PART 3: SCOPE OF WORK

Document reference	Title	No of pages
	This cover page	1
C3.1	*Employer*'s Works Information	145
C3.2	*Contractor*'s Works Information	0
	Total number of pages	146

TABLE OF CONTENTS

Table of figures

Tables

1. INTRODUCTION

Matimba Power Station has been in operation since 1987 and is in Limpopo province, South Africa. It is a base load power station with 6 units, each capable of producing 615 MW to the Eskom national grid. The switchgear that is currently installed is metal clad switchgear and is not internal arc classified as this was not a requirement at the time when the existing switchgear was designed.

The Power Station has several areas in which the installed equipment is obsolete, nearing obsolescence or does not meet the requirements for safety of personnel. This is posing a growing risk on the sustained production capabilities of the Power Station. It is expected that as the equipment ages, plant performance will deteriorate until a stage where it is necessary to shut units down.

The Power Station, therefore, requires major refurbishment of the Switchgear to maintain the Power Station's ability to produce electricity safely, reliably and within the legislative requirements.

The project scope is highlighted in this Works Information and describes the *Employer's* requirements for new medium voltage switchgear (Part 1A), protection schemes (Part 1B), Substation Automation System (SAS) (Part 1C) and Control & Instrumentation (C&I) interface scope (Part 1D) at the Power Station.

Part 1A of the Works Information covers all the requirements for new internal arc classified Medium Voltage (MV) switchgear that is required for the Power Station. The MV switchgear includes Air Insulated Switchgear (AIS) and Gas Insulated Switchgear (GIS). Part 1A also highlights the requirements for project management, quality management, safety, engineering, procurement, and construction.

Part 1B of the Works Information covers the requirements for the protection devices and the different protection schemes and the quantities required. This part also covers the signals that need to be catered for on the new MV switchgear that will be sent to the Distributed Control System (DCS). Part 1B also highlights the scope of work to be executed by the *Contractor*, for Others.

Part 1C of the Works Information covers the requirements for the SAS. This system is required to interface with several existing electrical systems at the Power Station for monitoring and control purposes. This system will be used mainly for the control of the electrical reticulation at the Power Station. The *Contractor's* Intelligent Electronic Devices (IEDs) will also be configured via this system.

Part 1D of the Works Information covers the requirements for interfacing the MV switchgear project to the Control & Instrumentation systems. This part is inclusive of the control system interface to the new MV switchgear on the Common Plant. The requirements for EOD with regards to ergonomics, interface to the PIS and interface to the station clock are discussed in this part of the Works Information.

2. DEFINITIONS AND ABBREVIATIONS

2.1 DEFINITIONS

The definitions of IEC 60694, IEC 62271, 240-56227573 and the standards referred to by this Works Information apply, as well as the ones listed below. Some of the definitions are repeated in this Works Information for ease of reference.

Definition	Explanation
3rd party system	All equipment that is interfaced to the proposed Substation Automation System as well as the Common Plant MV process switchgear, see "C&I Systems".
Acceptance	The Employer accept the condition or design but does not take responsibility from the Contractor
Automation Network	The network via which communication between the control system servers and automation units occur.
Buffer zone	The "neutral zone" in the demilitarized zones (DMZ) between the C&I system and open 3rd party systems.
C&I Systems	The term C&I systems when used applies to the following systems: - Unit Process Automation System used to monitor the Unitised Mechanical and Electrical plant areas. This System will be installed during the same outage as this project. - Plant Information System used for data archiving purposes. Common Plant Control System
Closed 3rd party system	Any network, system, computer, or component with neither connections nor interfaces to any external system other than the C&I system.
Common Plant	The station power supply system that is intended for all non-unit auxiliary plant (i.e., plant outside the turbine and boilers houses)
Conduit	A pipe or enclosure through which cables are conveyed.
Cyber Security	Security measures implemented to protect the C&I system and all associated components from unauthorised access or attack.
Disconnected position	Position of the withdrawable part of the switchgear in which an isolating distance or segregation is established in the withdrawable part, that part remaining mechanically attached to the enclosure.
Drives	Drives are all mechanical or electrical prime movers, e.g., actuators, pumps, etc.
Equipment	Plant and Material.
Exhaust duct	The duct that is used to evacuate gasses generated during an internal arc to a separate environment (e.g., to the outside of the room). This duct is found at the top of the enclosure and connected to the explosion vent.
ESKOM Standards	Means all Eskom standard documents referred to, expressly or impliedly, in the Contract
Field Cabling	All cabling between field devices and the first junction and/or splitter box.

GPS Time Sync System	A complete GPS based time synchronisation system used to synchronise the entire C&I system, as well as other third-party systems, according to the local time offset with relation to GPS time.
Hard copy	A laser colour printed document appropriately labelled, numbered, and filed.
High Availability	An availability of 99,999% or better. This translates into downtime – including both scheduled and unscheduled maintenance – of less than 5 minutes per year.
Input/Output Devices of a Workstation	The keyboards, screens, and mouse.
IT Peripherals	Include Screens, Keyboard, Mouse and KVM module.
KVM Module	A device or set of devices that allows the input/output devices of a workstation to be remotely accessed.
Network Cabling	All the cabling that forms part of the automation network, operating & engineering network, and common network.
Open 3rd party system	Any network, system, computer or component with a connection or interface to an external system other than the C&I system.
Operating Screen	Display screens used in the operator workstations.
Operator System	The system via which the C&I system is operated and monitored.
Operator Workstation	The primary interface of the operating plant personnel. It is the computer via which the HMI is accessed with the specified number of operating screens and pointing devices.
PIS User Interface	The human interface via which the information stored in the PIS database(s) is accessed and manipulated.
PIS Client	A computer on the Station LAN via which the PIS User Interface is accessed. The computer uses Microsoft Windows XP or a later operating system.
PIS Database(s)	The database(s) which contain all plant information stored by the PIS.
Plant	ALL equipment forming part of the works including Medium Voltage Switchgear and Controlgear, Protection Schemes, Substation Automation System, Essential supplies (DC and UPS) and Control and Instrumentation Interface.
Plant Area	A specific plant area refers to one of the six Unit Plants, see ‘Unit’.
Plant Information	All information from the Power Station.
Power Station	Matimba Power Station.
Power Station C&I System	The C&I system consists of the unit C&I systems, the Common C&I System, and the common power distribution system.
Power Supply Cabling	All the cabling to power field devices.
Process Automation System	The primary system via which the Unit is controlled.
Project	Matimba MV/LV Switchgear Replacement Project
Radiation Areas	Areas where radiation tests are performed.

Service or connected position	Position of the removable part in which it is fully connected for its use.
Site	Within the boundaries of the Power Station.
Soft copy	An electronic of software file in the software format specified in Appendix 01.
Specification	The document/s forming part of the contract in which the methods of executing the various items of work to be done is described, as well as the nature and quality of the materials to be supplied and it includes technical schedules and drawings attached thereto as well as all samples and patterns.
Station LAN	Station wide Eskom Business LAN at the Power station. The Station LAN lies outside the C&I system and is an open 3rd party system.
Switchgear	Refers to the switchgear and controlgear assembly; in cases where the term is used alone.
Tag	Any analogue signal, binary signal, event originating from field equipment, or signals created by the control system.
Tag Name	An alphanumeric code that is unique to a tag.
Trunking	A rigid structure supporting a number of cables.
Trunk Cabling	All the cabling between the junction boxes and the automation system(s)
Unit	Boiler, Turbine, generator, cooling system, precipitator and including all auxiliary plant and systems associated with the particular unit.
Works Information	The document(s) forming part of the contract in which are described the methods of executing the various items of work to be done, and the nature and quality of the materials to be supplied and includes technical schedules and drawings attached thereto as well as all samples and patterns.

2.2 ABBREVIATIONS

Abbreviation	Description
%	Percentage
24/7	24 hours a day, 7 days a week
AC	Alternating Current
AFC	Approved for Construction
AFLR	Classification A – Front, Lateral, Rear
AI	Analogue Inputs
AIS	Air Insulated Switchgear
AMS	Alarm Management System
AO	Analogue Outputs
BIL	Basic Impulse Level
BI	Binary Inputs
BO	Binary Outputs
BoP	Balance of Plant / Outside Plant
BS	British Standards
BTU	Battery Tripping Unit
C&I	Control & Instrumentation
COC	Certificate of Compliance
COMTRADE	Common Format for Transient Data Exchange
CT	Current Transformer
DC	Direct Current
DCF	Direct Current Failure
DCS	Distributed Control System
DIN	German Specification
DVD	Digital Video Disk
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EOD	Electrical Operating Desk
EWS	Engineering Workstation
FAT	Factory Acceptance Testing
GIS	Gas Insulated Switchgear
GOOSE	Generic Object-Oriented Substation Events
GPS	Global Positioning System

Abbreviation	Description
HMI	Human Machine Interface
HRC	High Rupturing Capacity
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
I/O	Input / Output
IAC	Internal Arc Classified
IDMTL	Inverse Definite Minimum Time Lag
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IP	Ingress Protection
IPC	Interposing Close
IPO	Interposing Open
ISO	International Organisation for Standardisation
kA	kilo Ampere
KKS	Kraftwerk Kennzeichen System
kV	kilo Volt
LAN	Local Area Network
LAR	Limited Access Register
LCD	Liquid Crystal Display
LSC	Loss of Service Condition
LV	Low Voltage
m	meter
mcb	Miniature Circuit breaker
MCR	Maximum Continuous Rating
MIE	Master Installation Electrician
mm	Milli meters
ms	Milli seconds
MTBF	Mean Time Between Failures
MTTF	Mean Time to Failures
MW	Megawatt
MV	Medium Voltage
NTP	Network Time Protocol
OEM	Original Equipment Manufacturer

Abbreviation	Description
OHS Act	Occupational Health and Safety Act
OWS	Operating Workstation
PC	Personal Computer
PM	Partition Class
PIS	Plant Information System
PRD	Pressure Relief Device
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
QMP	Quality Management Programme
QoS	Quality of Supply
RAM	Reliability, Availability, Maintainability
RMU	Ring Main Unit
RTU	Remote Terminal Unit (i.e., substation processors)
rms	Root mean square
SABS	South African Bureau of Standards
SANAS	South African National Accreditation System
SANS	South African National Standards
SAS	Substation Automation System
SAT	Site Acceptance Testing
SCADA	Supervisory Control and Data Acquisition
SCL	Substation Configuration Language
SF_6	Sulphur Hexafluoride Gas
SHEQ	Safety Health Environment and Quality
SNTP	Simple Network Time Protocol
TCS	Trip Circuit Supervision
TMO	Training, Maintenance and Operating
UPS	Uninterruptable Power Supply
V	Voltage
VDSS	Vendor Document Submittal Schedule
VLAN	Virtual Local Area Network
VT	Voltage Transformer

Abbreviation	Description
WBS	Work Breakdown Structure

3. PART 1A: MV SWITCHGEAR - DESCRIPTION OF THE WORKS

3.1 *EMPLOYER'S* OBJECTIVES AND PURPOSE OF THE *WORKS*

One of the Employer's objectives and purpose of the works is to replace all MV switchgear at the Power Station; the list of switchgear to be replaced is presented in Appendix A1. Because of the replacement of the MV switchgear certain associated equipment as set out in Parts 1B, 1C and 1D must also be replaced. The following is a record of the replacement/equipment/systems that are required:

a) Replacement of the existing MV switchgear (as listed in Appendix A1) 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 designed life span of 30 years.

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

c) Provision of SAS to facilitate implementation of communication, interlocking, monitoring and control of electrical reticulation, enhance and speed up diagnosis of plant errors.

d) Provision for the Control & Instrumentation (C&I) interface to the new MV switchgear on the Common Plant, EOD with regards to ergonomics and interface to the station clock.

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:

MV switchgear (Parts 1A, 1B and 1C)

a) Metal enclosed air insulated switchgear and controlgear
b) Metal enclosed gas insulated switchgear and controlgear
c) Exhaust ducts
d) Switchgear unit struts for floor levelling
e) Protection schemes to be installed on switchgear panels (Part 1B)
f) Stand-alone buszone panels (Part 1B)
g) Substation Automation System including stand-alone cubicles (Part 1C)

C&I (Part 1D)

a) Interface hardware
b) Cables
c) All software, license, and copyright agreements for the *works*

The *Contractor* performs the mounting of protection equipment, the wiring of the relays and control circuits on the MV switchgear as specified in Part 1B. The *Employer* provides the typical functional protection and interface block diagrams as presented in Appendix B2.

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.

The *Contractor* supplies all IEDs in accordance with Appendix B3 of the Works Information.

Disconnection and removal of the existing power and control cabling from the MV switchgear and the removal of switchgear from the respective substations listed in Appendix A5 & A6 is not part of this Works and will be carried out by Others. 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 Others. The contractor to advise on the termination details required for all the cabling interfaces.

The *Contractor* designs the C&I interface in accordance with part 1D of this Works Information. In Part 1D, the *Contractor's* activities include the decommissioning, removal, and disposal of the existing C&I interface infrastructure to a designated area (to be advised by the *Employer*).

The *Contractor* is responsible for the marking of the substation floor for additional cable entry holes. The drilling of holes on the floor and sealing of the holes that becomes redundant is the responsibility of Others.

The *Contractor* provides engineering, operating and maintenance training on the Plant (as detailed in this Works Information) in accordance with the part specific Vendor Document Submittal Schedule (VDSS). The *Contractor* provides the documentation as per the requirements set out in the applicable VDSS. The VDSS for Part 1A is in Appendix A8. 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 Compliance Schedule in Appendix A13, B1, and C1 and describes any deviations from this Works Information in the comments section of the respective Compliance schedules.

The *Contractor* provides the current transformers for differential protection on the neutral or star side of the motors/diesel generators larger than 1MW for installation on the motors/diesel generators by Others.

3.3 MANAGEMENT AND START-UP

3.3.1 Management meetings

3.3.1.1 Meetings shall be held monthly between the Project Manager and the Contractor (and any other co-opted members). The Contractor is represented at each meeting by the appropriate members of the staff.

3.3.1.2 The venue for these meetings is as determined by the Project Manager. The minutes of the meeting are recorded in writing.

3.3.1.3 Any action of the Project Manager and the Contractor implied in the minutes of meetings with contractual implications is confirmed by a separate communication given in accordance with this Works Information and the NEC3 ECC

3.3.1.4 The Contractor reports the overall progress and as a minimum requirement, the following is addressed:

- Contractor's current activity progress and planned finish dates.
- Health, safety, and quality Management.
- Technical or commercial issues.
- Interfaces with Others
- Problem areas or concerns.

3.3.1.5 Regular meetings of a general nature may be convened and chaired by the Project Manager as follows:

Title and purpose	**Frequency**	**Location**	**Attendance by:**
Overall contract progress and feedback (from contract date to execution commencement)	Weekly during outages or as determined by the *Project Manager*	Venue determined by the *Project Manager*	*Employer*, *Contractor,* and Others as determined by the *Project Manager*
Planning Meetings (Including integration meetings with Others)	Weekly during outages or as determined by the *Project Manager*	Venue determined by the *Project Manager*	*Employer*, *Contractor*, Planners and Others as determined by the *Project Manager*
Employer's Outage Feedback Meetings during outages	Daily or as determined by the *Employer*	Venue determined by the *Employer*	*Employer, Contractor* and Others as determined by the *Project Manager*

3.3.1.6 Meetings of a specialist nature may be convened as specified elsewhere in this Works Information or if not so specified by persons and at times and locations to suit the Parties, the nature and the progress of the works. Records of these meetings shall be submitted to the Project Manager by the person convening the meeting within five days of the meeting.

