimum, the configuration management program shall include:

a) Plant Coding

b) Plant labelling

c) Engineering Change Management

In addition, the AS BUILT physical and functional characteristics of the works are accurately reflected in selected documents and databases, including those for design, procurement, construction, and operation, testing and training.

3.4.8 Engineering Change Management

The *Contractor* takes note of the *Employer*'s Engineering Change Procedure (240-53114026). Engineering changes includes any proposed change originating from engineering, *Contractor*s, project management or construction management.

The Engineering Change Procedure applies to the *Employer*'s personnel or *Contractor*'s performing engineering or engineering related work where the quality of the engineering work performed is the direct responsibility for the *Employer*.

3.4.9 Documentation Submission and Recording

The *Contractor* establishes a document tracking system to record the dates for the supply and receipt of all design drawings, calculations, and requests for information.

The *Contractor* submits to the *Project Manager* a document deliverable schedule within one month of the *starting date* of all documents for acceptance. This schedule provides individual titles of drawings and calculations, and their proposed submittal dates, for submittals as requested in the Works Information and as necessary for the review by the *Project Manager* of the proposed means of compliance by the *Contractor* with all aspects of the requirements of the contract. The scheduled date of first submittal, time allowed for acceptance and expected date of issue after acceptance will be shown for each drawing.

3.4.10 Design Schedule

The design schedule contains a full list of documents and drawings, their submission dates and duration for review as specified by the *Contractor* in the applicable VDSS. The schedule also illustrates the sequence of work for the project and the submission of drawings, studies, and reports.

The design schedule meets the requirements of the *Contractor* and Others engaged on the project. The *Contractor* is required to submit the schedule for review and acceptance by the *Project Manager*.

3.4.11 Training Workshops and Technology Transfer

The *Contractor* provides training on the *works* regarding operating, maintenance, and engineering aspects. The *Contractor* provides training material and a separate training course for operating, maintenance, and engineering personnel.

3.5 Engineering and the *Contractor*'s Design

3.5.1 *Employer*'s Design

The *Employer* will provide the following documentation/drawings for this SoW:

a) Existing Substation Layout.
b) Single Line Drawings
c) Updated Switchgear Schedule
d) Power cables details
e) Relevant Eskom Standards and Drawings
f) Schematic diagrams
g) Protection Function & Interface Block Diagrams
h) 300T Balancing Plant C&I Interface Signals

All *Employer* information and property made available to the *Contractor*, including the work done by the *Contractor* for the *Employer*, is confidential and may not be disclosed to anyone unless authorised by the *Project Manager*.

3.5.2 Parts of the works which the *Contractor* is to Design

The *Contractor* is responsible for the design of the following as a minimum:

a) Switchgear panels in accordance with:
    i. 240-82332407 and SANS 62271
    ii. Technical Schedule A and B
    iii. Switchgear Schedules
b) Layout of the switchboards and panels
c) Protection and control schemes in accordance with MV Switchgear schedule
d) Interlocking system in accordance with 240-82332407.
e) Power and control cabling
f) C&I interface to the 300T Balancing plant.

3.5.3 General Requirements

The *Contractor* designs MV switchgear that complies with 240-82332407 and this SoW. The *Contractor* completes Technical Schedule A and B to provide guarantees on the offered Plant concerned. The MV Switchgear must be of a type tested design as per SANS/IEC 62271-200 as a minimum.

The *Contractor* designs protection schemes that comply with all referenced applicable standards in this SoW. The *Contractor* completes Technical Schedule A and B to provide guarantees on the offered Plant.

The *Contractor* supplies, install, test and commission power and control cabling that compliles with 240-56227443 of this SoW. The voltage ratings, terminations, and joints for MV and LV cables shall be in accordance with 240-56227443 Generation Requirements for Control and Power Cables for Power Stations Standard (Rev 2). The *Contractor* cuts back the power cables, join and terminate into the Switchgear. Where a power cable is shorter than 10 metres, *Contractor* replaces the entire length. MV cables that have two joints or more will be completely replaced with a new XLPE cable.
No cutbacks and joining will be done for control and protection cables, i.e., replace the entire length of all protection and control/process cables.

The *Contractors* specifies the floor smoothness required by switchgear panels to ensure that their integrity is not compromised for the duration of its design life. The *Contractor* assesses in the substations and provides switchgear unit-struts and solution required for ensuring that the floor level is even and within the required tolerances.

The *Contractor* provides all the protection devices and auxiliary equipment required to perform the functions defined for the different protection schemes. Protection functions are numerical devices (IED's), and the logics are user configurable.

The *Contractor* designs a comprehensive protection scheme that defines the interfaces between all relays as well as the other related systems.

The *Contractor* makes provision for the supervision and indication of the status of wiring and signals from all the tripping relays to the external trip coils.

The designs of the protection schemes are presented in the form of Protection & Control Functional & Interface Diagrams and detailed design drawings together with the related documentation describing the functions of the different devices used.

Protection & Control Functional & Interface Block Diagrams should be developed according to the requirements in the standard for each scheme. All indicated optional functionalities are catered for and tendered for separately on an individual basis. Preliminary designs for the*PA1200 and *PA01000, schemes are required.

All IEDs are user configurable and pre-programmed with the respective logics that enable the protection scheme to comply with the specification as provided during the engineering phase. The programmable logics are also aligned with the relevant design drawings that define the functionality of the scheme. No logic programming is required after delivery of the equipment, but the application of conventional functional settings is necessary.

The *Contractor* supplies at least two licences for the software as a minimum for application of settings and for IED logics.

All IEDs and auxiliary relays provided by the *Contractor* are type tested by an independent laboratory and these results are made available to the Project Manager for evaluation and acceptance. In addition to independent laboratory tests, the protection and associated equipment offered are evaluated, tested and accepted by the Project Manager as per 240-56227589 and 240-143485806 prior to offer.

All IEDs, auxiliary relays and their modules have a proven service record of at least five years and a combined effective service life of one hundred years. An international and national relay reference sales list is provided by the *Contractor* with tender submission.

The *Contractor* provides the information regarding maintenance requirements of the electronic devices necessary to keep them in a condition where the protection functions are considered as adequate as described in the standard (240-143485806, page 11) and perfect working order or any other required intervention by the OEM, after the sale of equipment that has a financial impact on the *Employer*.

All future upgrades and modifications of the electronic devices are communicated timeously to the *Employer*. Any malfunction of the same device experienced by other users or known to the *Contractor* is communicated to the *Employer*.