3.3.1.7 All meetings shall be recorded using minutes or a register prepared and circulated by the person who convened the meeting. Such minutes or register shall not be used for the purpose of confirming actions or instructions under the contract as these shall be done separately by the person identified in the conditions of contract to carry out such actions or instructions.

3.4 CONFIGURATION AND DOCUMENT MANAGEMENT

3.4.1 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*.

3.4.2 Document Management

All documents supplied by the Contractor are to be subject to Eskom's approval. The language of all documentation is to be in English. All documentation is to be controlled and managed in accordance with the following procedures:

- Document and Records Management Procedure (32-6).
- Document Management System 240-154220175
- Records Management 240-146112094

3.4.3 Document Identification

The *Contractor* is required to submit the Vendor Document Submission Schedule (VDSS) as per agreed dates to the delegated *Employer's* Representative. *Employer* will allocate document numbers on the VDSS and send back to the *Contractor* through the delegated *Employer's* Representative. The VDSS is revisable and changes must be discussed and agreed upon by all parties. Changes in the VDSS can be additional documentation to be submitted, changes in submission dates or corrections in documentation descriptions, document numbers, etc. The *Contractor's* VDSS is to indicate the format of documents to be submitted.

3.4.4 Document Submission

All project documents must be submitted to the delegated *Employer's* Representative with transmittal note according to Project / Plant Specific Technical Documents and Records Management Work Instruction (240-76992014). In order to portray a consistent image it is important that all documents used within the project follow the same standards of layout, style and formatting as described in the Work Instruction. The *Contractor* is required to submit documents as electronic using SharePoint transmittal and hard copies and both copies must be delivered to the *Employer's* Representative.

In addition, the *Contractor* is to be provided with the following standards which must be adhered to:

- Project Plant Specific Technical Documents - Handover Works Instruction 240-124341168
- Project Documentation Deliverable Requirement Specification 240-65459834
- Technical Documentation Classification and Designation Standard 240-54179170
- Project/ Plant Specific Technical Documents and Records Management Work Instruction 240-76992014

The *Contractor* list all project soft copies and hard copies for submittal on the transmittal with the following metadata fields, use *Employer's* transmittal template (240-71448626):

a) Title of the document
b) Document unique identification number
c) Revision number
d) Name of discipline
e) Reason for issuing/submission
f) Sender's details
g) Sent date
h) Recipient's details
i) Date received
j) Quantity of documentation referenced on the transmittal
k) Number of copies
l) Format/medium submitted (e.g. paper,USB Stick, etc)
m) Sender signature
n) Recipient signature, once submitted, to acknowledged receipt

The format of the final documentation handover will be specified in the Vendor Document Submittal Schedule. The Vendor Documentation Submittal Schedule (VDSS) specifies the following:

a) The limits of supply of the documentation, i.e., whether the documentation is provided / maintained by the *Contractor* or the *Employer*.
b) The type of documentation provided.
c) The software format (where applicable) in which the documentation is provided.
d) The stage in the project execution during which the documentation is provided as a deliverable.
e) The *Contractor* is to be responsible for planning the supply of the documentation during the various project stages and to provide the documentation in accordance with the Vendor Documentation Submittal Schedule (VDSS).

The documents are to be submitted to the Eskom Representative accompanied by the Transmittal Note. The *Contractor* submits all documentation to the Eskom Representative as well as the Project's Documentation Centre in the following media:

3.4.4.1 Bulk Submission

Electronic copies large for transmitting via SharePoint (>700MB) will be delivered on USB Stick, large file transfer protocol and/or hard drives to the Project Documentation Centre. For bulk document submission, the following link can be used https://zendto.eskom.co.za/

3.4.4.2 Emails and Other Submission Methods

Electronic copies will be submitted to Eskom Documentation Centre via the project mailbox that will be set up for the project.

Where applicable and contractually agreed, e-mail submissions can be used, as well as other submission methods employed in the relevant project.

3.4.4.3 Hard Copies

Two hard copies of documents are to be submitted to the *Employer's* Representative accompanied by the document transmittal.

a) Drawings

The creation, issuing and control of all Engineering Drawings will be in accordance to the latest revision of engineering drawing Standard 240-86973501. Drawings issued to Eskom will be a minimum of two hardcopies and an electronic copy that is editable. The *Contractor* is required to submit electronic drawings in Micro Station (DGN) format, and scanned drawings in pdf format. No drawings in TIFF, AUTOCAD or any other electronic format will be accepted. Drawings issued to Eskom may not be "Right Protected" or encrypted. The *Employer* reserves the right to use these drawings to meet other contractual obligations. The *Contractor* is to include the *Employer's* drawing number in the drawing title block. Drawing numbers will be assigned by the *Employer* as drawings are developed.

The *Contractor* submits all drawings in accordance with the requirements stipulated in the *Employers* Engineering Drawing Standard 240-8673501. Manufacturing of the equipment commences when drawings are accepted for construction, by the *Employer*. Two paper print, editable native CAD format (.dgn) and in .pdf format of each drawing are submitted to the *Employer* for acceptance as per agreed schedule before manufacturing of equipment commences, by the *Contractor*.

The *Contractor* submits a 3D Model in DGN format. The structure of the 3D model is to be according to the Plant Breakdown Structure. The 3D model is to clearly indicate all interfaces.

The *Contractor* submits all relevant drawings, documents, and design information for approval before commencing any work. After the *Employer* accepts the drawings and design and designs freeze has been established, the Contractor is required to follow the Project Engineering Change Management for any changes on baselined drawings.

The *Contractor* is responsible for any error or deficiency in any drawings or documents supplied by him and for any loss, damage or expense arising out of such error or deficiency, notwithstanding that such drawing or document may have been accepted by the *Project Manager*.

Drawings are submitted to *Employer* in editable native CAD format (.dgn) and in .pdf format, after commissioning of the equipment. The drawings reflect any changes made during commissioning and are submitted as "As built" drawings.

The *Contractor* notes that all General Arrangement (GA) and detailed manufacturing and erection drawings become the property of the *Employer*. The *Employer* is permitted to purchase replacement parts off these drawings from the lowest cost suppliers.

3.4.5 Drawing 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 *Contracto*r and the *Project Manager* during a kick-off meeting. Proposals are submitted to the *Project Manager* for review and acceptance.

3.4.6 CONFIGURATION MANAGEMENT

The *Contractor* to provide the *Employer* with the Configuration management plan to elaborate on how the configuration management activities will be implemented for the duration of the project.

3.4.6.1 Plant Coding

All plant, material, equipment, and documentation supplied will be codified as per the current plant coding applied in existing system.

KKS Coding and labelling of all Plant & Materials and documentation supplied is part of the Works and is the responsibility of the *Contractor* and shall be done in accordance with KKS Coding standard 240-54179170". The *Employer* shall supply the *Contractor* with the level 1 KKS codes. It is the responsibility of the *Contractor* to populate the level 2 and 3 components, before any KKS coding is to be undertaken.

The *Contractor* to submit equipment list and the drawings when they request of level 1 codes from the *Employer*.

The *Contractor* is responsible for coding the components inside the panels, if applicable. The *Contractor* consistently applies the KKS codes throughout the rest of the technical documentation, including:

1. Load schedules
2. Board parts lists
3. Cable block diagram
4. Termination diagram
5. Drive and actuator schedules
6. Instrument schedules
7. Alarm lists, loop diagrams

8. Signal lists
9. Schematic diagrams
10. Logic diagrams
11. Equipment list
12. P&ID
13. Single line
14. General arrangement

As a bases for plant coding any changes and additions are communicated with both the *Employer* and the *Contractor*.

The *contractor* shall submit the KKS code to the *Employer* for the review and approval of all coding work before the implementation stages and provide guidance where necessary. The *Employer* may “Accept”; “Accept with Comments” or “Reject”. If required.

Plant codification for new equipment will be done according to the following:

- 240-93576498 KKS Coding Standard
- 240-109607736 KKS Key Part Standard

3.4.6.2 Plant Labelling

All labels that are required under the project scope will be provided by the *Contractor*. This will include the manufacturing and installation.

The C*ontractor* shall submit the equipment list using the template that *Employer* will provide.

Labels will be manufactured and installed according to the following:

- 240-71432150 Plant Labelling Standard.
- 240-109607332 Eskom Plant Labelling Abbreviation Standard.

All labelling in accordance with the “Red Zone” classification philosophy of Matimba Power Station procedure.

All the labelling and inscriptions shall be to the Matimba Technical Specification for KKS Labels 240-164249072 and shall be submitted for acceptance by the *Project Manager* prior to label manufacture (wording of all labels and inscriptions as well as the prototype labels).

3.4.7 Change Management

All Design change management is to be performed in line with the Eskom Project Engineering Change Management Procedure 240-53114026 and the *Employer* ensures that *Contractor* is provided with latest revisions of this procedure. Any uncertainty regarding this procedure is to be clarified with the *Employer* and clarification updates should be reflected in updated versions of this procedure.

3.4.8 Design Review Documentation

The *Contractor* conducts design reviews as per the Employer’s Designs Review Procedure (240-53113685). The *Employer* may “Accept”; “Accept with Comments” or “Not Accepted”. If required, the *Contractor* makes the necessary revisions on the documentation and ensures acceptance is obtained from *Employer*. The *Contractor* includes these design reviews as part of the schedule and suggests appropriate timing for such reviews.

3.5 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. For more detailed requirements on the training required refer to Section 3.29.2 of this Works Information.

3.6 ENGINEERING AND THE *CONTRACTOR'S* DESIGN

3.6.1 *Employer's* Design

The *Employer* will provide the following documentation/drawings for parts 1A, 1B and 1C of this Works Information:

a) Existing and Proposed Substation Layouts
b) Updated Single Line Drawings
c)Updated Switchgear Schedules
d) SAS Concept Design
e) Relevant Eskom Specifications and Drawings
f) Matimba C&I Interface Signals
g) Applicable Internal Standards

Other documentation/drawings being provided by the *Employer* are listed in the sections of the respective Parts (B-D) of this Works Information document.

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*.

3.7 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. 240-56227573 and SANS 62271
    ii. Technical Schedule A and B
    iii. Switchgear Schedules
b) Layout of the switchboards and panels
c) Arc ducting layouts
d) Protection and control schemes in accordance with Part 1B
e) Interlocking system in accordance with 240-56227573
f) Substation Automation System in accordance with Part 1C
g) C&I interface in accordance with Part 1D.

3.7.1 General

The *Contractor* completes the Compliance Schedule in Appendix A14 in accordance with 240-56227573. The *Contractor* describes and provides reasons for any deviations from 240-56227573 in the Compliance Schedule.

The *Contractor* designs MV switchgear that complies with 240-56227573 and Part 1A of this Works Information. The *Contractor* completes Technical Schedule A and B in Appendix A2 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 Part 1B of this Works Information. The *Contractor* completes Technical Schedule A and B in Appendix B2 to provide guarantees on the offered Plant.

The *Contractor* designs Substation Automation System that complies with Part 1C of this Works Information. The *Contractor* completes Technical Schedule A and B in Appendix C2 to provide guarantees on the offered Plant.

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 levels for the purpose on installation.

3.7.2 Rating and Operating Conditions

a) Panel ratings are in Switchgear Schedules in Appendix A4 and Technical Schedule A and B in Appendix A2.
b) Ratings for switching devices are in accordance with 240-56227573 and 240-82332407.
c) The system characteristics and operating conditions are stipulated in 240-56227573 and 240-82332407.
d) Switchgear operating and service conditions are also stipulated in 240-56227573 and 240-82332407.

3.7.3 Panel Design and Construction

Panel design and construction of the switchgear is as per 240-56227573 and 240-82332407. The switchgear is for indoor use, air and gas insulated, metal-enclosed and internal arc classified in accordance with IEC 62271-200.

3.7.4 Special Consideration for Internal Arc Proof Design

The *Contractor* complies with the internal arc requirements according to 240-56227573 and 240-82332407. The switchgear is for indoor use, air and gas insulated, metal-enclosed and internal arc classified in accordance with IEC 62271-200.

3.7.5 Circuit Breakers

Circuit breakers are provided as per Switchgear Schedules in Appendix A4 and comply with 240-56227573 and 240-82332407.

3.7.6 Earthing Devices

The switchgear design includes busbar and cable earthing devices as an integral part of the associated functional unit as per Switchgear Schedules in Appendix A4. The earthing devices are as per 240-56227573 and 240-82332407.

3.7.7 Accessories

Each functional unit is equipped with accessories to meet the design requirements and the accessories comply with 240-56227573 and 240-82332407.

3.8 DESIGN ACCEPTANCE AND TYPE TESTING

3.8.1 Type Testing

The type tests and special tests are carried out on all types of functional units in accordance with 240-56227573, 240-82332407 and SANS/IEC 62271-200.

The *Contractor* provides the relevant certificates and test reports to prove the compliance with 240-56227573 and 240-82332407. The minimum requirements for the type tests applicable on MV Switchgear are provided in Schedule C of 240-56227573 (Including requirements for Gas Insulated Switchgear). The *Contractor* completes Technical Schedule C in Appendix A7.

The *Contractor* offers MV Switchgear that is similar to the type of functional unit tested. If any functional component of the MV Switchgear differs from the one described in the type test certificates/ reports, the components will be subject to re-testing before approval by the *Project Manager*. The conditions (i.e., panel configuration, number of tests to be done, etc.) under which the type tests are performed will be agreed between the test authority, *Employer* and *Contractor*.

The *Employer* will accept the type testing before the *Contractor* starts with the manufacturing of the first switchboard.

3.8.2 Special Test – Open LV Door Compartment

The requirements for special test are contained in 240-56227573.

3.8.3 Routine Tests

Routine tests are done by the accredited test authority in accordance with 240-56227573 and 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 Works Information.

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.

3.8.4 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 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) Compliance Schedules
c) Engineering Change Register
d) Single Line Diagrams for Switchboards
e) General Arrangement Drawings
f) Substation Layouts

g) Switchgear Schedules
h) Protection Functional and Interface Block Diagrams
i) Schematic Diagrams for Protection and Control Systems
j) Component Schedules
k) Technical Manuals
l) Architecture of SAS
m) Site Layout indicating Cable Routing for SAS
n) Cable Block Diagram for SAS
o) Accepted Prototype/ Training Switchboard

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, chop-over, the *Contractor* discusses the requirements with the *Project Manager* and work out a suitable design which the *Contractor* submits for acceptance.

3.9.1 Design Prototype/ Training Switchboard Acceptance

The *Contractor* designs, manufactures and tests one complete prototype switchboard as per Switchgear Schedule in Appendix A4 after Contract Date. The prototype switchboard complies fully with this Works Information.

The prototype switchboard is designed and manufactured within six months from Contract Date.

The following data must be submitted before any manufacturing on the prototype switchboard can start:

a) List of components used on the prototype switchboard.
b) Technical Manuals.
c) Type Test Certificate of all active components. If evidence is available of type tests already made on similar component, this may, subject to the *Project Manager's* approval, be acceptable in lieu of the relevant tests.
d) Type Test Certificates and Reports
e) General Arrangement of the prototype switchboard.
f) Schematic Diagrams of the prototype switchboard.
g) Bus wiring Diagrams of the prototype switchboard.
h) Protection and Control Logic Diagrams
i) Switchgear Schedule of the prototype switchboard
j) Component Schedule for each circuit used on prototype switchboard.

After the completion of the manufacturing of the prototype switchboard, they are tested in accordance with the required routine tests specified in 240-56227573. The test requirements are agreed between the *Employer* and the *Contractor*. All tests and results are documented and signed by the *Project Manager* and the *Contractor*.