3.5.4 Rating and Operating Conditions

a) Panel ratings are in Switchgear Schedules and Technical Schedule A and B.

b) Ratings for switching devices are in accordance with 240-82332407.

c) The system characteristics and operating conditions are stipulated in 240-82332407.

d) Switchgear operating and service conditions are also stipulated in 240-82332407.

3.5.5 Panel Design and Construction

Panel design and construction of the switchgear is as per 240-82332407. The switchgear is for indoor use, gas insulated, metal-enclosed and internal arc classified in accordance with SANS/IEC 62271-200 and relevant parts.

3.5.6 Special Consideration for Internal Arc Proof Design

The *Contractor* complies with the internal arc requirements according to 240-82332407. The following special requirements are considered:

a) If required, the *Contractor* determines the requirements for the openings on the substation walls for venting ducts.

b) These openings are adequate for the effective release of the gases and vapour from the substation when internal arcing occurs in accordance with 240-82332407.

c) The *Contractor* illustrates that the design of the venting systems caters for the effective release of pressurized gases during arcing conditions. Results from theoretical calculations and/or simulations done in this regard are provided to the *Employer* for acceptance.

Pressure relief flaps in a power compartment are designed such that the gasses are not directed to any other compartment during an internal arc fault. Each functional unit contains the arc without spreading it to any other functional unit. Due to the internal arc classification and for maintenance purposes, no VT or earthing device is installed within the pressure relief area on top of any functional unit.

3.5.7 Circuit Breakers

Circuit breakers are provided as per Switchgear Schedules and comply with 240-82332407.

3.5.8 Earthing Devices

The switchgear design includes busbar and cable earthing devices as an integral part of the associated functional unit as per Switchgear Schedules. The earthing devices are as per 240-82332407.

3.5.9 Accessories

Each functional unit is equipped with accessories to meet the design requirements and the accessories comply with 240-82332407.

3.5.10 Vermin and Fire Proofing

Access to seal the cable slots is provided from the front or rear of the factory-built panel to reduce the risk of spreading fire and prevent vermin from entering the switchboards. The *Contractor* provides and installs fire seal.

3.5.11 Removal of Existing Equipment

The existing panels and junction boxes no longer required on the plant are removed by the *Contractor*.

3.5.12 Padlocks

The *Employer* supplies all padlocks. All pad lockable devices, doors etc., can accept the *Employer's* standard padlock as specified in Schedule A. Sample of padlock used is provided by the *Supervisor* on request. Drawing 0.00/10344 shows the padlock in the closed position, the *Contractor* ensures adequate space is provided to insert the padlock into locking devices when in the open position.

3.5.13 Current and Voltage Transformers

The *Contractor* is responsible for designing and supplying all the required current and voltage transformers in the MV Switchgear.

3.6 Protection Requirements

3.6.1 Power Supplies

Auxiliary power for the protection systems will be provided from an external DC power supply system provided by the *Employer*. The nominal rating of the voltage supply will be 220V DC. IEDs, auxiliary relays and other DC equipment can operate continuously at extreme tolerances of the DC supply voltage, which is 220V DC ± 20%. The equipment is therefore capable of operating at either 176V or 264V continuously without detriment to the protection system.

All indications are non-volatile i.e., if the DC supply fails, then on restoration of the DC supply the indication resumes the status that it had before the supply failed.

3.7 Intelligent Electronic Devices

3.7.1 Design and Construction

The *Contractor* designs and provide Protection schemes for all the power circuits (i.e., incomers, feeders and others) consisting of IEDs constructed as a 19 inch rack mountable unit or according to *Contractor*'s standard arrangement. No terminals are provided on the 19 inch rack. According to the latest MV switchgear standard, wires to plant and material on swing doors are so arranged as to give a twisting motion and not a bending motion to wires. It is required that robust wiring looms at doors are used with clamps on both ends (Clamp on the door and a clamp inside the panel.

All IEDs are equipped with screen or display facility to allow for human interface. The contents are clearly visible from a distance of 2 m and at an angle of 30° from either side. This display is of the Liquid Crystal Display (LCD) with anti-glare and non-blinking properties. The IEDs display makes it possible for the mimic of the circuit protected by the device to be illustrated on the display. The mimic shows as a minimum the status of circuit breakers (ON or OFF), status of earth switches, position of circuit breaker (connected or disconnected) and electrical parameters (voltage, current, power, etc.) for a particular circuit. The mimic should also display an interlock on a device if present.

Provision is made for the local control of the breakers to be performed from the associated IED using an integrated control pad for local test purposes during maintenance only.

LEDs are required for indication of the operation of the alarm and protection functions within the IED and are an integral part of the device. The allocation of the LEDs to the different functionality is configurable to allow for flexibility during the engineering phase.

The devices are equipped with ports to allow for access to information via a communication link. These ports have the capacity that matches the data transfer requirements for the associated communication bus.

A label stating the firmware version is fixed to all IEDs. Information regarding the estimated data retention time of the storage medium used in the IEDs is provided to the *Employer*.

3.7.2 Functions

The protection, control, indication and data capturing functionalities are provided by the IEDs. All functions, settings and internal logic are programmable through the IED software and a personal computer (PC), except where otherwise stated.

The *Contractor* specifies and gives written details of protection functionalities that are inherently part of their IEDs but are not required by the performance specification.

A single IED is able to provide all the required main and back-up protection functions for the scheme in question as a minimum. The control and indication functions are also incorporated in the IEDs.

The integration of the auxiliary functions such as the DC Fail and Trip Circuit Supervision (TCS) functions within the device is compulsory. The IEDs have a self-monitoring function of both integral hardware and software that is done on a continuous basis. Any fault or irregularity is immediately alarmed to an output contact.

The random switching of the DC auxiliary supplies at high rate does not affect the functionality of the IED. Where required, the internal battery requirements for numerical IEDs (i.e. battery lifetime, type of battery etc.) is stated on a label attached to the front of the numerical device.

Unless otherwise specified, all IED are provided with manual-reset operation indicators for each function of the IED. These do not operate until the IEDs have operated. Resetting is accomplished without opening the case.

The IEDs have disturbance or event recording and data logging capability with the integral storage media. The information stored in the IED is accessible via the communication port. Information regarding the estimated data retention time of storage medium of the IEDs is provided to the *Employer*.

All IEDs have the capability to perform control, indication or monitoring, interlocking and data transfer functions via a communication bus. The IED's communication capability complies with IEC 61850 standard.

3.7.3 Software

Software installed on the IEDs for event or disturbance recordings, data logging, settings and marshalling or configuration is accessible via a dedicated communication link using engineering tools. This software allows information to be downloaded in COMTRADE format in accordance with IEEE C37.111-2013. All software required to perform the marshalling and settings of the IEDs is contained in one package.

The *Contractor* supplies evidence, on request, in the form of reports from a mutually acceptable third party that an adequate formal specification for the software has been produced at no additional cost. The specification is based on a requirement document and comprehensive risk analysis. The software is formally verified to ensure that it matches its specification.

All software purchased on this contract and subsequent software upgrades supports the latest Microsoft Windows operating system. The *Contractor* informs the *Employer* of all new releases. The latest software version is always compatible with the installed base of IEDs, which originally were compatible with the previous version of software that was compatible with the previous Microsoft Windows operating system. For example, if the existing software is only compatible with Windows 95, it is upgraded to Windows 10 (the latest Microsoft supported operating system).

All software and firmware are backward and forward compatible (i.e. the software on this contract is such that all future versions of software will be compatible with the installed base of IEDs).

3.7.4 Analogue Voltage and Current Inputs

The current inputs of the devices are rated at 1A. Where required, the voltage inputs are rated at 110V AC, unless otherwise stated.

The configuration of the inputs is programmable. The minimum number of inputs required is provided in the C&I Interface Signals for MV Switchgear.

3.7.5 Digital Inputs

The IED is also provided with the digital inputs for the control and indication functions as determined by the schemes.

The configuration of the inputs is programmable. The minimum number of inputs required is provided in the C&I Interface Signals for MV Switchgear.

3.7.6 Output Contacts

The *Contractor* designs all protection schemes such that all output contacts of the IEDs have self-resetting capabilities, except for those linked to master trip and lockout functions, which have manual-reset capabilities.

Each protection scheme has at least two output contacts for tripping. The IED is also provided with the digital outputs for the control and indication functions as determined by the schemes described.

The configuration of the device's outputs is programmable. The minimum number of outputs required is provided in the C&I Interface Signals for MV Switchgear. Where required, some of the trip, alarm and indication outputs are channelled via the communication ports.

DC Fail and under voltage protection functions are facilitated by normally closed contacts. All other relays have normally open contacts.

3.7.7 Testing of Devices

The *Contractor* submits certificates and report stating that protection devices offered have been subjected to routine and type tests which cover at least the tests recommended in standard 240-143485806. The program of routine and type tests is submitted to the Project Manager for acceptance.

Unless otherwise specified, all IEDs are provided with suitable test facilities for VT and CT circuits to enable tests carried out on the IEDs while in position inside the panel without disconnecting any wiring or links. Test facilities are provided in accordance with standard 240-143485806.

Two copies of all test certificates are submitted to the Project Manager for acceptance once the tests have been completed.

3.8 DC Fail Function

DC Fail function is provided to monitor the DC supplies of all the protection schemes at the last supply point. This functionality can either be incorporated in the IED, if a separate power supply is available, or a dedicated auxiliary relay.

The function allows for operating on loss of DC voltage. Alarm output signal is also transmitted to the DCS system and indicated on the IED, if separate suppliers are used.

Conveyor belts are critical safety circuits. The preferred method to trip from the belt protection system and emergency trip (pull wire, green wire) are with a separate no volt trip coil. This no volt trip coil is inherent part of the circuit breaker. The supply for this no-volt trip coil (de-energise to trip) is from the control and/or belt protection system. This trip is monitored by the IED and must be user configurable to be used as a re-enforced trip also and start for the breaker fail function.

In an event when the substation battery charger fails and the DC decay slowly, the circuit breaker must be tripped before the IED switch off, possibly mal-operated and the voltage level are not sufficient to operate the trip coil (energised to trip). Tripping is required when the DC control voltage decays to 70%.

The design of the DC monitoring and tripping functionality is dependable on the installed amount and type hardware trip coils. The trip coils redundancy is described in the standard (240-143485806, point 3.2.2.2). There is a possibility of 3 different trip configurations. The final design must be accepted by Eskom.

3.9 Design Acceptance and Type Testing

3.9.1 Type Testing

The *Contractor* offers type tested functional units. The type tests and special tests are carried out on all types of functional units in accordance with 240-82332407 and IEC 62271-200.

The *Contractor* provides the relevant certificates and test reports to prove the compliance with 240-82332407 and populating Appendix J.

3.9.2 Routine Tests

Routine tests are done by the accredited test authority in accordance to 240-82332407. The performance of the switchgear and controlgear as well as the associated protection schemes is proven to comply with the technical requirements stipulated in this SoW.

Two copies of the final routine test reports for each functional unit of the Plant are provided by the *Contractor* not later than the delivery date of the Plant.

3.9.3 Components Acceptance

All active components of the Plant that do not form part of the OEM's original design are subject to acceptance by the *Employer*. The component complies with the relevant requirements of this Works Information as a minimum.

Where required, the *Contractor* provides calculations to prove the component application, design, and compliance to the requirements. The relevant schematic drawings are used for the acceptance of component application. Should the requirements not meet the component application design requirement, the additional cost is borne by the *Contractor*.

The *Contractor* provides original copies of the technical documentation of each component in a file complete with contents list as well as all calculations or justification per component. The *Contractor* submits two copies of files labelled Components Acceptance Application in this regard.

3.9.4 Detail Design Freeze

After Contract Date, the *Contractor* performs Detail Design in accordance to *Employer's* requirements presented by Typical Schematic Diagrams. The designs are agreed with the *Employer* to achieve Design Freeze status.

The *Contractor* submits the following data in neat files for acceptance by the *Project Manager* before the Design Freeze status can be declared as a minimum:

a) Technical Schedules A and B

b) Engineering Change Register

c) Single Line Diagrams for Switchboards

d) General Arrangement Drawings

e) Substation Layout

f) Switchgear Schedules

g) Protection Functional and Interface Block Diagrams

h) Schematic Diagrams for Protection and Control Systems

i) Component Schedules

j) Technical Manuals

The Employer will accept the following set of drawings, per board, before any manufacturing can take place:

a) General arrangement drawings for each switchboard;

b) Switchgear schedule for each board with reference to component schedule;

c) Schematic diagrams for each circuit (this must include all the wire numbers, termination numbers, termination strip numbers, fuse sizes and spare contacts);

d) Component schedule for each circuit on the ASSEMBLY;

For non-standard circuits i.e., incomer, the *Contractor* discusses the requirements with the *Project Manager* and work out a suitable design which the *Contractor* submits for acceptance.