A technical manual for each design prototype switchboard is prepared after the completion of the tests. The manual contains the information on the switchboard as listed above, the test reports as well as photos of the construction, layout, and wiring of the switchboard. This information is used as a reference for further manufacturing. The prototype switchboard remains at the *Contractor's* local (in RSA) facilities for training purposes during the Contract Period.

After the Contract Period the *Contractor* transports the prototype switchboard to Site where it is installed and tested. The installation place of the prototype switchboard is advised by the *Project Manager*.

3.10 MANUFACTURING RELEASE

The prototype switchboard is inspected and tested for acceptance by the *Employer* before the manufacturing process of the switchboards can start.

The *Employer* accepts the set of drawings, per board, as per schedule in Section 3.9 of Part 1A before any manufacturing can take place.

The *Employer* accepts the set of drawings, per bus zone protection panel, as per schedule in Section 3.9 of Part 1A before any manufacturing can take place.

The *Employer* accepts the set of drawings, per SAS cubicle, as per schedule in Section 3.9 of Part 1A before any manufacturing can take place.

3.11 SWITCHGEAR ROOMS

The following general requirements applies with regards to switchgear rooms:

a) The design layout indicating the recommended height, position with respect to switchgear location and size of the venting ducts is provided to the *Employer* for review.
b) The IP rating of the vents is IP41 in accordance with IEC 60529.
c) The cable entry openings do not jeopardise the integrity of the substation floor. The *Contractor* provides the details of the weight and dimensions of the switchboards offered to the *Employer* for review (which includes the centre of gravity).
d) Cable entry and arc ducting requirements is checked against the structural design of the rooms to avoid clashes with other structures.
e) The *Contractor* provides the switchgear unit-struts for ensuring that switchgear panels are laid on an even floor base, which is within the acceptable tolerances of smoothness.
f) The repositioning of lights inside the substations is performed by Others. The lights are repositioned to suit the switchgear internal arc venting on the top of the switchgear. No light fittings are allowed within the pressure relief zone of the switchgear.
g) The *Contractor* provides an estimation of the amount of heat dissipated by each switchboard with the tender as per Appendix A3.
h) The room floor plan drawings are provided as part of the works under referenced Drawings. The *Contractor* provides the Plant layout designs for acceptance by the *Project Manager*.
i) The *Contractor* liaises with Others to confirm the final position of power and control cable entries, subject to acceptance by the *Employer*.
j) The *Contractor* liaises with Others to finalise the substation layout that incorporates all substation equipment.

3.12 SPECIAL DESIGN REQUIREMENTS

3.12.1 Boiler Trip Philosophy

The control circuits on the boards supplying power to loads in the boiler plant are designed such that if there is a total loss of the 220V DC system to the main trip coil, the circuit breakers can trip using another independent 220V DC supply from one of the other 220V DC backup boards.

All circuit breakers on the boards supplying power to loads in the boiler plant is equipped with two 220V DC trip coils to enable such a philosophy to be implemented. These circuit breakers are marked accordingly to avoid accidental usage on other dissimilar circuits.

All circuit breakers on the board supplying the boiler plant are equipped with a no-volt coil or undervoltage release coil. The coil is energised using 24V DC.

The MV switchgear will be SIL 2 compliant according to the affected drives switchgear schedules in Appendix A4.

3.13 CONTROL OF MOTOR SPACE HEATERS

The *Contractor* makes provision for the control of motor space heaters where required for MV motors.

The power supply requirements of the heaters are evaluated per application and a control mechanism is put in place to ensure that the heaters are switched on once the motor stops running and switched off once the motor starts running.

The requirement for a power supply to space heaters for large MV motors is specified in Technical Schedule A and B in Appendix A2.

3.14 INTERPOSING RELAYS

The *Contractor* is responsible for supplying interposing relays. The 24V DC interposing relay will be used to control the breaker from the DCS. The requirement of the interposing relays is indicated on the Switchgear Schedules in Appendix A4.

3.15 PLANT INTERFACES

The *Contractor* is responsible for providing sufficient spare contacts as per the Technical Schedule A and B in Appendix A2. These contacts would be used to trip the circuit breaker from pressure switches etc as per the existing designs at the Power Station.

3.16 PROCEDURE FOR SUBMISSION AND ACCEPTANCE OF *CONTRACTOR'S* DESIGN

3.16.1 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

3.16.2 Engineering Change Procedure

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

The Generation Engineering Change Management 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*.

3.16.3 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.

3.16.4 Time Required for Acceptance of Designs

Not later than 14 days after receipt, the *Project Manager* will return a comments sheet for a copy of the drawing marked with "Accepted"; "Accepted with comments" or "Not Accepted", as may be appropriate. The notations "Accepted" authorize the *Contractor* to proceed with the manufacture of the Plant covered by such drawings subject to the corrections, if any, indicated thereon. Where drawings have been "Not Accepted" or "Accepted with comments" 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.

3.17 OTHER RQUIREMENTS OF THE *CONTRACTOR'S* DESIGN

3.17.1 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.

3.17.2 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 and proposed substation layouts. The substation layouts can be seen in Appendix A5 and A6. 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.

3.17.3 Current Transformers for Large Motors/ Diesel Generators

The *Contractor* specifies and supplies all the required neutral or star side current transformers (CT's) in accordance with Part 1B. The details of the required CTs for differential protection of the motors/diesel generators larger than 1MW is provided in a schedule attached to Appendix A10.

In case the CTs exist, it is preferred that the *Contractor* ensures that the characteristics of the differential CT installed on the switchgear matches those on the neutral or star side of the motor(s).

3.17.4 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 in Appendix A4.

3.17.5 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.

3.17.6 Voltage Transformers

The *Contractor* provides the calibration certificates for the metering VTs 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. Accuracy results are given for a burden of 75% of rating at unity power factor.

3.17.7 Substation Floors

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* proposes the floor levelling designs for all substations and submit to the *Project Manager* for acceptance.

3.18 DESIGN OF EQUIPMENT

No additional requirements for the design of equipment over and above those specified.

3.19 EQUIPMENT REQUIRED TO BE INCLUDED IN THE *WORKS*

3.19.1 Circuit Breaker Trolleys

The *Contractor* provides circuit breaker trolleys for each type of circuit breaker provided, per switchgear room as specified in Schedule A of Appendix A2.

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. Circuit breaker trolley indicates the type of breaker intended.

3.19.2 Access Ladders

The number of access ladders to be provided for each of the substations is as specified in Schedule A of Appendix A2.

3.19.3 Operating and Maintenance Tools

The *Contractor* provides any special maintenance tools and equipment for the switchgear as per 240-56227573 and 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 of Appendix A2.

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.

3.20 WORKS AND THINGS FOR THE *WORKS* SUPPLIED BY THE *EMPLOYER* AND OTHERS

3.20.1 Supervisor and Responsible Person Course

The *Contractor* appoints at least 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.

3.20.2 Cabling

The control and power cabling for the switchgear is provided by Others. The core drilling for cables, sealing the cable slots, disconnecting the existing equipment and cables, reconnecting the cables to the new switchgear, and repositioning the lights is the responsibility of Others.

The *Contractor* provides the detailed technical specification for all power cable plugs. The power cable plugs will be supplied by Others. All other cable plugs will be provided by the *Contractor*.

3.20.3 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 vermin and fire proofing are provided by Others.

3.20.4 Removal of Existing Equipment

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

3.20.5 Switchgear Rooms

Personnel and equipment access doors and all room labelling is the responsibility of Others.
The holes in the substation walls for the explosion ducts and pressure relief vents are provided by Others.

3.20.6 Padlocks

The *Employer* supplies all padlocks. All pad lockable devices, doors etc., can accept the *Employer's* standard padlock as specified in Schedule A of Appendix A2. 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.

3.20.7 Currents Transformers

The *Contractor* is responsible for supplying all the required current transformers in the MV Switchgear. The current transformers (CT's) for differential protection on the neutral or star side of the motors/diesel generators larger than 1MW is provided by the *Contractor*. These CTs on the neutral or star side of the large motors/diesel generators will be installed by Others.

3.20.8 DC Power Supplies

The *Contractor* provides the *Employer* with a detailed power supply requirements/ electrical consumption equipment lists for all the *works*. Electrical Load templates to be used.

3.21 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 SANS/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.

3.21.1 Drawing Requirements

The *Contractor* provides drawings for the required equipment as per 240-56227573 Clause 9.2 and 240-82332407 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:

3.21.1.1 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.

3.21.1.2 General Arrangements 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.

3.21.1.3 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:

a) All protection and control devices and their contacts, each of which are labelled with its correct ANSI device function number, or reference.
b) Device terminal numbers, terminal block numbers and terminal numbers.
c) All internal interconnections, bus wiring, inter-panel wiring and connections to external equipment such as Control and Instrumentation (C&I) panel.
d) All control and protection switches
e) Power supply connections

3.21.1.4 Wiring Diagrams

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

a) Approximate physical locations of all items in each control panel.
b) All interconnecting wiring between control panels.
c) Identification of all terminals, terminal blocks, and wires by numbers.
d) 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.

3.21.1.5 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:

a) All power circuit equipment and their descriptions including type and specifications.
b) Electrical connections of instrument transformers (i.e., VTs and CTs) with relation to the cabling of protected Plant.
c) Details of the instrument transformers
d) Protection devices and the description of functions provided with their ANSI device numbers.
e) Protection scheme
f) Metering points
g) Tripping and control (including interlocking logic)

The *Contractor* provides single line diagrams for substation automation system to show the functionality and interfaces between the different components and subsystems. Such a diagram shows the following as a minimum:

a) All substation automation devices and their descriptions including type and specifications.
b) System architecture for the conceptual design illustrating all the communication links from station level up to board level.

3.21.2 Operating and Maintenance Manual

The *Contractor* provides operating and maintenance manuals as per the requirements stipulated in Technical Schedule A and B in Appendix A2. The manuals comply to 240-56227573 and 240-82332407.

The procedures are provided by the original equipment manufacturer detailing descriptions of the maintenance work in accordance with 240-56227573 and 240-82332407. The procedure covers the requirements for maintenance of the equipment over the design life.

3.21.3 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.

3.22 PLANT AND MATERIALS

3.22.1 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, 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) Prototype approval
c) Design Review
d) FAT
e) Delivery to Site
f) Erection
g) SAT
h) All manuals and drawings (in the specified format)
i) 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).

3.22.2 Plant and materials provided "free issue" by the *Employer*

None.

3.22.3 *Contractor's* procurement 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, 240-56227573 and 240-82332407. The *Contractor* makes use of the KKS codes provided on the Switchgear Schedules in Appendix A4.

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.

3.22.4 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* makes use of the list of spares template provided by the *Employer* in Appendix A12.

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.*

3.23 TESTS AND INSPECTIONS BEFORE DELIVERY

3.23.1 Factory Acceptance Test (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 240-56227573, 240-82332407 and 240-53114248, 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.

j) Verification of the functionality of the substation automation system.

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

3.23.2 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.

3.24 MARKING PLANT AND MATERIALS OUTSIDE THE WORKING AREAS

No additional requirements.

3.25 *CONTRACTOR'S* EQUIPMENT (INCLUDING TEMPORARY *WORKS*)

The *Contractor* supplies, installs, maintains, and removes all temporary construction facilities and utilities necessary to provide the *works*. The temporary works are required to support the common plant that the employer requires to support production. This works includes the following but not limited:

- Provision of a Factory Tested (FAT) MV Switchgear for the use of temporary power supply, the installation of which will be for the account of *Others*.
- Installation of control cables to the temporarily installed Switchgear to interface with C&I systems at the common plant.
- Commission of the control and monitoring systems (interface with common plant C&I systems) of the process circuits.
- The *Contractor* to provide any necessary information required for the installation, testing, commissioning, and operation of the temporarily installed switchgears.
- Provision of any special conditions or terms that may affect the guarantees and warrantees of the board/s provided for temporary supply to be clearly disclosed to the *Employer.*
- Where required, provision of support of during commissioning of the temporarily installed MV Switchgear.

3.26 CONSTRUCTION

3.26.1 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.

3.27 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.

3.27.1 Performance Tests after Completion

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

3.27.2 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*.

All training (except that of the Up-front Engineering training) provided by the *Contractor* is customized for the Power Station and is directly applicable to the actual equipment and software supplied for the works.

C&I interface training is focused on the specific Third-Party System Interface architecture, configuration, layout, equipment, software, hardware, and design that the *Contractor* provides for the works.

Training provided by the *Contractor* is directly applicable to the actual equipment *supplied* for the works. Generalized 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.

Training material and tools are not shared by trainees during the training.

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 in Appendix A2. 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.

The Power Station specific engineering training, basic & advanced maintenance training, simulator instructor training and operator training is completed 2 months before the Breaker Open on the first Substation.

The training is structured such that competency tests are done at the end of each training session on all the training participants.

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

3.27.2.1 Training and 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 familiarization with documentation (maintenance plan, procedures etc.), hardware and software familiarization, and hardware maintenance training of all equipment supplied as part of the works, low level programming, maintenance of protection, control, and instrumentation.

Advanced maintenance training includes high level programming, network design configuration, programme for storage and software reloading, software maintenance, on-line system documentation maintenance, system administration and system backup and restore including disaster recovery.

Maintenance training is provided prior to the old installed equipment being de-energized.

3.27.2.2 Training and Maintenance Operators

Operators are trained and declared competent on the manufacturer's new systems prior to the old installed equipment being de-energized. This will include familiarization with documentation including drawing configuration logic, as well as operator interface familiarization 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.

3.27.2.3 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.

Engineering training also includes as a minimum:

- A system design philosophy which includes lessons and improvements from previous products and operating and maintenance concepts,
- The system structure showing the hierarchy from the HMI, the Substation Automation System. The structure must also show the hierarchy from sub-systems, to modules, down to components (frequently used and critical ones) for both HMI and the Automation System. The aim is to be aware of the risks subjected by external changes in electronic technologies.
- System configuration and documentation control, including all necessary activities for system expansion/modification, and software storage.
- Development, debugging and testing of all software.
- Software configuration and low-level programming.
- Graphic display design, development, and configuration.
- Data base generation, configuration, and storage.
- Network design, communication, configuration, security, and expansion
- Cyber security.

3.27.2.4 Trainee Participants

The number of participants that are to be trained is as indicated in Technical Schedule A of the relevant Appendices for parts A, B and C of this Works Information.

The total number of participants to be trained for part D are as follows:

- Basic maintenance : 5
- Advanced maintenance : 5
- Operator : 4
- Specific engineering training : 5

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.

The *Contractor* provides additional (repeat) training courses as and when instructed by the *Project Manager*.

3.27.2.5 Training Documentation

The *Contractor* provides all course material including manuals in accordance with the requirements of the VGB R171, 2nd edition, 2010.

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 and 3 soft copies 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.

All training documentation provided by the *Contractor* is customized for Power Station.

The training documentation contains the specific Power Station Systems' architecture, configuration, layout, software, equipment, HMI, and design provided by the *Contractor* as part of the works.

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

3.27.2.6 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.

3.27.2.7 Specialised Training for Protection and Substation Automation System

The *Contractor* makes provision for specialized training in the use of the systems and components of the protection and substation automation 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.

Training for operators of the SAS includes, as a minimum: Electrical reticulation control and operating philosophies, use of the HMI during various types of unit start-up and shutdown, use of the HMI during load following and use of the HMI during emergency operations.

3.27.2.8 Upfront Engineering Training

The *Contractor* provides Up-front engineering training to the Employer's engineering and operating team such that the *Employer's* team is fully conversant with all aspects of the *Contractor's* technology, systems, and design philosophies.