3.10 Manufacturing Release

The *Employer* accepts the set of drawings before any manufacturing can take place.

The *Employer* accepts the set of drawings for bus zone protection panel before any manufacturing can take place.

3.11 Inter Posing Relays

The *Contractor* is responsible for supplying interposing relays. The 24V DC interposing relay will be used to control the breaker from the Control room (Plant PLC).

3.12 Procedure for Submission and Acceptance of *Contractor*'s Design

3.12.1 Design Review Procedure

The *Contractor* is the Design Authority as defined in the Design Review Procedure (240-53113685). The *Contractor* is responsible for following this design procedure and conduct all the design reviews as specified in this procedure. The *Contractor* is responsible for conducting the following design reviews:

a) Design Freeze Review

b) Integrated Design Review

c) Construction Completion Review

d) Acceptance Testing Review

3.12.2 Engineering Change Procedure

The *Contractor* takes note of the *Employer's* Engineering Change Procedure (240-53114026). Engineering changes includes any proposed change originating from engineering, *Contractor*s, project management or construction management.

The Engineering Change Procedure applies to the *Employer's* personnel or *Contractor's* performing engineering or engineering related work where the quality of the engineering work performed is the direct responsibility for the *Employer*.

3.12.3 Process for Submission of Documents

The *Contractor* submits all documents according to the accepted VDSS. The process for the submission of documents is described below:

a) The *Contractor* submits the documents/drawings to the *Project Manager*.

b) The *Employer's* Document Controller registers the documents.

c) The *Employer's* Document Controller will supply the documents/drawings to all relevant parties within the *Employer's* project team.

d) The *Employer's* project team reviews the documents/drawings and will submit all comments or inputs to the *Project Manager* and the *Project Manager* submits to the *Contractor* for consideration.

e) If the *Employer* finds major deficiencies in the submitted documents/drawings, the *Contractor* revises the documents/drawings and resubmits to the *Project Manager*.

f) The *Employer* reviews the documents/drawings and if no major deficiencies are found, the *Contractor* organises a Design Review session.

g) The *Employer* and the *Contractor* conduct a Design Review.

h) If any fundamental errors were found in the designs or further actions are required, the *Contractor* records all concerns raised and revises the designs.

i) The *Contractor* organises a Design Review session once all designs were revised according to the concerns raised by the *Employer*.

j) If no fundamental errors were found in the designs during the Design Review session, the *Contractor* compiles the Design Review minutes or report and submits it to the *Project Manager*.

k) The *Employer's* Document Controller registers the report.

l) The *Employer's* project team reviews the *Contractor's* report/minutes. If the report/minutes are not acceptable, the *Contractor* revises the report/minutes and resubmits to the *Project Manager*.

m) The *Project Manager* will accept the *Contractor's* design once the report/minutes are accepted by the *Employer's* project team.

3.12.4 Time Requires for Acceptance of Designs

Not later than one month after receipt, the *Project Manager* will return one copy of the drawing marked "Accepted"; "Accepted as Noted" or "Not Accepted", as may be appropriate. The notations "Accepted" and "Accepted as Noted" authorize the *Contractor* to proceed with the manufacture of the Plant covered by such drawings subject to the corrections, if any, indicated thereon. Where prints or drawings have been "Not Accepted" or "Accepted as Noted" the *Contractor* makes the necessary revisions on the drawings and submit further copies for acceptance in the same procedure as for the original submission of drawings. Every revision shows by number, date, and subject in the revision block on the drawing.

3.13 Other Requirements of the *Contractor's* Design

3.13.1 System Interface

The *Contractor* is responsible for all system interfaces which forms part of the works. The *Employer* will provide the relevant information defining the system interfaces. The *Contractor* caters for all the identified interfaces.

3.13.2 Equipment Layout

All panels are installed at least 800mm from the wall. A space of at least 2m (or breaker length plus 800mm) is allowed between the switchgear panel and any other positioned in front. The distance between the adjacent (i.e., side-ways) switchboards and associated panels is at least 2m.

The *Employer* will provide the existing substation layouts. The *Contractor* is responsible for the as built substation layouts after the Plant is installed.

The *Contractor* is responsible for the final positioning of the Plant. The *Contractor* assesses any possible clashes with the existing structures and equipment in the substations. The *Contractor* notifies the Project Manager of any possible clashes before the Plant is delivered to site.

3.13.3 Instrument Transformers for Metering Systems

The *Contractor* specifies (with the exclusion of the accuracy class and quantity) and supplies all the required metering current transformers and voltage transformers in accordance with the switchgear schedules.

3.13.4 Current Transformers

The *Contractor* provides the calibration certificates for the metering CTs (where efficiency is also determined) from an accredited SANAS laboratory in accordance with SANS/IEC/ISO 17025. The certificates include the test results for accuracy through the load range and the applicable range of burden.

3.13.5 Voltage Transformers

The *Contractor* provides the calibration certificates for the metering VTs from an accredited SANAS laboratory in accordance to SANS/IEC/ISO 17025. The certificates include the test results for accuracy through the load range and the applicable range of burden. Accuracy results are given for a burden of 75% of rating at unity power factor.

3.13.6 Substation room floor

The *Contractor* is responsible for levelling of the MV switchgear room floors to meet the floor level requirement of the new switchgear. The *Contractor* assesses the substation floor prior to levelling and submits a detailed report of the findings to the *Project Manager* for acceptance. If the substation floor is found to be outside the requirement of the equipment to be installed, the *Contactor* corrects the floor level by use of steel unistruts. The floor levelling unistruts designs for all substations are submitted to the *Project Manager* for acceptance.

3.14 Equipment Required to be Included in the *works*

3.14.1 Circuit Breaker Trolley

The *Contractor* provides circuit breaker trolley for each type of circuit breaker provided.

Circuit breaker trolley wheels do not damage any painted substation floors when the circuit breaker is moved away from the panel. Circuit breaker trolley wheels are lockable by hand. Wheel surface material is provided with the tender.

3.14.2 Access Ladders

The access ladder to be provided for the MV switchboard.

3.14.3 Operating and Maintenance Tools

The *Contractor* provides any special maintenance tools and equipment for the switchgear as per 240-82332407, the *Contractor* also supplies the necessary toolbox for the storage of the tools. The numbers of operating and maintenance tool sets are specified in Schedule A.

Any special tools or keys that may be required for maintenance or for adjustments are provided by the *Contractor*. Handling equipment is provided to facilitate the removal from the housing of the withdrawable devices weighing more than 25kg unless the device carriage itself is designed for the duty.

3.15 Works and Things for the *works* Supplied by the *Employer* Others

3.15.1 Supervisor and Responsible Persons Course

The *Contractor* appoints two people to attend necessary training intervention or course provided by the *Employer* for authorisation to take out a work permit. No work will commence without an authorised Supervisor and Responsible Person/s in accordance with Generation Plant Safety Regulations (240-150642762) on site. The authorisation process will take at least two weeks.

3.15.2 DC Power Supplies

The *Contractor* provides the *Employer* with a detailed power supply requirements/ electrical consumption equipment lists for all the *works*.

3.16 As-built Drawings, Operating Manuals and Maintenance Schedules

a) Language

All documentation, including reports, manuals, etc is in the English language.

b) Type Test Reports

Type test reports represent the design of the functional unit with respect to the configuration, type and rating. The information to be included in type test reports is in accordance with IEC 62271-200. The report of the type tested functional unit and associated components reflects the equipment under consideration. The type test report is provided in full, containing all records of the tests conducted as well as the drawings. Softcopies are provided for all type test documentation.

c) Manuals

The technical, training, maintenance and operating manuals are provided for each type (e.g., for different ratings, voltage levels etc.) of a functional unit. Technical manuals include all technical data, information on the switchgear construction as well as the technical data and leaflets of each individual component used in the switchgear provided. Where generic manuals are provided, an addendum is provided indicating the applicable project specific components.

Manuals are of a good quality and cover the following as a minimum:

i. Technical descriptions of the equipment and component parts
ii. General arrangement drawings
iii. Installation instructions with drawings or pictures
iv. Operating and maintenance instructions for all components
v. Detailed parts lists (accompanied by exploded view type drawings clearly detailing the part and uniquely identifying it)
vi. Spare part ordering instructions

Any special instructions pertaining to storage of spare parts, or their shelf life is included in the maintenance manual. All drawings requested for component location, dismantling and re-assembly for maintenance are included in the maintenance manual. All special tools required for operating and maintenance of the equipment are presented in a form of a schedule in the operating and maintenance manual, respectively. The content of the training manual is based on the content of the technical, operating and maintenance manuals.

3.16.1 Drawing Requirements

The *Contractor* provides drawings for the required equipment as per 240-82332407 clause 3.11.4. The *Employer* provides typical drawings for tender purposes only and will form the basis for the design and formatting.

The *Contractor* supplies reproducible drawings according to the applicable VDSS. The *Contractor* develops the following minimum requirements for the drawings:

a) Drawing Numbering System

The following Eskom drawing numbering system is proposed for the new MV Switchgear drawings. The *Contractor* may assign his own drawing number as required to meet his document control system requirements:

Table 1: The proposed drawing numbering system

Sheet number		
A-F	*Contractor*	Cover Sheet
G-Z	*Employer*	Cover Sheet
1-30	*Employer*	Switchgear Schedule
31-40	*Contractor*	Summary Sheet
41-49	*Contractor*	Bus Wiring Arrangement
50-55	*Contractor*	General Arrangement Drawing
56-100	*Contractor*	Schematic Drawings
101-199	*Employer*	Cable Block Diagram
200-299	*Employer*	Cable Schedule
300-399	*Employer*	Cable termination Drawings

400-499	*Employer*	Schematic Drawings

The number of each switchboard drawing shall be noted on the single line drawing for easy referencing.

b) General Arrangement Drawings

The *Contractor* provides general arrangement drawings completely dimensioned, showing:

a) Arrangement of equipment offered.
b) Plant, front view, and other elevation views.
c) Required clearances for opening doors and for removing breakers.
d) Conduit or cable entrance locations for bottom entrance.
e) Venting duct arrangement and opening requirements (if required).
f) Busbar locations and configurations.
g) Incoming and outgoing cable termination positions.
h) The height of all cable glands above floor level.
i) Instrument transformers (i.e., VT's and CT's) physical positions.
j) Position of control panels and associated relays and IED's.
k) Position of earth switches.
l) Terminal block locations.
m) Earthing connections.
n) Mass of equipment. Individual mass of stationary units and breakers, if transported separately.
o) Details and position of the holding down bolts.

c) Schematic Drawings

The *Employer* provides typical functional protection and control block diagrams in the Referenced Documents of Part 1B, which will have to be used as guidelines for the development of schematic drawings for the protection, control, and monitoring schemes. Schematic diagrams provided by the *Contractor* will show the following:

I. All protection and control devices and their contacts, each of which are labelled with its correct ANSI device function number, or reference.
II. Device terminal numbers, terminal block numbers and terminal numbers.

III. All internal interconnections, bus wiring, inter-panel wiring and connections to external equipment such as Control and Instrumentation (C&I) panel.

IV. All control and protection switches

V. Power supply connections

d) Wiring Diagrams

The *Contractor* provides detailed wiring diagrams to show the following:

I. Approximate physical locations of all items in each control panel.

II. All interconnecting wiring between control panels.

III. Identification of all terminals, terminal blocks, and wires by numbers.

IV. Clear identification, by some distinguishing method, of all wiring which will be installed by the *Contractor*. This will include, but not be limited to, leads from external current transformers, trip circuits from remote devices, auxiliary contacts to remote devices, incoming dc control power, and separate incoming ac power. This also includes spare auxiliary contacts and relay contacts which are wired to terminal blocks for future use.

e) Single-Line Functional Diagrams

The *Contractor* provides single line diagrams for each circuit to illustrate the functionality and interfaces between protection, control, and metering systems. Such a diagram will show the following:

I. All power circuit equipment and their descriptions including type and specifications.

II. Electrical connections of instrument transformers (i.e., VTs and CTs) with relation to the cabling of protected Plant.

III. Details of the instrument transformers

IV. Protection devices and the description of functions provided with their ANSI device numbers.

V. Protection scheme

VI. Metering points

VII. Tripping and control (including interlocking logic)

3.16.2 Operating and Maintenance Manual

The *Contractor* provides operating and maintenance manuals as per the requirements stipulated in Technical Schedule A and B in Appendix B. The manuals comply with 240-82332407.

The procedures are provided by the original equipment manufacturer detailing descriptions of the maintenance work in accordance with IEC 62271-1. The procedure covers the requirements for maintenance of the equipment over the design life.

3.16.3 Maintenance Schedule

The *Contractor* ensures that the MV Switchgear design and construction and component selection is such that maintenance interval is 6 years or more.