The upfront engineering training includes, as a minimum:

Control System hardware and software configuration, which includes the servers, workstations, processing modules, communication modules, IO modules, power supply monitoring modules, network modules and all other peripheral equipment supplied as part of the works.

System design philosophies, including lessons learnt and improvements from previous products, and operating and maintenance concepts.

System documentation control and configuration, including all necessary activities for system expansion/modification, and software storage.

Functional logic and HMI graphic display development, including concepts and design philosophies.

A detailed training program and the full training material must be submitted by the *Contractor* to the *Project Manager* before the commencement of the training.

The training only begins once the Project Manager has:

- Accepted the training program provided.
- Accepted the training material provided.

Completion of the Up-front engineering training is granted once the *Project Manager* is satisfied that the *Employer's* engineering team has been adequately trained.

3.27.3 Maintenance of Equipment

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.

3.28 LIST OF REFERENCE PROCEDURES, STANDARDS AND SPECIFICATIONS

The *Contractor* complies with all standards, specifications and regulations contained in 240-56227573 and 240-82332407 and the standards as highlighted below:

[1]	ISO 9001	Quality Management Systems
[2]	DIN 6779-10	Structuring principles for technical products and technical product documentation - Part 10: Power plants
[3]	VGB-R 171e	Guideline for the supply of technical documentation for fossil-fired and regenerative power stations

[4]	ISO 15926	Interoperability standard
[5]	ISO 10007	Quality Management Systems – Guidelines for Configuration Management
[6]	240-143485806	Generation Auxiliary Plant Medium Voltage Protection Standard
[7]	240-56227589	List of Approved Electronic Devices to be used on Eskom Power Stations
[8]	IEC 61850	Communication networks and systems in substations
[9]	240-56355731	Environmental Conditions for Process Control Electronic Equipment used at Power Stations.
[10]	240-56227573	AC Metal-Enclosed Switchgear and Controlgear for Voltages above 1kV up to and including 52kV
[11]	IEEE C37.111.1991	Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems
[12]	IEC61511	Safety Instrumented Systems for The Process Industry Sector
[13]	240-62629353	Specification for Panel Labelling Standard
[14]	240-641002472	Standard for Earthing of Secondary Plant Equipment in Substations
[15]	240-70413291	Specification for Electrical Terminal Blocks
[16]	240-70975231	Specification for Current and Voltage Transformer Test Blocks
[17]	240-86973501	Engineering Drawing Standard Common Requirements
[18]	240-64685228	Generic Specification for Protective Intelligent Electronic Devices (IEDs)
[19]	NRS 048	Electricity supply - Quality of supply
[20]	IEC 61000-6-5	Electromagnetic Compatibility (EMC) – Part 6-5: Generic standards – Immunity for power station and substation environments
[21]	IEC 61850	Communication networks and systems in substations
[22]	IEC 61850-3	Communication networks and systems in substations Part 3: General requirements
[23]	IEC 61850-5	Communication networks and systems in substations Part 5: Communication requirements for functions and device models
[24]	IEC 61850-10	Communication networks and systems in substations Part 10: Conformance testing
[25]	IEC 6087-5-101	Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks

[26] IEEE 802	IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture
[27] IEEE 1613	Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations
[28] 240-56355466	Alarm Management Guideline (**Note:** When analyzing the guideline substitute "DCS" with "SAS".)
[29] 240-56355728	Human Machine Interface Design Requirements Standard
[30] 240-53114248	Thyristor and Switch Mode Chargers AC/DC TO DC/AC Converters and Inverter/uninterruptable Power Supplies Standard
[31] 240-56227443	Requirements for Control and Power Cables for Power Stations Standard
[32] 240-49230046	Failure Mode and Effects Analysis Guideline
[33] 240-49230030	Reliability Engineering Analysis Guideline
[34] NRS 024 Part 1	Diesel Alternator Sets Part 1: Diesel Alternator Sets for Fixed Installations
[35] NRS 040 Part 2	High Voltage Operating Regulations – Part 2: Voltage Colour Coding for Diagrammatic Displays in Control Room – Colour Coding for Wall-Mounted Operating Diagrams and Electronic Displays Relating to the Generation, Transmission and Distribution of Electricity
[36] 32-6	Document and Records Management Procedure
[37] 240-154220175	Document Management System
[38] 240-146112094	Records Management
[39] 240-114967625	Operating Regulations for High Voltage Systems
[40] 32-85	Information Security Policy
[41] 240-76992014	Plant Specific Technical Documents and Records Management Work Instruction
[42] 240-124341168	Project Plant Specific Technical Documents - Handover Works Instruction
[43] 240-65459834	Project Documentation Deliverable Requirement Specification
[44] 240-54179170	Technical Documentation Classification and Designation Standard
[45] 240-165018752	KKS Coding Standard
[46] 240-109607736	KKS Key Part Standard
[47] 240-71432150	Plant Labelling Standard

[48] 240-109607332 Eskom Plant Labelling Abbreviation Standard

[49] 240-164249072 Matimba Technical Specification for KKS Labels

[50] 240-53114026 Engineering Change Procedure

[51] 240-53113685 Design Review Procedure

[52] 240-82332407 Generation Fixed Pattern Gas Insulated Metal-Enclosed Indoor Primary Switchgear and Controlgear Specification for Rated Voltages above 11kV up to and including 52kV

[53] 240-56227589 List of Approved Electronic Devices to be used on Eskom Power Stations Standards

[54] 240-55410927 Cyber Security Standard

[55] 240-55863502 Definition of Operational Technology (OT) and OT/IT Collaboration Accountabilities

[56] 240-56355910 Management of Plant Software Standard

[57] 240-79669677 Demilitarized Zone Designs for Operational Technology

[58] 240-129014618 Generation Cyber Security Compliance Guideline

[59] 240-56355815 Control & Instrumentation Field Enclosures and Cable termination Standard

[60] 240-56355754 Field Equipment Installation Standard

[61] 240-56356411 Fire Barrier Seals for Electrical Cable Installations at Power Plants Standard

[62] 240-56355808 Ergonomic Design of Power Station Control Suites Guideline

[63] 240-164751654 Decommissioning Procedure

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

4. PART 1B: PROTECTION - DESCRIPTION OF THE *WORKS*

The scope of the Works includes the provision for the engineering, design, procurement, manufacture, factory acceptance testing, supply, delivery, off-loading, storage, erection, installation, site testing and commissioning of all equipment forming part of the protection system and devices.

The *Contractor* Provide the Works in strict accordance with the contract, this Works Information. In addition to the requirements of this Works Information, the Works conform to the documents and drawings listed in section 3.4 of the Works Information, as well as other documents forming part of the references.

The applicable revisions and amendments of the reference documents are the latest versions in force at the time of the contract award.

Unless specifically stated in Part 1B of the Works Information (Part 1B), the *Contractor* proposes the specifications required for the detail engineering, fabrication, installation, and commissioning. Such specifications are supported by international specifications, standards; codes, practices and their use are accepted by the *Project Manager*.

4.1 DRAWING CONVENTION

Where reference is made in this Works Information to the normal position of auxiliary contacts, the convention is such that the contacts are in the normal condition when:

a) Circuit breaker truck is in the service position.
b) Circuit breaker shown in open position.
c) Power and control supplies are "off".
d) Spring not charged.

Circuit diagrams produced by the *Contractor* comply with this convention.

4.2 GENERAL REQUIREMENTS

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.

Other protection functions required, such as internal arc and bus zone protection are performed by separate IEDs.

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, *PA0100, *PA0700, *PA0800 and Buszone protection (PA1600) 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* also supplies all IEDs for LV switchgear reticulation (Incomers and bus sections) in accordance with Appendix B5 of the Works Information. Engineering, in the form of logic development and the programming of the IEDs in accordance with the LV switchgear philosophies is the responsibility of the *Contractor*. The *Contractor* is also responsible for testing and commissioning of the IEDs.

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.

Tendered equipment is designed for a working lifespan of at least 15 years in a controlled environment which is in accordance with 240-56355731 whereby temperature is controlled at 22°C ± 2°C. All common and outside plant substations are pressurised and their ambient temperature can be taken to range between 5°C to 40°C. Written guarantees to this effect are provided. The *Contractor* also states the maximum allowable operating temperature to achieve a 15-year life span of the devices.

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 modifications and firmware upgrades 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*.

4.3 POWER SUPPLIES

Auxiliary power for the protection systems will be provided from an external DC power supply system provided by the *Employer* in accordance with section 3.22.8 of this Works Information, including the unitised (i.e., Unit 1 to 6 and Common Plant Substations) switchgear. 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.

4.4 PROTECTION DEVICES

The *Contractor* supplies protection devises that conforms to the requirements stated below in the following subsections.

4.5 INTELLIGENT ELECTRONIC DEVICES

IED devices provided shall comply with Standard [13] 240-64685228: Generic Specification for Protective Intelligent Electronic Devices (IEDS).

4.5.1 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 2m 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*.

4.5.2 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.

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.

4.5.3 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).

4.5.4 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 found in Appendix B4.1 of Part 1B.

4.5.5 Digital Inputs

The IED is also provided with the digital inputs for the control and indication functions as determined by the schemes described in section 6 of Part 1B.

The configuration of the inputs is programmable. The minimum number of inputs required is provided in the C&I Interface Signals for MV Switchgear found in Appendix B4.1 of Part 1B.

4.5.6 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 in section 6 of Part 1B.

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 found in Appendix B4.1 of Part 1B. 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.

4.5.7 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.

4.6 BUSZONES PROTECTION RELAY

Bus zone protection is implemented by utilising a numerical differential relay. These devices comply with the requirements of 240-143485806 standard as a minimum.

Only a low impedance scheme is acceptable. The *Contractor* provides details of the CT requirements. CT selection methodology is required to be submitted to the Project Manager for acceptance.

All devices are fitted with contacts which are self-resetting with exception of the tripping function.

The devices are provided with hand-reset operation indicators for each of the functions. The indicators do not operate until the relays have closed their contacts. Re-setting is accomplished without opening the case.

The protection schemes are provided with suitable test facilities to enable tests to be carried out on the device while in position on the panel without disconnecting any wiring.

The buszone protection scheme is alone standing panel. The buszone panel shall be a biased current differential (low impedance) type and shall also provide back-up protection to any feeder protection scheme for over current conditions. Buszone protection is required on all 6.6kV and 11kV boards as well as critical 3.3kV boards.

The buszone protection equipment is housed in separate panels designed to accommodate 482.6 mm (19 inch) type racks or the *Contractor's* standard arrangement. The panels are constructed in accordance with Eskom Standard number 240-143485806.

Auxiliary power for the bus zone protection device will be provided at 220V DC nominal voltage rating from an external DC power supply system provided by the *Employer*.

DC line filters are installed in the bus zone system such that it protects the electronic components against voltage spikes.

4.7 ARC DETECTION SYSTEM

The *Contractor* designs and supplies arc protection schemes that are integral part of the switchgear as described in this Works Information.

The arc detection system conforms to the requirement stated below in the following subsections.

4.7.1 Protection Relays

The arc protection function is provided by a device that accepts both light and current signals as input. These signals are detected simultaneously to initiate a trip and alarm.

The arc protection relay performs the high-speed tripping of the supply circuit breaker in the event of an arc fault when the current exceeds a pre-set reference value. The device has a maximum sensor detection function pulse delay time of less than 5ms and subsequently issues a breaker trip pulse in a time of less than 10ms from fault inception. The total (including breaker and arcing time) fault clearance time required is less than 100ms from fault inception.

All devices are fitted with contacts which are self-resetting with exception of the tripping function.

DC line filters are installed in the arc detection system such that they protect the electronic components against voltage spikes.

4.7.2 Light Sensors

Arc detection is performed with light sensitive type elements located in the respective switchgear chambers (including segregated busbars between panels). The elements are installed in such a way that they completely cover the space to be protected.

The light sensors are not triggered by external light sources such as camera flashes or welding arcs.

The sensor has the degree of protection to operate within the boards' internal environmental conditions.

4.7.3 Monitoring

The internal arc protection system has a self-diagnostic (self-monitoring) function that prevents the relays from operating if a system (i.e., devices and sensors) fault is detected. It clearly indicates by means of an alarm indicator the fault and the location thereof.

The system gives an indication of the fault location (i.e., which compartment faulted) locally at the switchgear panel through an IED and remotely on the dedicated engineering station/ SAS.

The power supply modules are continuously monitored and should provide an alarm in the event of failure.

4.7.4 Auxiliary Relays

Where required, the auxiliary relays are provided with the desired trip or indication function with the operation time of less than 50ms. The auxiliary relays must comply with the requirements of 240-143485806.

Unless otherwise specified, all the relays are provided with manual-reset operation indicator/s for the dedicated function. The indicator/s does not operate until the relay has operated. Resetting is accomplished without opening the case.

Each relay has at least two output contacts for tripping and two output contacts for external alarms.

4.8 PROTECTION SCHEMES

Contractor to supply conceptual designs for protection schemes for each circuit type at tender stage.

Conceptual Design to be as per the switchgear schedules and in accordance with Generation Auxiliary Plant Medium Voltage Protection Standard 240-143485806.

4.8.1 Matimba Unit Boards Protection Philosophy

The new electrical reticulation Single Line Diagram (SLD) for Matimba Power Station introduces changes to the operating philosophy and protection application of the system. The changes result from enhancing maintenance/operating opportunities but still meeting safety requirements and ensuring that new switchgear is installed with minimal impact to the Unit Transformers. The changes impact the generator protection and metering systems which are planned to be replaced in 2025. Inevitably, additional nodes to the reticulation change the station's protection philosophy. The objective is to ensure that the new protection philosophy complies with the Generation Auxiliary Plant Medium Voltage Protection Standard (240-143485806) and other station requirements to ensure plant and personnel safety.

The main changes that have been introduced are, the addition of Unit Maintenance Isolator Boards (MIB) A and B, as well as the Loop Supply MIB. The loop supply itself has also been sectionalised.

Adding the unit MIB allows:

1. Terminating the five (xyz mm^2) cores per phase from the Unit Transformer on the MIB. Thereafter, use four (nnn mm^2) cores to the unit boards, since GIS has a limitation of only terminating four cores per phase using the cable plug technology.
2. To allow maintenance on the 11kV unit boards without shutting down the unit.
3. Considering that the Unit Transformer sizes have been increased to 70 MVA, the MIB may be used to supply future loads while maintaining the rating of the unit boards, particularly for Unit Board B.
4. Not exceeding the maximum load current for naturally cooled GIS switchgear

Adding the Loop Supply MIB allows similar principles to be applied to the Loop Supply, which gives Matimba more flexibility when maintaining the loop supply circuits and ensuring that a single fault on the loop does not affect the whole loop.

The addition of the MIBs requires the application of the current protection philosophy to the new layout. A decision was made to apply unit type protection on the sectionalised parts that have been introduced to fulfil the core requirement of protection to isolate only affected plant safely and fast. The proposed protection design philosophy minimises unnecessary trips/operations for interconnecting cables.

Based on the philosophy mentioned above, each circuit will use the schemes represented on the SLD. The conventional current differential schemes for cables (*PA0800) may be replaced with current differential schemes found in the *PA0100 or *PA0400 schemes. The conventional cable differential protection uses an IED at each end of the cable with only three current inputs which communicate with each other and provide the main current differential and back over current protection. The motor differential or transformer differential IEDs uses a minimum of six current inputs into one IED to do the comparison. The final decision will be based on a cost comparison and functional requirement. Interlocking and synchronism check are integral parts of the scheme that needs to be applied, which does not exist in the motor or transformer differential schemes.

The 11kV Unit boards, being of GIS design, does not require a buszone scheme to be implemented. However, to ensure back-up protection for 11kV/400V feeder circuits for faults occurring on the secondary side of the transformers, a low impedance buszone scheme with individual circuit over current elements is required as described in the MV protection standard. The bus-zone functionality may be disabled for GIS installation and only be used to provide backup protection for specific circuits.

The Loop Supply MIB will require buszone protection based on the AIS design. The application of internal arc protection will be challenging, and its feasibility is still to be determined.

Each circuit in the unit (and common plant) will comply with the schemes defined on the SLD, where the full detail for each scheme is defined in the MV Protection standard 240-143485806. The detailed technical requirements of each scheme are defined in the Schedule A of the appendix.

Description of circuit protection schemes to be supplied by the *Contractor*.

4.8.2 Numbering System

The “PA” numbering is a numbering system dating back to the 1980's. The first numerical represents the protection technology. In this Works Information, the first numerical is not included. Instead, a * is used to represent the technology phase. “PA” stands for Protection Auxiliary. The last four numbers signify the type of circuit being protected.

The below mentioned protection schemes and their full detail is documented in the protection document standard 240-143485806.

4.9 UNIT BOARDS PROTECTION REQUIREMENTS

The unique Matimba 11kV Unit board configuration makes it possible for various protection schemes to be used to achieve full protection, according to the standard. Taking this into consideration the contract should quote on two different protection scheme configurations. The detail of these configurations is below.

Table 2: Protection scheme configuration 1

	Scheme Allocation	
1	**Loop Supply MIB**	**11kV Board A**
	*PA0800	*PA0800

2	**Unit MIB A**	**11kV Board A**
	*PA0800	*PA0800

3	**Unit MIB B**	**11kV Board B**
	*PA0800	*PA0800

Table 3: Protection scheme configuration 2

	Scheme Allocation	
1	**Loop Supply MIB**	**11kV Board A**
	*PA0100/*PA0700	*PA1200

2	**Unit MIB A**	**11kV Board A**
	*PA0100/*PA0700	*PA1200

3	**Unit MIB B**	**11kV Board B**
	*PA0100/*PA0700	*PA1200

Furthermore, the following protection scheme adaptations must be noted. The detailed specifications are detailed in Schedule A & B, appendix B2.

- The variable speed drives on the 11kV boards, refer to circuits 14 11kV boards A and 02,04 on Boards B as seen on the SLD (0.58.60894) is connected to the 3-winding transformer. Therefore the *PA0700 scheme for these circuits must have a 3-winding diff protection.
- The Loop supply MIB will have an alone standing buszone protection scheme that overlap the cable differential protection schemes. (The alone standing panel is necessary to prevent human errors during maintenance).
- Three winding differential scheme will be used for Unit transformer A located in the Generator protection scheme and will cover the MIB A.
- Three winding differential scheme will be used for Unit transformer B located in the Generator protection scheme and will cover the MIB.
- The 11kV unit boards A and B will have low impedance busbar protection to provide individual over current protection for each 11kV circuit. (Detection of sustained LV faults on the 11kV/380V transformers – circuit IED failures) A *PA1600 scheme.
- The 11kV Unit boards will have change-over schemes (synchronising schemes) to enable bright changeovers to supply the 11kV unit boards either from the loop supply or unit supply.

The below mentioned protection schemes and their full detail are documented in the protection document standard 240-143485806. Schemes shall comply with Standard 240-143485806.

4.9.1 Motor Protection Scheme – *PA0100 (Motors ≥ 1MW)

The schemes have binary Input/output (I/O) facilities as well as analogue outputs. These input facilities are for external trip and close signals and to enable thermistors to decrease the tripping time of the overload elements. The trip outputs are latched.

The protection elements have setting ranges as detailed in Schedule A in Appendix B2 of Part 1B. The characteristic curves of IDMTL overcurrent and earth fault protection elements conform to IEC standards.

Thermal overload protection monitors the current flowing into the motor. Based on these currents, it models the temperature inside the motor.

Negative phase sequence protection function is made available in the motor protection scheme. This function protects the motor against overheating caused by induced double frequency currents. The negative phase protection has an inverse and a definite time characteristics.

Motor stall protection function is available in the motor protection scheme. This function is preferably an overcurrent protection element set below the locked rotor current and a time delay set to the stall capability time of the motor. The time delay is adjustable over the range specified in Schedule A in Appendix B2 of Part 1B.

Three-phase definite time undervoltage protection function is made available in the motor protection scheme. This function does not operate for the loss of a single-phase VT supply but only operates for the loss of all three phases after a predetermined period. The undervoltage protection function trips the motors for a sustained under voltage condition. The protection elements are energized from voltage transformers with secondary of 110 V phase-to-phase and 63.5 V phase-to-neutral. The elements are adjustable to operate in the voltage ranges specified in Schedule A and have drop-off/pick-up ratios greater than 95%. Setting adjustment is preferably continuously variable, but if adjusted in steps, these do not exceed 10%. The time delay is adjustable over the range specified in Schedule A in Appendix B2 of Part 1B.

Other functions required in the motor protection scheme such as current interlock, long starting time, etc. are indicated in Schedule A in Appendix B2 of Part 1B.

Provision is made for output analogue signals (i.e., current and power) from the IEDs. The *Contractor* provides separate measurement modules (i.e., transducers) for both current and power. Alternatively, the measurement modules are provided as an integral part of the protection IED. The *Contractor* also provides in the Rates Price Schedule both the takeout price for having separate measurement modules, as well as the price for transducers provided as an integral part of the IED.

4.9.2 Motor Protection Scheme – *PA0400 (Motors < 1MW)

Directional earth fault is required if the option of a zero-sequence current balancing transformer is considered across the motor feeder cables since the MV system is resistive earthed with the MV motor neutral unearthed.

Other functions required in the motor protection scheme such as current interlock, long starting time, etc. are indicated in Schedule A in Appendix B2 of Part 1B.

4.9.3 Transformer Feeder Protection Scheme – *PA0700 (Transformer > 10 MVA)

The IDMTL overcurrent and earth fault are set as back-up protection for the transformer differential protection as well as protection for downstream circuits.

In addition, the IEDs have binary input facilities. These input facilities cater for external alarm and trip signals such as Buchholz, winding temperature, oil temperature and pressure relief protection. A minimum of eight binary inputs are required.

The protection elements have setting ranges as detailed in Technical Schedule A in Appendix B2 of Part 1B. The characteristic curves of IDMTL overcurrent and earth fault protection elements conform to IEC standards.

4.9.4 MV Interconnector Protection Scheme – *PA0800

The overcurrent and earth fault elements (i.e., IDMTL or definite time) are set as main protection for the interconnector and back-up protection for downstream circuits.

The *Contractor* specifies and supplies the fibre optic or pilot wire cables, which are suitable for the cable differential protection, to be installed by Others. Fibre optic links are preferred for differential protection application.

The protection elements have setting ranges as detailed in Technical Schedule A found in Appendix B2 of Part 1B. The characteristic curves of IDMTL overcurrent and earth fault protection elements conform to IEC standards.

The *Contractor* provides output analogue signals (i.e., current and voltage) from the IED's. These measurement modules are an integral part of the protection IED. The *Contractor* also provides a takeout price for having separate measurement modules (i.e., transducers) in the Rates Price Schedule.

4.9.5 Transformer Feeder Protection Scheme – *PA1000 (Transformer < 10 MVA)

The IDMTL overcurrent and earth fault are set as main protection for the transformer / feeder and back-up protection for downstream circuits.

In addition, the IED's have binary input facilities. These input facilities cater for external alarm and trip signals such as Buchholz, winding temperature, oil temperature and pressure relief protection. A minimum of eight binary inputs are required.

The protection elements have setting ranges as detailed in Technical Schedule A found in Appendix B2 of Part 1B. The characteristic curves of IDMTL overcurrent and earth fault protection elements conform to IEC standards.

The *Contractor* provides output analogue signals (i.e., current) from the IED's. These measurement modules are an integral part of the protection IED. The *Contractor* also provides a takeout price for having separate measurement modules (i.e., transducers) in the Rates Price Schedule.

4.9.6 MV Incomer Protection – *PA1200

The overcurrent and earth fault protection are utilised to provide the required current input for the arc detection interlock and act as back-up protection for downstream circuits.

In addition, the IEDs have binary input and output facilities in accordance with the scheme requirements for external trip signals.

The protection elements have setting ranges as detailed in Technical Schedule A found in Appendix B2 of Part 1B. The characteristic curves of IDMTL overcurrent and earth fault protection elements conform to IEC standards.

The *Contractor* provides output analogue signals (i.e., current and voltage) from the IEDs. These measurement modules are an integral part of the protection IED. The *Contractor* also provides a take-out price for having separate measurement modules (i.e., transducers) in the Rates Price Schedule.

4.9.7 Bus Section (*PA1400) and Maintenance Isolator (*PA1400A) Control Schemes

The bus section and maintenance isolator schemes are used as control and indication device only without protection functions.

The details on the requirements of the scheme are given in Technical Schedule A in Appendix B2 of Part 1B.

4.9.8 Diesel Generator Protection Scheme – *PA1500

Protection scheme provided for an incomer from a 3.3 kV diesel generator includes the following functions:

a) Generator differential protection,

b) Three-phase definite time overcurrent protection,

c) Three-phase IDMTL overcurrent protection,

d) Definite time earth fault element,

e) Three-phase IDMTL earth fault protection,

f) Negative phase sequence protection,

g) Three-phase undervoltage protection,

h) Three-phase overvoltage protection,

i) Three-phase under-frequency protection,

j) Three-phase reverse power protection.

In addition, the scheme has binary I/O facilities as well as analogue outputs. These input facilities are for external trip and close signals. The trip outputs are latched.

The protection elements have setting ranges as detailed in Technical Schedule A in Appendix B2 of Part 1B. The characteristic curves of IDMTL overcurrent and earth fault protection elements conform to IEC standards.

Negative phase sequence protection function is made available in the diesel generator protection scheme. This function protects the diesel generator against overheating caused by induced double frequency currents. The negative phase protection has an inverse and a definite time characteristics.

Three-phase definite time undervoltage protection function is made available in the generator protection scheme. This function does not operate for the loss of a single-phase VT supply but only operates for the loss of all three phases after a predetermined period. The undervoltage protection function trips the generator for a sustained under voltage condition. The protection elements are energized from voltage transformers with secondary of 110 V phase-to-phase and 63.5 V phase-to-neutral. The elements are adjustable to operate in the voltage ranges specified in Schedule A and have drop-off/pick-up ratios greater than 95%. Setting adjustment is preferably continuously variable, but if adjusted in steps, these do not exceed 10%. The time delay is adjustable over the range specified in Schedule A in Appendix B2 of Part 1B.

Other functions required in the diesel generator protection scheme such as current interlock, long starting time, etc. are indicated in Schedule A in Appendix B2 of Part 1B.

4.9.9 Arc Protection Scheme

4.9.9.1 General

The system protects the segregated breaker, busbar, and cable chamber respectively in the case of an internal arc fault for air insulated MV switchgear.

The main protection device is mounted on the board incomer panels with the auxiliary devices in different panels as required.

4.9.9.2 Current Detection Methods

A three-phase CT connection from the board incomer or upstream feeder overcurrent and/or earth fault function is provided together with an arc sensing device (two-out-of-two measuring criteria). The current rating of the input to the device is 1 A.

An overcurrent or earth fault signal is activated once the current on any one phase exceeds the reference values. This function has the capability to capture and display the three phase currents that caused the protection operation. The system can provide arc protection with low fault currents as well (i.e., smaller than 4 kA fault current).

Detection of overcurrent conditions is implemented to increase the stability of the detection system under normal conditions. This feature ensures that the system does not act on incidents where light is emitted without the existence of excessive current in the circuit concerned.

4.9.9.3 Circuit Breaker Failure Protection

Breaker fail functions are required on all MV switchgear and shall trip all sources of supply when required. The breaker fail requirements are describe in the Standard (240-143485806, point 3.2.8). The total tripping time does not exceed the switchgear internal arc test time, Tt (as defined in IEC 62271-200).

4.9.9.4 Bus Chamber Protection

The function of this application is to detect and clear internal arc faults in the busbar chamber on a particular board. When any of the light sensors on the board detect an arc together with an overcurrent or earth fault current on the incomer feeder, it trips the incomer feeder, bus section breaker and all the feeder circuit breakers of the relevant zone.

The internal arc detection devices are applied to overlap in the bus section chamber, thus tripping only the faulty zone for an internal arc fault in the bus section chamber.

4.9.9.5 Protection of Circuit Breaker Compartment

The function of this application is to detect and clear internal arc faults in the circuit breaker chamber. Where multiple tripping is required the arc sensing devices detect an arc together with an overcurrent or earth fault current from the incomer feeder, it trips the incomer feeder, bus section breaker and all the feeder circuit breakers of the relevant zone.

4.9.9.6 Protection of Cable Termination Compartments

The function of this application is to detect and clear internal arc faults in the circuit breaker chamber. Where multiple tripping is required the arc sensing devices detect an arc together with an overcurrent or earth fault current from the incomer feeder, it trips the incomer feeder, bus section breaker and all the feeder circuit breakers of the relevant zone.

4.9.9.6.1 Feeders

The function of this application is to detect and clear internal arc faults in the feeder cable chamber. Where multiple tripping is required the arc sensing devices detect an arc together with an over current or earth fault current from the incomer feeder it trips the incomer feeder, bus section breaker and all the feeder circuit breakers of the relevant zone.

4.9.9.6.2 Incomers

The function of this application is to detect and clear internal arc faults in the incomer cable chamber. Where multiple tripping is required the arc sensing devices detect an arc together with an over current from the upstream feeder it trips the upstream feeder circuit breaker.

4.9.10 Buszone Protection Scheme – *PA1600

The bus zone protection scheme is designed to protect the breaker, busbar and cable chamber respectively in the case of a three-phase bolted fault for air and gas insulated MV switchgear. The protection scheme is based on basic operation principles of low impedance differential current measuring system.

The function of the bus zone protection system is to perform fast clearance of phase to phase and phase to earth faults. The supply breaker and all feeder breakers are tripped in the event of a fault and current exceeding a pre-set reference value.

The bus zone should have a backup tripping function for fault conditions as previously mentioned on the feeder side of the board, should opening of the breaker does not clear the fault, the bus zone should be activated in order to safe guard the board and all equipment connected to it. The board bus zone protection should be housed in a separate standalone panel in the room and be supplied from an alternative power supply.

A check feature such as integral circuit supervision is included to prevent tripping of bus-zone protection if any of the current transformer circuits become disconnected during normal load conditions. Alarm contacts operate under these conditions to initiate a remote alarm.

A testing system, consisting of current isolation and measuring facilities at the input from each current transformer, and facilities for short-circuiting the current transformer circuits, when they are isolated from the protection system, is included.

The *Project Manager* may request the *Contractor* to check whether the bus zone protection is stable under external fault conditions.

The protection CT core is fed onto standard switchgear terminals and then to the CT test block and protection device measuring elements with overlapping of the bus section CT cores.

The boards requiring single or double zone tripping are indicated in the Appendix B3 of Part 1B.

4.9.11 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.

The circuit control DC must be monitored, and the circuit must be user configurable to select to trip the breaker and/or alarm to the SAS when the control DC are lost.

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.

Details on this function are explained in the standard 240-143485806.

4.10 IEDs PROVIDED BY THE *CONTRACTOR* FOR THE LV BREAKERS

In addition to IEDs provided for MV Switchgear, the *Contractor* supplies the IEC 61850 compliant IEDs for incomer and bus section circuits of the following LV Switchgear Boards, the full details are descripted in Appendix B5 of this Works information.