The equipment of the same rating should be fully interchangeable to allow for low inventory and reduced down-times.

The *Contractor* ensures that the equipment offered as well as the MV Switchgear offered have a production lifetime for at least 15 years after Contract Date (this excludes production for spares only). The equipment and MV Switchgear supplied are the same over the *works*.

The *Contractor* provides a maintenance schedule. The maintenance schedule provided is for the switchgear life expectancy of 30 years. The *Contractor* also makes provision for maintenance spares during the life expectancy of the equipment.

3.17 Plant and Materials

3.17.1 Quality

All Plant and Materials are new, unused, and free from defects and imperfections.

The *Contractor* will not use Plant or Materials which are generally recognised as being unsuitable or otherwise to be avoided for the purpose for which they are intended.

Only components of high reliability will be utilised, with a proven operating history, to enable the Plant to achieve required reliability and availability. Plant and Material design, engineering and manufacture will accord with the best modern practice applicable to high-grade products of the type to be furnished, so as to ensure the efficiency and reliability of the works and the strength and suitability of the various parts for the works.

Plant and Materials withstands ambient conditions and the variations of temperature arising under working conditions without distortion, deterioration, or undue strains in any part.

All parts are made accurately, and where practicable, to standard gauges to facilitate replacement and repairs. Like parts are interchangeable.

No repair of defective Plant and/or Materials will be permitted without the *Project Manager's* approval and any such repair, if approved, will be carried out to the satisfaction of the *Employer*.

The *Contractor* ensures that co-ordinated and formally documented management system is in place for the assurance of quality as specified in ISO 9001, Quality management Systems – Requirements.

The *Project Manager* is free to specify hold and witness points during the installation and on-site testing stages of the project. The *Contractor* issues preliminary notification of such hold and witness points by fifteen working days advance notice to the *Project Manager* and confirms such hold and witness points at least seven days prior to the activity.

Typical holding points are listed below:

a) Type Testing Approval
b) Design Review
c) FAT
d) Delivery to Site
e) Erection
f) SAT
g) All manuals and drawings (in the specified format)
h) Commissioning

In addition to maintaining appropriate inspection and test records to substantiate conformance to requirements, the following records are safely stored for a minimum period of seven years following the final completion of the *works*:

a) Construction, layout and component approvals
b) Type and routine test certificates
c) Construction drawings and approvals

After this period, the *Contractor* offers these records to the *Project Manager* (in writing) and obtains a disposal instruction.

Documentation regarding quality procedures is submitted within thirty days of the Contract Date. The *Project Manager* will review and comment on the acceptability of these documents in a time frame as per the requirements of the contract for contractual correspondence. If controlled copies of these documents have been submitted to the *Project Manager*, then the controlled copy numbers may be quoted in the submission.
This quality management philosophy is developed from the basis that manufacturers produce quality products, *Employer's* design engineers ensure quality, the *Employer's* quality inspectors and/or third-party inspectors verify quality, and the project team monitors quality. All the parties involved are contracted according to this principle.

The *Employer's* design engineers control the entire product quality assurance process and produce a plan through which they ensure the quality of engineering deliverables, equipment and ultimately the related plants. Product quality control plans are produced by the *Contractor* or manufacturer which indicate the level of product quality control to be applied. These plans are reviewed by the *Employer's* engineers together with the quality team. The project team monitors that these plans are being implemented and that it is yielding the expected results through process and product verifications.

Monitoring means the minimum number of activities through which the project team assures itself that the *Contractor's* delivers engineering deliverables, equipment, and the plant to the required quality.

All the work is done in accordance with the quality management system of Matimba Power Station as set out in the quality manual, in addition to the ISO 9001:2008 quality management system, as well as Eskom Quality Standard QM 58. High quality standards are also assured by conforming, but not limited, to the following:

a) The use of sound design and engineering principles,
b) The design process uses a good performance and functional specification,
c) It is ensured that the installation conforms to the works information,
d) Design review procedure is followed
e) Engineering change procedure
f) Electrical asset creation process
g) QA/QC on project (manufacturing, installation, commissioning)

3.17.2 *Contractor's* Procurement of Plant and Materials

The functional unit is suitable for handling and removal by providing mechanism for crane hooks. The functional unit is suitable for handling and removal by providing mechanism to avoid damage to the functional unit. During transportation the electrical components are packaged in such a way that damage is prevented. Components of the functional unit that are transported separately are marked accordingly and are easily identifiable.

The *Contractor* supplies the labelling for the Plant that forms part of the *works*. The *Contractor* provides labels for the MV Switchgear according to 0.00/10343 and 240-82332407. The *Employer* provides the labels' description to the *Contractor* design and install.

The labels are affixed in such a way that they are easily legible and not obstructed by the wiring or by other components.

Clamping methods applied to the labels ensures that removal of the labels requires force. The *Contractor* submits the proposed method of clamping to the *Project Manager* acceptance prior to use.

The *Contractor* supplies the *Project Manager*, for verification and acceptance purposes, with a label list showing the text only. The *Project Manager* will indicate acceptance of the positioning and designation of labels.

The KKS codes are used accordingly on documentation (e.g., drawings, manuals, equipment lists, cable schedules etc.) as a unique identification means. References to plant are accompanied by the relevant KKS code for that item of plant.

Abbreviations to descriptions on the labels are generally not acceptable. Where abbreviations are unavoidable, due to the limited number of characters that can be engraved/etched on labels, the abbreviations are submitted to the *Project Manager* for acceptance. The *Contractor* makes use of the *Employer's* Standard Plant Related Abbreviations for Inter-System Use.

3.17.3 Spares and Consumables

Development of the Plant and Materials is not considered complete until the *Contractor* has provided a comprehensive list of spares to be held in stock which, at minimum, include one of each of the different rectifier and controller modules, auxiliary relays, MCBs, switches, lamps as well as empty sub-racks, plugs and sockets and consumable items, if any.

The *Contractor* provides as part of the tender proposal, a recommended parts list as well as a proposal for the execution there of.

The *Contractor* prices each spare item individually in the price schedule and the lists include a description of the item, a reference number, and the pricing details.

The *Employer* is responsible for purchasing of recommended spares.

The *Contractor* is responsible for ensuring that consignment spares are available when required.

All spares are delivered in approved packaging suitable for storing such parts over a period of ten (10) years without damage or deterioration.

Each recommended spare part is uniquely identified with a part number, which can be cross referenced to a parts list and associated drawing.

The *Employer* prefers that support from the OEM is available locally in South Africa. The *Contractor* is required to keep high-cost items such as circuit breakers, contactors, and voltage transformers in stock for 24 hours delivery on demand, and to provide technical and product support for the design life of the new switchgear.

Spare rectifiers and controller modules are available for a period of at least 10 years after the delivery of the last unit to the *Employer.*

3.18 Tests and Inspections before Delivery

The *Employer* carries out quality inspections at his discretion.

All inspections and testing to be performed in accordance with the Quality Control Procedure (QCP) developed by the *Contractor*.

3.18.1 Factory Acceptance and Testing (FAT)

The *Employer* will inspect and test some parts of the Plant at the manufacturer's premises before dispatch, where required. The *Contractor* advises on a period required for the inspection and testing activities of part of the Plant. The *Supervisor* then advice on the parts of Plant and Materials he/she needs to inspect and/or test and the *Contractor* makes allowance in the delivery time to cater for this requirement.

The *Contractor* supplies a detailed procedure that is used for Factory Acceptance Testing (FAT) to be accepted by *Project Manager*, 30 calendar days prior to starting date of the first FAT. The *Contractor* gives the *Supervisor* at least 14 calendar days' notice of the date on which any panel is ready for inspection and testing.

Notwithstanding the routine tests specified in 240-82332407 and 240-56227443, the following tests and checks are conducted by the *Contractor* as a minimum:

a) Visual inspections to verify the mechanical and/or physical integrity of the Plant as well as specifications of the major and/or active components.

b) Dielectric test of current transformers, voltage transformers, auxiliary wiring, and control circuitry.

c) Current transformer test to prove the ratio, polarity, resistance, and magnetising curves. Check the nameplates and connections.

d) Voltage transformer test to prove the ratio and polarity. Check the nameplates and connections.

e) Functional circuit breaker and motor switching device tests to check operation of auxiliary contacts, relay coils, trip and close circuitry, spring rewind motor and circuitry and the indication circuitry. Checks include MCB ratings, labelling, ferrule numbers, crimping and tightness of all connections including lugs.

f) Checking mechanical tripping and closing devices, mechanical spring rewind and all mechanical interlocks.

g) Manual electrical operation test of the circuit breakers and motor switching devices including checks of electrical interlocks (if applicable). The test is conducted at the maximum, nominal and minimum voltages.

h) Verification of the functionality of the different circuit protection schemes integrated in the switchboards. The verification to include continuity checks on the circuits.

i) Verification of the functionality of the different components and systems measurements and metering panels.

The *Supervisor* reserves the right to conduct testing of any motor switching device or circuit breaker at his discretion.

3.18.2 Factory Inspection and Clearance for Dispatch

The *Supervisor* will inspect switchboards or panels forming part of the Plant before they are released from the *Contractor's* premises. This inspection entails a thorough check to ensure complete compliance with this specification including schedules, design drawings and other applicable standards.

The *Contractor* obtains clearance from the Supervisor before dispatching of the Plant. This factory release inspection and clearances provided by the *Employer* do not release the *Contractor* of any of his obligations under the contract.

No Plant will be released for dispatch without the AS MANUFACTURED documentation and drawings accompanying them.

3.19 *Contractor's* Equipment (Including Temporary Works)

The *Contractor* supplies, installs, maintains, and removes all temporary construction facilities and utilities necessary to provide the *works*.

3.20 Construction

3.20.1 Commissioning

The *Contractor* provides the *Employer* with the following documents a minimum of two (2) calendar weeks before the date of commissioning:

- erection completion certificate handed to the *Project Manager*,
- the dates of the tests listed in paragraph a-k below.

The *Employer* elects as his sole discretion to attend the tests listed in paragraphs a-k below. The *Contractor* conducts, amongst others, the following tests, and checks for the *Employer* to allow commissioning to occur as part of his commissioning or Site Acceptance Testing (SAT) once the erection of the Plant on site has been completed (erection completion certificate handed to the *Project* Manager):

a) Adjustment setting, operational checking and electrical injection testing of each relay, functional unit, circuit, and accessory prior to installation of cables.

b) Check for any visual damage to the circuit breakers, current transformers, bushings/insulators, instruments, switches, auxiliary relays, and all other equipment.

c) Check tightness (torque where applicable) on all connections.

d) Power frequency voltage test.

e) Check the continuity of all current transformer and voltage transformer loops.

f) Check the fixing and locking devices on doors and covers.

g) Repetition of all functional tests (i.e., mechanical, electrical and automation functions) on some parts of the Plant as done in the *Contractor's* premises. The *Employer* will use his own prerogative to determine the need for such tests.

h) Check the operation of all mechanical/manual devices for racking, earthing and spring rewind.

i) Verify the operation of the interlocking system

j) Any other tests and checks required in terms of the *Contractor*'s interface, alignment and compatibility obligations and requirements.

k) any other tests and checks specified in the *Contractor*'s Works Information; any other tests and checks required by Best Industry Practice.

The *Contractor* compiles a report regarding the above tests and checks as well as any other tests and checks required to enable the *Employer* to confirm commissioning of the works. The *Contractor* submits such report to the *Employer* a minimum of two (2) calendar weeks prior to the commissioning date. The *Contractor* makes such amendments to the report as required by the *Project Manager* which requirement is not a compensation event.

The *Employer* conducts his own erection and commissioning checks to ensure conformance with the contract. These checks do not release the *Contractor* of his obligation to ensure conformance compliance with the contract.

The *Contractor*'s failure to ensure compliance with all the pre-requisites for the *Employer* to allow commissioning to proceed will entitle the *Employer* to claim all damages arising from or in connection with this breach, including damages suffered by Others.

The *Contractor* conducts the following tests for the *Employer* to certify that commissioning has occurred in accordance with the contract requirements:

a) Any tests required in terms of the *Contractor*'s interface, alignment and compatibility obligations and requirements.

b) any tests specified in the *Contractor*'s Works Information.

c) any tests and required by Best Industry Practice commissioning to occur:

Upon completion of commissioning, the *Contractor* provides AS BUILT drawings incorporating the changes arising from or in relation to commissioning within 14 calendar days.

The *Contractor* provides supervision and all necessary resources during the erection, installation, site testing and commissioning of the Works.

Records are to be kept of each SAT in a logbook defining the tests to be undertaken, time and date of the commencement of the test, duration of the test, criteria that need to be met and results entered of the tests. These records are submitted to the *Project Manager*.