Generic technical requirements of these IEDs are as per section 4.2 and section 4.5 of this Works Information (Part 1B). However, the design functionality, descriptions, schematic drawings, and protection settings for the specific circuits are provided by Others. The *Contractor* uses the information provided by Others to program or configure IEDs in such a manner that they function according to the design issued by Others. The *Contractor* also configures the IEDs to interface with SAS network. Physical installation of these IEDs into the LV Switchgear panels is the responsibility of Others. The configuration of the IED, FAT, SAT, routing, and termination of SAS fibre optic cables are the responsibility of the *Contractor*.

4.11 PROTECTION ALGORITHMS AND SETTINGS

The *Contractor* provides a detailed description including formulas and diagrams of the algorithms used to perform the protection functions to the *Project Manager*. This information is treated as strictly confidential. This information is provided for all protection scheme developments.

The *Contractor* provides a comprehensive set of blank forms and example setting details to cover all user settable configurations/functions in the module to the *Employer*.

The IED marshalling is seen as part of the scheme as it is imperative that it is in accordance with the scheme design for the scheme to function correctly. All settings/marshalling related to the different protection schemes is pre-programmed at the factory and all IED's are delivered pre-programmed in accordance with the scheme design.

The final protection settings for the relays will be provided by the *Employer* for the *Contractor* to implement. In case the settings are not available at the time of Factory Acceptance Tests (FAT's), the *Contractor* develops the preliminary settings for the purpose of testing. These settings are accepted by the *Project Manager*.

The settings/marshalling are seen as integral parts of the scheme documentation. They are provided as part of the documentation as well as in software format in the file type as required by the associated IED.

4.12 INTERFACE WITH CONTROL AND COMMUNICATION SYSTEMS

Interfacing with control and communication systems to be in accordance with the standard 240-143485806.

The different operating conditions (i.e., normal, and abnormal) that are monitored by the protection schemes initiate different alarms. These alarms are communicated between IEDs, SAS and DCS via dedicated hardwired and communication bus links. The description of the concept proposed for the communication network is described on Part 1C of this Works Information.

The interface between the IEDs on the switchgear and the operating and engineering stations are facilitated by an Ethernet based Local Area Network (LAN) using IEC 61850 protocol as described in Part 1C of this Works Information.

Data transfer between IEDs and DCS is done using hard wiring method and in accordance with C&I Interface Signals for MV Switchgear spreadsheet provided in Appendix B4.1 of Part 1B. The signal descriptions can be found in Appendix B4.2 of Part 1B.

Safety trip signals (e.g., Boiler trip, conveyor trip, etc.) issued from the DCS are done via interposing relays with potential free contacts. The operating voltage of the interposing relays is 24V DC. The interposing relays are designed to withstand the rated current of the closing coil for two times the longest possible closing time. SIL 3 rating interposing relays in accordance with the requirements of IEC 61511 are required. The interposing relay is also designed to withstand the making of the closing coil current at maximum system voltage rating. The tripping requirements are detailed in 240-143485806 section 3.2.11.

4.13 MAINTENANCE AND AFTERMARKET SUPPORT

Contractor to provide maintenance requirements for major and minor activities and details of aftermarket support for protection equipment.

5. PART 1C: SUBSTATION AUTOMATION SYSTEM

5.1 SCOPE OF THE WORKS

The *Contractor* provides in his tender a conceptual design for the SAS architecture with the description of each component and their specifications. The design for the main offer for the SAS is in accordance with the proposed architecture overview provided in Part 1C of the Works Information and drawing 0.58-60909-01-00.

The *Contractor* also submits an alternative offer for the SAS that provides a more reliable and optimised solution, in line with the offered devices.

The *Contractor* provides in his tender preliminary system descriptions that describe the working of the system.

The *Contractor* performs detailed Reliability, Availability and Maintainability (RAM) studies of the complete SAS system and submit with his tender, RAM study reports for both the main and alternative offers. The *Contractor* provides reliability and availability calculations using established methodologies and 240-49230030 to demonstrate the adequacy of the designs. The reliability and availability calculations should be based on reliability block diagrams and indicating any redundant equipment that may be required. The study shall highlight the impact of quality of repairs (completeness and correctness of repairs). Detailed FMECA study in accordance with 240-49230046 guideline shall be conducted and used as input to the reliability and availability studies. In addition to the Price, the tender submission includes life cycle costs of both the main and the alternative offers.

The VisualSPAR latest version reliability simulation software package shall be used in performing the RAM analysis.

During detailed design, the *Contractor* provides a detailed philosophy (system description) document and technical operation manual for the SAS offered. The documents describe in detail, the operation of the automation system and include elements such as the philosophy of the automation system, interlocking, controls provided on each protection scheme, the operation of the HMI etc. The documents are such that engineers and technicians can easily understand the relevant portions of the philosophy of operation of the complete system once he/she has read the document.

The *Contractor* also provides a detailed document describing how to configure the system and its components. The document is such that an engineer can easily understand how to configure the complete system once he/she has read the document. The *Contractor* provides a RAM study report of the final system configuration and individual system components once the detail design is complete.

The *Contractor* provides a detailed specification of the logical nodes with associated data sets supported by each IED offered. The *Contractor* indicates which data sets in their offer are mandatory and which are optional.

No annual license renewal is required for software or operating systems. All licenses that are required are a once-off purchase. The fact that a bug is only found after the warranty has expired does not make it acceptable and therefore all bug fixes are free.

The *Contractor* and the associated supplier/s have at least 5 years' experience in development, design, engineering, and implementation of the SAS. All equipment used in the system will form part of the *Contractor's* current marketed range of equipment and will not be experimental nor prototype in nature nor obsolete within 15 years. The *Contractor* provides information regarding reference sites and projects of similar nature where the offered equipment has been installed. If equipment has been launched as a commercial product on the international market but has never been installed at a previously commissioned similar reference site, such equipment will have been tested rigorously and to the satisfaction of the *Employer.* Hence, the *Contractor* declares such cases.

The *Contractor* provides a disaster recovery process in a form of a detailed procedure for each communication device (i.e., network equipment, servers, IEDs and the EWSs). This process must be auditable, and a recovery test must be performed during the Factory Acceptance Testing (FAT) to confirm recovery times.

The *Contractor* provides for an OPC UA protocol link to the Station Historian or Plant Information System. The *Contractor* provides for receiving a time stamping signal from the Station GPS. The *Contractor* also engineers the SAS to receive information from electrical equipment at the Power Station as per this Works Information.

5.2 GENERAL SPECIFICATION

The *Contractor* designs and supplies a system of which the architecture is based on the seven-layer model of the International Standards Organisation (ISO) for communication between devices. The design and functionality of the communication system and components is based on IEC 61850 standard.

The architecture, protocols and all equipment are designed for the substation environment and not for industrial process control or office environment. It is implied that all protection, communication, and control equipment comply with the same environmental requirements (i.e., EMC and EMI) as those currently required for numerical protection relays, specifically Class IV as defined in IEC 61000-6-5.

All equipment is designed to work efficiently in the environment where they are installed, without any decrease in performance, reliability, and life expectancy. The temperature range in which all equipment forming part of the SAS can operate is -10 ºC to +55 ºC, irrespective of HVAC provided for the room(s). The room/s where the servers are housed will be controlled according to Eskom standard 240-56355731: Environmental Conditions for Process Control Electronic Equipment used at Power Stations. The HVAC for all substations is provided in accordance with 240-56355731 by Others.

5.3 SYSTEM DESIGN

The *Contractor* designs the SAS for extremely high reliability and availability, through total redundancy at every level including data busses. The SAS structure follows the electrical reticulation system configuration to minimise the effects of equipment failure on the overall plant. A functional distribution of network switches is designed and installed by the *Contractor*. Redundant equipment and communication paths do not have common points of failure. The *Contractor* provides separate cabinets for different redundant equipment. All common modes of failure are considered and eliminated in the design, specifically in terms of power supplies, communication paths, routing etc. The layout, design and configuration of the system is such that no individual fault on the SAS causes the unit to drop below 50% MCR or causes a forced outage or unit trip. Also, no two concurrent faults cause a Multi-Unit Trip.

The offered system has enough Ethernet ports to cater for all the IEDs required as per Part B of the Works Information, and it is possible to add future devices at all levels of the network when the substation is expanded in future. This implies that the automation system is extendable/expandable.

The SAS is designed for the future reality of eventually replacing the system, without requiring the extensive and complete shutdown of plant or running plant without monitoring and control functionality during the replacement for part of plant that is running.

The communication network equipment is reliable, flexible, and modular. The architecture, design and equipment do not introduce significant risk to the *Employer* than a conventional substation designs. Further, the system, including hardware, firmware, software, configuration, and networking requires minimal maintenance. No moving parts such as fans are allowed since they significantly reduce reliability, and they introduce onerous maintenance requirement. Substation hardened networking hardware and software is used.

It must be possible to separate defective components from the system by switching off or blocking the respective communication processes, so that the rest of the system continues to function properly. Redundant equipment such as network switches and servers are completely independent, and can fail, have parts replaced, have updates installed, be completely replaced, be booted up and shut down independently without affecting the functionality SAS.

Equipment hot swapping between power supplies is seamless and does not have any effect on the equipment such as loss of data or equipment restarting. Data is not lost when there is a complete loss of the auxiliary power supply to the system.

All communication devices are suitable to transfer maximum data between the IED and the other devices in the communication network without any restrictions that might limit speed, capacity and quality of data transferred.

The communication architecture, protocol and configuration is able to provide high speed operation, since peer-to-peer communication requires much data sharing and the communication network is also used for protection purposes, i.e. transferring trip signals, interlocking signals etc. The performance of the system is in accordance with the requirements mentioned in section 5.8 of this Works Information and requires a fast communication network. The communication speed of the network is selected appropriately.

IEDs are addressable, more specifically each data source/receiver or devices have a unique address to identify it in the substation but also in the entire network to which it is connected. This implies that all IEDs have unique user configurable Internet Protocol (IP) addresses.

Substation Configuration Language (SCL) files, based on IEC 61850 Part 6, are used to describe the substation. Since the data model in IEC 61850 is well defined, it is required that the network and all equipment allow for interoperability (i.e., it is possible for IEC 61850 compliant Intelligent Electronic Devices (IEDs) from different manufacturers to efficiently communicate over the SAS).

5.4 FUNCTIONAL SPECIFICATION

5.4.1 Substation Automation System

The SAS is dedicated entirely to the purposes of configuration, control, monitoring, etc. of the main reticulation system and process feeders within the Power Station. However, control functionality is disabled for all process feeders. SAS is a dedicated system such that there is no sharing of resources with other control systems, e.g., the units, the Common plant, the Outside plant, the water treatment plant, etc., except the Station Historian or Plant Information System (PIS) for information archiving only. More specifically, no processors, network switches, busses, RTU's (i.e., substation processors), servers, PC equipment etc. may be shared with other control systems.

An interlocking system is implemented by the *Contractor* for the purposes of interlocking different devices to enhance safety during operating done by Power Station operators. The interlocking rules are implemented in the IEDs but are also available in the SAS servers and backup system. Electrical interlocking is implemented using the SAS LAN. GOOSE messages used for interlocking are restricted to the levels at which they are relevant to prevent overloading of the network. IEC 61850-based GOOSE tripping and closing signals are enabled; however, these signals are also hardwired as detailed in 240-143485806.

Safety of personnel and equipment are an integral part of the functionality under all conditions. Failure of the network equipment, network cabling, switches, RTU (i.e., substation processors), servers and the EWSs does not negatively impact the safety and interlocking functions in the substation. It is therefore necessary that such devices/functionality is both supported by a second level of redundancy and that such functionality is implemented in a distributed manner (i.e., all logics are not implemented in the servers but on each respective IED).

All equipment provided can perform self-diagnostics and alarm failures, both locally at the equipment and remotely at the OWSs. The alarm information is sent to the OWSs over the network. Failure of any device is alarmed via an alternate path of the redundant network.

All the necessary diagnostic tools are 'on board' and are therefore part of the SAS. It is possible to perform diagnostic, monitoring, and control functions locally within the Power Station, through the substation LAN and on a portable EWS.

The amount of engineering time spent to configure the system is minimised through the provision of a suitable substation configuration tool that may be used to configure all devices provided by the *Contractor* and the

communication system. Interoperability as defined in IEC 61850 and the offered substation configuration tool minimises the amount of time required to configure a system with different suppliers' IEDs.

A communication network management function/tool that can provide the system administrator with up to the minute information about various crucial statuses of the communication network, for example the network size, its operating conditions, alarms, system loading, and error statistics is provided. The network management function/tool is also used to add new devices to the network, configure them and to perform certain diagnostic investigations.

The SAS is an open system so that automation functions (for example command processing, configuration of operating sequences and interlocks as well as generation of derived information) are configurable. Programming functionality on a bay, board, unit, and station level is provided using the portable EWS with user friendly software. A graphical configuration system is therefore available and operational. It is important to note that what is referred to here is the interface between the user and the programming tool in terms of what is visually seen on the computer screen by the programmer. To simplify the configuration process, a library with system tested function blocks for power automation specific functions is integrated.

Mathematical configurations are also possible, for example to calculate the I^2t summated analogue value and compare it with set points before issuing a derived alarm when the setting is exceeded. As a second example, it is possible to add the respective phase currents from the different bays to each other in real time and to perform a programmed characteristic algorithm on it.

The set of automation functions are developed during the design phase of the project. A final list of automation functions agreed upon between the *Employer* and the *Contractor* at the final design review are signed off at the design freeze.

The communication system is capable of transferring data stored on the IED's for condition monitoring purposes, such as the record of events or disturbances as well as measured values (e.g., voltage, current, power, temperature, breaker status, breaker operations, earth switch operations etc.) for normal running conditions.

All event data, fault records, as well as the continuous daily binary and analogue values are stored on the SAS. The Station Historian or PIS is provided by the *Employer,* where some of this information will be stored for the life of the Power Station. The *Contractor* liaises with Others to interface the SAS to the Historian or the PIS.

Switchgear must be able to be safely operated even in the case of a communication bus failure, where the communication bus is employed to exchange interlocking data between IEDs. A technical procedure is drawn up including visual sequential steps (popups) within the EOD HMI system, outlining in detail, all the steps that should be executed, to safely operate the concerned equipment. The procedure also includes all steps to be executed to ensure that IEDs retain their normal state on completion.

It is not allowed for any information pertaining to or required for control, supervision, indication, alarms, metering, measurements, interlocking, event logs, fault records etc. to be transported, stored, or archived directly on a business LAN. All networks used for this purpose are dedicated to the SAS. If an interface is required between the SAS and the business LAN, the SAS network is to be separated from the business LAN by a high reliability fire wall provided by the *Contractor*. More details are provided in section **Error! Reference source not found.**.

5.4.2 Operating WorkStation

The primary function of EOD is to control and monitor the main reticulation and monitor process feeder systems within the Power Station. The technology used for the control, as well as the HMI systems associated with it, needs to be specifically developed for electrical control, and not primarily for the control of other processes and plants like boilers, turbines, chemical plants, etc.

The SAS includes all the functionality required by the Eskom Operating Regulations for High Voltage Systems and the Eskom Plant Safety Regulations, e.g., showing the application of manual earths, permits that are in force, prohibit signs etc.

The *Contractor* is responsible to employ a comprehensive method of display, access across all types of display is provided, while always providing the operator with an overview of high-level plant status. Navigation is clear, simple, and unambiguous. Selection of any display should not require more than two keystrokes. In alarm or abnormal conditions only one keystroke is required to access the relevant display. In all cases, a standardised back track facility is available for the operator to escape from displays.