In the event of an error of any test (hardware/software) the fault is logged and analyzed. The *Project Manager* determines if the item is of a minor nature. The *Contractor* is allowed to rectify the fault and the item re-tested for the full duration.

3.21 Start-Up Procedures Required to put the *works* into Operation

The *Contractor* gives the *Project Manager* written notice that the works are ready for energization. Such notice will suit the requirements of the *Employer* but will not, unless otherwise agreed, be less than 48 hours or more than fourteen (14) calendar days.

No alterations or adjustments will be made to the *works* after functional checks are complete without the *Project Manager's* written permission.

At this stage the following must have been achieved:

a) Installation and pre-commissioning completed.

b) Testing report and the associated certificates received by the *Employer*.

c) Signed erection and safety clearance certificates.

d) Final Draft of the Technical, Operating, Maintenance manuals delivered.

e) All Quality Control Plan (QCP) documentation received.

3.21.1 Performance Tests after Completion

The Supervisor is available during functional checks at the commissioning stage of the works done by Others.

3.21.2 Training and Technology Transfer

The *Contractor* provides training on the Plant, equipment and systems included as part of the *Works* to the various categories of the *Employer's* technical staff (operators, maintenance, and engineering personnel) for the duration of the *works*.

Training provided by the *Contractor* is directly applicable to the actual equipment *supplied* for the works. Generalised training based on similar equipment is not acceptable. Training will be both theoretical and practical.

The facilities for training provided by the *Employer* are a suitably sized air-conditioned room, as well as trainee and trainer desks, an overhead projector and flipchart or white board. The number of personnel to be trained is as specified in all Technical Schedule A appendices of this Works Information.

The *Contractor* submits to the *Project Manager* for acceptance a detailed training programme as well as a prospectus for each course. Course material is provided for the number of trainees as per Schedule A. The *Contractor* provides electronic and hard copies of the training material to the *Project Manager*, these copies are also sufficient for the training attendees.

The training schedule is incorporated in the Accepted Programme.

Practical hands-on training for each individual trainee forms an integral part of each of the following courses:

a) Training of Maintenance Personnel

Maintenance personnel are trained in all components and functions of the Plant i.e., method of maintenance, fault finding, correction, routine maintenance (frequency and methods of lubrication). Training will include familiarisation with documentation (maintenance plan, procedures etc.), hardware familiarisation, and hardware maintenance, maintenance of protection, control, and instrumentation. Maintenance training is provided prior to the old installed equipment being de-energised.

b) Training of Maintenance Operators

Operators are trained and declared competent on the manufacturer's new systems prior to the old installed equipment being de-energised. This will include familiarisation with documentation including drawing configuration logic, as well as operator interface familiarisation e.g., operational functions, alarms etc.

The *Contractor* makes provision for training of all operators, for every shift on the unit, station, and outside plant boards.

c) Engineering Training

Formal engineering training will be provided on basic Plant design, capabilities, and procedures upfront, prior to design freeze. Thereafter, training will be on-job training throughout the design process. The overview design and control/interface functions will be covered by this training. The engineering team should be trained sufficiently to enable them to work as part of the implementation team on and off site. Engineering training includes training on all protection schemes offered, prior to FAT of the first switchboards.

d) Trainee Participants

The number of participants that are to be trained is as indicated in Technical Schedule A of the relevant Appendices for each part of this Works Information. The *Employer* bears the cost of salaries, accommodation, travelling expenses and other allowances of his personnel during the training, but all other training costs are borne by the *Contractor*. The trainee participants will be certified and declared competent by the *Contractor* on the new systems after completion of the training.

e) Training Documentation

The *Contractor* provides all course material including manuals in accordance with the requirements of the OPS 0002. The course material is in English and includes all third-party documentation.

A copy of the training documentation is supplied for each trainee with an additional 3 master sets for the *Employer's* library and training department.

The training dates are included and shown in the Accepted Programme. The supply of drafts, pre-print proofs and printed copies of training documentation is planned by the *Contractor* in such a way that the required training is complete before commissioning of the first unit commences.

Training manuals are continuously updated by the *Contractor* up to the date of issue of the Defects Certificate for the whole of the *works*.

f) Training, Maintenance and Operating (TMO) Manual

Instruction manuals comply with the requirements laid down in OPS 0002. The number of copies is as specified in Technical Schedule A of the relevant Appendices for each Part of this Works Information. The *Contractor* provides the electronic and hard copies of the manuals prior to delivery of the Plant.

g) Specialised Training for Protection

The *Contractor* makes provision for specialised training in the use of the systems and components of the protection for *Employer's* personnel. This training covers engineering (e.g., design, configuration etc.), commissioning, maintenance, and application of the systems.

A recommended course structure, period, and price per week of training is provided by the *Contractor* for review by the *Employer*. The price quoted assumes that the *Contractor* provides the venue, scheme (including protection devices) and tutors.

3.21.3 Operational Maintenance after Completion

The maintenance of the equipment is the responsibility of the *Employer* and does not form part of the *works* and the cost of such maintenance does not form part of the works. If the works does not meet the mean time between failure ratios, the *Contractor* is liable for all costs associated with remedying the works and ensuring that the mean time between failure ratios are achieved.

The *Contractor* provides rates prices in the Rates Price Schedule for provision of operating and maintenance training as described above.

3.22 List of Reference Procedures, Standards and Specifications

- The *Contractor* complies with all standards, specifications and regulations contained in 240-82332407.
- Appendix A: 6.6kV Balancing Plant switchgear schedule rev 1
- Appendix B: 6.6kV Balancing Plant switchgear Technical schedule A&B.
- Appendix C: 300T Balancing Switchgear Layout 2 (Drawing 13.25/ABC).
- Appendix D: Single Line Diagram.
- Appendix F: Transformer feeder 1 and 2.
- Appendix G: Transformer feeders 3 5 6 and 7.
- Appendix H: General Arrangement.
- Appendix I: Transformer Feeder breaker and Incomer breaker IO Block

The *Employer* provides all his/her standard documents with the [enquiry], unless stated otherwise in the Scope of Work. All other standards and references are to be obtained by the *Contractor*.

4. Authorisation

This document has been seen and accepted by:

Name & Surname	Designation

5. Revisions

Date	Rev.	Compiler	Remarks
March 2024	0.1	D. Monyane	Draft document for review
August 2024	0.2	D. Monyane	First Draft review
October 2024	0.3	D. Monyane	Final draft review
October 2024	1	D. Monyane	Final document for publication and authorisation

6. Development team

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

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