Every reticulation and process feeder system state change (breaker opening and closing) is recorded and an active mimic screen have the ability to page sequentially back through plant states.

A comprehensive and integrated alarm handing system is employed, which clearly distinguishes between different alarm types and priorities. Separate alarm lists are developed for electrical reticulation system and SAS alarms. Alarm priorities are developed in accordance with the guideline document 240-56355466. Alarm responses are developed for each alarm detailing the cause and remedial action in accordance with the guideline document 240-56355466 and are linked to the individual alarms and readily accessible by the operator through a link on the OWS alarm screens. In addition to the alarms and alarm responses, system displays are provided which show the real time health of the entire SAS and location of alarms.

Alarm information is not lost or inaccessible while navigating though displays, and alarm presentation dynamically provides the operator with information matched to the current situation and its criticality. The operator is alerted to new active alarms while navigating through displays, irrespective of which display the operator is on. Alarms from plant on permit may be required to be inhibited. True system errors are fully indicated as to type, cause, and remedial action. The history of alarms should be logged on the HMI alarm screens.

Where interlocks prevent the operation of a circuit breaker or switching device, a display is available illustrating the logic requirements with the various conditions that are satisfied and not satisfied, to aid in troubleshooting.

No set or sequence of keystrokes causes the operator monitoring and control functionality to fail or freeze. Any incorrect operation is highlighted to the operator by audible signal or text message.

The scope of EOD from an electrical control and supervision system perspective includes, but not limited to, the following:

a) MV reticulation system
b) LV reticulation system
c) DC reticulation system
d) Diesel generators
e) Batteries and battery chargers
f) Uninterruptable Power Supplies
g) Generator protection
h) On-load tap changers of the station and generator transformers
i) Active and reactive power of units
j) High level unit information that needs to be displayed at the EOD operator, such as Unit MW and Frequency
k) Status of the hardware comprising the SAS, including information buses as well as power supplies

The diagrams should automatically display and draw attention to the following:

a) Breaker, isolator/link, and earthing device status
b) Prohibiting signs associated with isolated equipment.
c) Voltages on breakers and cables
d) Protection operations

e) Currents in feeders (not dead-end load circuits)
f) State changes of all switching and state changing devices
g) Diesel generator operating parameters
h) Remaining battery capacity (estimate if not definitive)
i) Activation of the synchroniser of any unit
j) DC system status and configuration
k) Normal and abnormal operating conditions and alarms

The operator can add a manual note on the diagram display, which flags all operators' attention to the following:

a) Abnormal conditions
b) Permits in force on plant (according to *Employer's* Permit to Work System)
c) Local access of personnel in restricted areas

The following alarms are required as a minimum in terms of the electrical equipment:

a) Protection operations
b) Under-voltage conditions
c) Automatic starting (or failure to start) of diesel generators.
d) Diesel generator alarms
e) Alarms of batteries approaching exhaustion
f) Automatic chop-over activation (and failure)
g) Actions not allowed, due to interlocks not permitting the action.
h) Arming of the remote back-up protection of any unit
i) Activation of any fault or disturbance recorder
j) Interruption in the normal supply to battery chargers or UPSs
k) Alarms originating from major transformer monitoring equipment.
l) Over and under frequency conditions

The *Contractor* includes a simulator into the SAS to advise operators as to consequences of switching operations before carrying it out. Expected current, voltage and power values are available. Foreseeable overload or tripping must be flagged. The expected time durations of battery backed up systems and generate alarms of expected failure due to battery depletion are incorporated. Automatic restoration routines that recommend restoration solutions to the operator during abnormal or disrupted conditions are incorporated, which the operator can choose to allow or disregard.

5.4.3 Engineering Work Stations

The EWSs are used for the following functions:

a) Configuration of IEDs
b) Settings of IEDs
c) Configuration of OWS Displays
d) Fault/event recording
e) Archiving
f) Condition Monitoring

5.4.4 Servers

The following functions are provided on the SAS servers:

a) Fault/ event recording

b) Supervisory

c) Control

d) Data capturing

e) Network configuration

f) Self-diagnostics and network management

g) Archiving

h) Server to OWS Clients

i) Server to EWSs

5.5 SYSTEM ARCHITECTURE

5.5.1 Board Level Architecture

The IEDs on the switchgear panels are interconnected via board level network switch(es). Each board has its own board level network switch. Each IED on a board is connected to its board level switch in a star topology.

Board level switches are not shared between IEDs on different boards. The only situation where an IED not residing on a particular board is allowed to be directly interfaced to a particular board's board level switch is the case where there is only a single IED on a board, and that breaker is either directly feeding (e.g., Maintenance Isolator) or is being directly fed (e.g., Incomer or Bus Section on Low Voltage Board) by the board on which the board level switch resides.

Communication between IEDs is via the board level switches. The connection from each circuit's IED to the board level switch is a singular connection and hence no redundancy is available at this level.

The proposed board level architecture can be seen as part of drawing 0.58-60909-01-00.

5.5.2 Unit Level Architecture

The unit level architecture covers all areas of plant, namely: the units 1 to 6, the Common plant and the Outside plant. The topologies for the areas, however, are not identical. Redundant communication paths are available above the board level switches. Each board level switch is connected redundantly to redundant unit level switches. The proposed network topologies at the unit level for all areas of plant can be seen as part of drawing 0.58-60909-01-00.

Provision is made for a dedicated communication port on each unit and station level network switches for a portable EWS to be connected to the SAS LAN.

5.5.2.1 Units 1 – 6

The unit level architecture for units 1 to 6 consists of a redundant star network per unit, formed by fibre optic links and network switches. Each board level switch and RTUs (i.e., substation processors) are connected redundantly in a star topology to a pair of redundant unit level switches. Each of the redundant links from each board level network switch and RTUs goes to a different unit level network switch to prevent a common mode of failure for both links.

Where a single IED exists that cannot be interfaced to a board level switch as per the principle mentioned in section 5.5.1, the IED is connected directly to one of the unit level switches.

The *Contractor* supplies IEC 61850 compliant RTU panels with redundant processors, redundant connections to the unit level switches as per Part 1C as illustrated on drawing 0.58-60909-01-00. of this Works Information. The RTU is required for electrical equipment situated in the units which are not compliant to IEC61850 to

interface to the SAS, to allow the EOD operator to monitor and control the equipment. The RTU provided should be able to interface with Modbus protocol. The estimated number of signals for all 6 units RTU are 400 BI, 150 AI, 100 BO and 20 AO.

5.5.2.2 Common Plant and Outside Plant

The non-unitised plant is to be split into two parts. These two parts are according to their geographical location on the power station. Each part is seen as a unit on SAS network.

The unit level architecture for Common plant and Outside plant consists of a redundant ring network per unit, formed by fibre optic links and network switches. Each of the boards within each substation is connected to each other in a ring topology. Each of the substations are connected to each other and to the redundant unit level switches in a ring topology, per unit. Each end of the ring is connected to a different unit level network switch to prevent a common mode of failure for the ring. Each of the redundant links from board level network switch and RTU (i.e., substation processors) goes to a different unit level network switch to prevent a common mode of failure for both links.

The Common plant and Outside plant substations are monitored and controlled by the EOD operator using the substation automation network. The Outside plant substations are distributed far apart and far from the power islands. A star topology would be very cabling intensive for this plant. Hence a ring topology is used for the unit level architecture, which would help to reduce the amount of cabling required, at the same time providing redundancy, which is inherent in the ring topology.

A combination of ring and star topology can be used for plants in close proximity to the power islands, based on a feasibility assessment of the best design approach. Where a single IED exists that cannot be interfaced to a board level switch as per the principle mentioned above, the IED is connected directly to one of the unit level switches on the Common plant.

The Common plant and Outside plant switches at the board level serve a similar function to the unit level switches and reduce traffic flow (necessitated by interlocking requirements) through the station level switches and provide for clear network segregation as depicted on drawing 0.58-60909-01-00.

The *Contractor* supplies IEC 61850 compliant RTUs with redundant processors, redundant connections to the unit level switches on the Common plant and Outside plant as per Part 1C illustrated on drawing 0.58-60909-01-00 of this Works Information. The RTU is required for electrical equipment situated in this area which are not compliant to IEC 61850 to interface to the SAS, to allow the EOD operator to monitor and control the equipment. The number of redundant RTUs required and their physical and functional distribution is designed and optimized by the *Contractor* to achieve functional distribution and redundant communication paths to minimise the effects of equipment failure on the overall plant. The RTUs provided should be able to interface with Modbus protocol. The estimated amounts of signals RTUs is 700 BI, 80 AI, 70 BO and 20 AO.

5.5.3 Radio Link Communication

All Common plant and Outside plant reticulation equipment is required to interface to the IEC 61850 SAS LAN. Interconnection in the SAS network between Board Level Switches and Unit Level Switches is done using fibre optic cables. However, some substations are located far away (about 5km) from the power station. Use of fibre optic cables for interfacing with such plants might be cable intensive and challenging. Even so, use of fibre optic cables is preferred.

Radio link communication should be considered as an option for interfacing with the substations as illustrated on drawing 0.58-60909-01-00. The *Contractor* provides full solution and optimization of the design and equipment required accordingly, submitting both fibre optic cable and radio link options for consideration. The local control rooms located next to these plants will continue to be utilized as primary means of control. SAS will be used mainly for statuses and as a secondary means of control.

5.5.4 Station Level Architecture

The station level architecture consists of the connection of all the unit level networks to the station level network switches and of other devices connected to the station level switches.

The station level architecture consists of redundant star connections from each of the redundant unit level switches (units 1-6, Common plant and Outside plant) through dedicated links, to redundant station level switches. Each of the redundant links from each unit level network switch goes to a different station level network switch to prevent a common mode of failure for both links.

Two redundant SAS servers, two redundant HMIs, portable EWS and Station Historian are connected to the station level switches. Two local printers are required in the EOD. The interface of the SAS to the GPS Time Server and Station Historian is provided at this level. All interfaces at this level are implemented using a star topology.

Each station level switch connects to both the redundant servers. Provision is made for a dedicated communication port on each station level network switch for a portable EWS to be connected to the SAS LAN.

The proposed station level architecture can be seen as part of drawing 0.58-60909-01-00.

5.6 SYSTEM INTERFACE SPECIFICATION

The *Contractor* designs the system interfaces as per the requirement stated below in the following subsections.

5.6.1 MV Switchgear

MV Switchgear will have IEDs as per Part 1B of this Works Information. The process switchgear is interfaced to the DCS using a conventional hard-wiring method whereby each signal is allocated a dedicated wire. The interface is facilitated by a dedicated I/O card of the DCS. The control of process switchgear and process interlocking is facilitated by the DCS. The reticulation and process switchgear will be connected to the IEC 61850 based SAS Network.

The control of reticulation switchgear and electrical interlocking and protection is achieved via the IEC61850 based SAS[1]. Selected reticulation switchgear is also interfaced to the DCS using hard wiring for transfer of certain select signals for monitoring purposes.

5.6.2 LV Switchgear

LV Switchgear is required to be interfaced with the IEC 61850 SAS LAN. This interface is achieved using IEC 61850 compliant IEDs where available, whereas for switchgear without IEDs, signals are hardwired to an IEC 61850 compliant RTU (i.e., substation processors) which in turn interfaces with the SAS network. Only the LV Switchgear reticulation circuit breakers are required to be interfaced with the SAS. The *Contractor* makes provision accordingly.

5.6.3 DC Switchgear

The DC Switchgear at the Power Station is required to be interfaced with the IEC 61850 SAS LAN. The existing DC Switchgear signals will be hardwired to an IEC 61850 compliant RTU (i.e., substation processors) to interface with SAS network where Modbus communication is not available. Modbus will be used for DC Switchgear with such communication capability, hence all RTUs must be able to communicate using Modbus. All 24V and 220V DC boards reticulation circuit breakers, including board to board feeders are required to be monitored at the EOD using SAS.

[1] Electrical protection based on IEC 61850 co-exist with hardwired protection signals.

5.6.4 Transformers

All Power Station transformers (as per Single Line Diagrams provided as part of this *Works Information*) alarm and trip signals are required to be monitored via the SAS.

Where transformers are protected by IEDs, the alarm and trip signals are sent via the fibre optic cable to the SAS. The alarm and trip signals for Station Transformer are hardwired to an IEC 61850 compliant RTU (i.e., substation processors). The following signals are sent as a minimum:

a) Buchholz Alarm and Trip
b) Oil Temp Alarm and Trip
c) Winding Temp Alarm and Trip
d) PRD Operated

The 20/11kV Unit Transformers 1-6 and 20/400kV Generator Transformers 1-6 makes use of specialised gas monitoring systems, The specialised gas analysers makes use of a RS485 and RS232 ports respectively. Both systems utilise Modbus and DNP3 communication protocols. These systems are required to be interfaced to SAS using an IEC 61850 compliant RTU (i.e., substation processors). The *Contractor* makes provision accordingly.

5.6.5 Generator Protection Panels

The SAS is required to be interfaced with the IEC 61850 compliant Generator Protection IEDs for units 1 to 6 via two Ethernet port switches. The interface is for the purposes of retrieving information for monitoring the status of the generator protection system only. The SAS will also be required to interface with the tap changers for the 400/20kV Generator Transformers 1-6 and the 132kV/11kV Station Transformer.

The minimum number of signals that will be required to be monitored will be as per 240-56356401 Eskom Generator Protection Philosophy for Large Fossil Fuel Power Stations Generator with Circuit-Breaker Standard.

5.6.6 Diesel Generators

The Diesel Generators panels at the Power Station are required to interface with the IEC 61850 SAS LAN. The 3.3kV Diesel Generator relay panel forms part of the 3.3kV Station Diesel Generator Board. The *Contractor* interfaces the Diesel Generator panels with SAS by means of an IEC 61850 compliant relays.

The minimum number of signals that will be required to be monitored are as per clause 4.8.4.3 of NRS024.

5.6.7 Battery Chargers

The *Contractor* is responsible to interface the SAS with all 24V and 220V Battery Charger units at the power station including BTUs and Battery Banks.

The battery chargers RS485 port with Modbus communication protocol, as per 3.3.11 of 240-53114248 standard, will be interfaced to IEC 61850 compliant RTUs (i.e., substation processors) where available. For Battery Chargers without RS485 port with Modbus, signals will be hardwired to an IEC61850 compliant RTU. The minimum number of alarms and indications that will be required for monitoring is as per 240-53114248 standard.

5.6.8 Uninterruptible Power Supplies

The SAS is required to interface with all the station UPSs that will be provided by Others. The UPSs RS485 port with Modbus communication protocol, as per section 3.3.11 of 240-53114248 standard, will be interfaced to IEC 61850 compliant RTUs (i.e., substation processors). For UPSs without RS485 port with Modbus, signals will be hardwired to an IEC61850 compliant RTU.

The minimum number of alarms and indications that will be required for monitoring is as per 240-53114248 standard.

5.6.9 Station GPS

The time synchronisation of the IEDs internal clocks is done over the SAS network by synchronising to the existing time server that is linked to the master GPS. The *Contractor* is responsible to design the interface between the SAS and the master GPS. The master GPS is provided by Others. The fibre optic cable to the GPS is provided by the *Contractor.* The link to the time server is provided at the station level using Network Time Protocol (NTP).

The *Contractor* designs the link to the time server and SAS networks to minimise latency and ensures IEDs and RTUs (i.e., substation processors) are time synchronized to a 1ms accuracy. Time stamping of events is done at the IEDs and RTUs with a resolution of 1ms.

5.6.10 Station Historian/ Plant Information System (PIS)

The Station Historian that already exists at the Power Station, acts as a central but secondary point of information storage. Information from the SAS is required to be sent to the Station Historian. The *Contractor* is responsible for sending information from the SAS to the station historian, via a redundant OPC UA protocol link at station level. The fibre optic cable, all infrastructure requirements, software, and configuration requirements on the SAS for the OPC UA protocol link are provided by the *Contractor*.

The infrastructure requirements, software, and configuration requirements on the Station Historian to be able to accept this information will be provided by Others.

5.6.11 Power Requirements

The power supplies will be provided by the *Employer*. This includes the two Station servers UPSs and EWS UPS, which is sized by the *Contractor*. The *Contractor's* SAS equipment will be connected to the power supplies by Others. The *Contractor* provides the *Employer* with the detailed SAS equipment electrical consumption list. Power requirements for SAS equipment are as illustrated on drawing 0.58-60909-01-00 and Part 1C Appendix C2: Technical Schedule A & B.

5.7 TECHNICAL SPECIFICATION FOR CMMUNICATION HARDWARE AND APPLICATIONS

The *Contractor* supplies communication hardware and application that conforms to the requirement stated below in the following subsections.

5.7.1 Computers

The computers employ industrially hardened PC technology with proven state-of-the-art hardware based on the latest version of Microsoft Windows operating system with a RAM of 8GB or more, depending on the system requirement. The Contractor provides designs supported by calculations and reasonable assumptions for the recommended RAM size. All computers will have a minimum storage capacity of 2 months.

The engineering system is an open system allowing data to be downloaded and uploaded in the COMTRADE format. Further, it is possible to import/export messages to/from Microsoft Excel and Access for simple manipulation.

It is made possible to save all database and configuration data on both removable and non-removable media for back up purposes without taking the system off-line. It is possible to provide redundant storage media for configuration database. The system supports archive marking for variables. Marked variables are automatically archived.

The engineering software employ an intuitive MS Windows Explorer style interface, which allows the user to manage all aspects of the Input/Output (I/O) signals, Human Machine Interface (HMI), network and hardware configuration. The use of differing, inconsistent user interfaces is avoided as much as possible.

The communication ports are designed to be compatible with the communication bus system used on SAS. Provision is also made to accommodate the interface with other related systems through an Ethernet port. The computers are equipped with the communication software that is compatible with IEC 61850 communication protocol.

The system offers fast compile and download times. Standard printers are connected to the fixed EWSs for the purpose of printing reports, configuration files, HMI screen drawings, etc. A PDF printer software is also installed to allow for soft copy prints on all computers supplied.

All software is in the British English language.

An installation procedure with the required installation files is to be stored at the Power Station, where any computer which has a major failure can be replaced, configured and fully operational within 6 hours.

5.7.2 Servers

The SAS server is of a redundant active-passive type and has high availability. The data between the redundant servers is always kept in synchronism.

The health and status of the servers are continuously monitored, and any failure is alarmed via the alternate path. The loss of a single server does not affect the operation of the SAS, nor does it result in any data loss. No data corruption occurs in the event of a server crash or restart.

Individual servers can be removed and replaced without adversely affecting the operation of the SAS.

The server supports both client-server as well as peer to peer modes of operation. All the applications required for a fully functional SAS run on the same platform. The software used in the server is compatible with the software used on the EWS. All software applications that are required to run 24/7, run as operating system services.

The SAS server is required to have a dedicated screen that can be switched between the redundant servers.

Provision is also made for the SAS Server to interface with communication devices on other related systems such as LV Switchgear, Standby Power (DC system), Generator Protection, etc. In other words, the SAS Servers are expandable in a way that during design, provision is made to add information storage devices as required (i.e., a minimum of 60 days of all historical plant information is stored and available on-line for all the above-mentioned systems). If such a link is required, it can be facilitated by a RTU (i.e., substation processors) that has protocol conversion functionality, if necessary.

5.7.2.1 Communication interface

The following interface ports can be considered for communicating to auxiliary systems:

a) RJ45, RS-232C, RS-422, and RS-485 with full and half-duplex operation, and selectable baud rates (19200, 38400, 57600, and 115200)

IEEE 802.3 Ethernet port with 100 Mb/s speed. Communication protocol is IEC 61850 standard using IEC 60870-5-101 via a fibre optic coupler.

5.7.2.2 Database and information management

The *Contractor* provides an intelligent database that is maintained by the SAS server and access is provided to all EWSs. The purpose of the substation database is to manage non-real time data in the substation environment.

It is also able to handle data archiving and trending, data compression and organisation of internal data flow. It must send data to the right place where it is required, for example Quality of Supply (QoS) data to the power quality database and non-real time data to the relevant engineering database. This implies that the substation database is also divided according to the types of information stored in the database.

The data that is collected and stored consists of event records, disturbance records, statistical metering data, condition monitoring data, quality of supply data, back-up of settings, back-up of automation algorithms, wave form recordings, etc. other data that is also stored is IED technical manuals, software manuals, network data, etc.

The database can receive solicited or unsolicited messages/data from IEDs. It implies that the EWS is not only able to receive unsolicited data, but also solicit/extract data from the IEDs connected to it, by sending relevant messages to each IED.

Compact flash memory is used for storage of software and data instead of a hard disk drive. Hard disk drives are only used in addition to flash memory and are only used as an absolute last resort. Hard disk drives may only be used if *accepted* by the *Employer* in writing.

The system supplies tools for automatically backing up the database to removable media or to an alternate storage location. The backup utility executes the database backups automatically based on either of the following configurable criteria:

a) Time-based (e.g., every 24 hours)
b) Based on the size of the database (e.g., after the size reaches 1 MB)

All disturbance records are uploaded automatically to the substation database within 30 seconds of it being recorded. It is made possible to select whether the original records in the IEDs' memory is deleted or kept after transmission, to prevent the substation database memory from filling up.

It is possible to upload the engineering database contents (for example disturbance records, event records, condition monitoring data, etc. but excluding SCADA data) to an enterprise database (i.e., Historian of PIS) once a day. Only changes in the database (and not the complete database) are uploaded. The time at which these uploads are performed is user settable.

The system can perform the back-up operations both off-line and on-line.

5.7.2.3 Archiving capability

The *Contractor* ensures historical subsystems have the following specifications:

a) Provides the ability to define archiving rates in increments of milliseconds, seconds, minutes, hours, or days.

b) Can store all analogue tags at a resolution of 1 second or better, and all events at a resolution of 2ms or better.

c) Stores a minimum of 6 months of all historical plant information on-line. The recording function stores data on the First in First out (FIFO) basis.

d) Allows an individual archive rate to be programmatically modified and/or utilised as part of the control logic requirements.

5.7.3 Engineering Workstations

Substation group levels are supplied with a dedicated EWS as depicted on the SAS architecture drawing 0.58-60909-01-00. One fixed EWSs are provided by the *Contractor* at PTM offices. Two portable EWSs are supplied

by the *Contractor* in addition to the fixed EWSs, which can be fully operational if connected to any point on the IEC 61850 network.

The Human Machine Interface (HMI) level is derived from the project created on the EWS, automatically, to avoid duplicate input of information. Multi-layer technology is available for picture designing to enable clear engineering. The engineering supported with graphical resources; pure programming is not acceptable.

It is made possible to optionally obtain an application for analysis of historical data. This application must always use the original data as a base for further calculations or analysis. It is made possible to visualise variables in a user-friendly graphical format. Furthermore, it is made possible to export this data into a comma separated value file format for further analysis in other software packages, for example Microsoft Excel. It is also possible to perform all these functions online as well as offline.

It is made possible to handle the system engineering even without in-depth knowledge of object-oriented programming. Block programming sources is accessible to users. The system can detect errors in the configuration, test the connection between two different data types and reject them when applicable.

5.7.4 Operator Workstations

Redundancy of OWSs will ensure continuation of station electrical control even if one OWS fails. The *Contractor* designs the OWS on the EWSs and is running on the SAS Server. The OWS is displayed and controlled from client PCs based at the EOD.

The *Contractor* provides three (3) OWS's and displays at station level as illustrated on drawing 0.58-60909-01-00. The *Contractor* provides screens with minimum sizes as specified in Part 1C. Appendix C2: Technical Schedule A & B.

The following reports should be generated by the OWS:

a) Sequence of Events Log
b) List of all active simulations.
c) Operator Log (key stroke)

The OWS is also enabled to be used for the following:

a) Synchronisation Check (phasing)
b) Measurements
c) Quality of supply (NRS048) (with alarms)
d) Fault (event) recording

5.7.4.1 Human Machine Interface (HMI) development

The *Contractor* is responsible for the development of the HMI design, in accordance with the Human Machine Interface Design Requirements Standard 240-56355728, the *Project Manage*r accepts the designs.

Displays are configured in a clear and unambiguous manner to provide the operator with information relevant to the task. Icons and symbols are used consistently throughout the displays for all units, according to Eskom Operating Regulations for High Voltage Systems (ORHVS) 240-114967625. Symbols of plant in low level displays may be based on outline or physical structure of the plant device if ergonomically appropriate.

Colour codes used on mimics correspond to those listed in NRS 040 part 2. All voltages generated by the main generators are shown in black. A closed-circuit breaker is indicated as a solid red square and an open circuit breaker is indicated as a square outlined in green with no fill colour.

HMI Screens should not only be developed for the new MV switchgear but should include all the sub-systems the EOD interfaces to, showing all statuses.

5.7.5 Remote Terminal Unit (RTU)/ Substation Processors

The *Contractor* designs and supplies RTU that acts as a termination interface and protocol conversion system to be able to interface to the IEC 61850 network. The system accepts inputs and outputs from the plant.

All RTUs are IEC 61850 enabled and connected to the SAS Unit Level Switches with a redundant bus.

The system will be fully redundant, the *Contractor* guarantees no less than 99% availability. No single fault should stop the functionality of the RTU.

The *Contractor* proposes, for ***Employer's*** acceptance, hardware alarms (e.g., Power supply fail, CPU failure, Communication module failure etc.) to be engineered into the system as well. This is required to allow total user supervision of the system.

All modules, logic cards, power units, control and monitoring units are standard interchangeable modules which can be inserted and / or replaced with minimal or no interruption of operation of the system.

Any solution/s offered by the Contactor that do not comply with IEC 61850 or which are not specified in IEC 61850 are based on open standards and are presented to the Employer for acceptance.

5.7.6 Switching Devices

The *Contractor* ensures that 100 Mbps switched Ethernet network with a redundant bus architecture is used for the Board Level Architecture and 1 Gbps switched Ethernet network with a redundant bus architecture used for the Unit Level Architecture and the Station Level Architecture as a minimum.

Substation hardened LAN/Ethernet equipment such as switches, and routers are used in the substation environment. LAN equipment suitably specified for the substation environment is used. This refers mainly to the characteristics of the equipment, for example the electromagnetic interference specification, insulation levels, etc.

All communication equipment forming part of the SA system complies and is tested in compliance with the standard IEEE 1613™: Standard Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations. Ethernet switches used in substation automation applications comply with IEC 61850-3 standard for EMI (Electromagnetic Interference) immunity and environmental requirements to ensure reliable operation of networking equipment in substation environments.

Managed Ethernet switches are used, with features such as:

a) IEEE 802.1p Priority Queuing, to allow frames to be tagged with different priority levels, to ensure that real-time critical traffic makes it through the network, even during high periods of congestion.
b) IEEE 802.1Q VLAN (Virtual Local Area Network), to allow for the segregation and grouping of IEDs into virtual LANs in order to isolate real-time IEDs from data collection or less critical IEDs.
c) IEEE 802.3x Full-Duplex operation on all ports
d) IEEE 802.1w Rapid Spanning Tree Protocol
e) IGMP (Internet Group Multicast Protocol) Snooping / Multicast Filtering that allows for multicast data frames, to be filtered and assigned only to those IEDs which request to listen to them.

The communication system performs error free data transmission. It can perform a "fail soft" recovery from various conditions, for example communication link congestion. It is unnecessary to provide redundant communication services, but it is possible to support redundancy. It is also able to support complete redundancy, even though it is not required in all cases.

5.7.7 Communication Cables

The communication channel between different devices and systems are facilitated by fibre optic links. The *Contractor* provides this fibre optic cabling between the different SAS equipment including Generator Protection, Historian or PIS, and the Master GPS clock. Multimode fibre optic cables are used for all the short distance communication requirements and the single-mode type are only considered for long distance communication. The *Contractor* provides the total cost for fibre optic cables as well as the price per metre costing. Costing takes into consideration the distance between the substations and as well as cable routing, using SAS Architecture drawing 0.58-60909-01-00 and the Station layout drawing 0.58/4 as the basis. The *Contractor* advises and designs for optimised alternative solutions for SAS network configuration.

The *Contractor* is responsible to ensure that cables installed outside the boards have adequate protection to minimise the possibility of physical damages. Environmental conditions are also taken into consideration while selecting such a cable.

The colour of the outer insulation (i.e., sheath or jacket) of all the fibre optic cables is GREY. The cables have Low Smoke and Fumes (LSF) sheath to ensure that the cables are not liable, like ordinary PVC cables, to produce corrosive halogens and copious smoke in the event of a fire.

The communication cables are designed such that there is minimal number of connections to limit the losses. The attenuation as well as the bandwidth of the communication link is optimised to allow for optimal data transfer.

The control cabling that will be hardwired to IEC 61850 compliant RTUs (i.e., substation processors) will be in accordance with 240-56227443 standard.

5.7.8 Time Synchronisation System

The *Contractor* is responsible to design the system in such a way that all devices connected to the SAS network are synchronised over the network using the Network Time Protocol (NTP). The internal clocks are time synchronised for time stamping with a resolution of 1ms. The time synchronised devices, such as the IEDs automatically recover, without any user intervention, should there be an interruption of the time synchronisation signal.

In case NTP cannot be supported by the devices offered, the *Contractor* indicates and lists all GPS protocols that are compatible with the IEDs and the hardware requirements for the communication interface.

For general purposes, ±1ms is sufficient accuracy, and for higher accuracy data such as analogue data sharing, 1 µs ± 0,5 µs.

5.8 PERFORMANCE

Message types are subdivided into performance classes. There are two independent groups of performance classes, one for control and protection, another one for metering, monitoring and disturbance recording applications. The transmission time for the different message types complies with the performance requirements specified in IEC 61850-5 Clause 11.1.1.4.

The port-to-port transmission time of a protection command by making use of a GOOSE message as defined in IEC 61850 over the Ethernet LAN is less than 4ms. The delivery time of a message is the time allowed to transfer routinely updated data elements from a sending to a receiving IED and it must be less than the average update interval. It implies that peer-to-peer communication is a minimum requirement for a system that is expected to perform protection functions and communicate over the LAN network within the specified 3ms time frame.

The communication system is, under maximum conditions, i.e., when all devices are communicating simultaneously; only operate at a maximum of 30% of capacity.

There are three categories of timing constraints for data transfer intervals and all three are provided for:

a) high speed, less than 3ms;
b) medium speed, 3ms < t < 15ms, and
c) slow speed t > 15ms.

The following functional performance and timing criteria is also adhered to:

a) time to send a control command/message (< 20ms)
b) time to send or receive a protection message (< 3ms) (port to port time)
c) time to send and receive an interlocking message (< 20ms)
d) time to display a state change (< 500ms)
e) time to display analogue input (< 500ms)
f) time to display alarm (< 500ms)
g) time to change HMI screen view (< 1000ms)
h) time to change control mode (e.g., from local to remote) (< 50ms)
i) automation function execution time (< 20ms) (calculation of algorithm, excluding the field execution)
j) boot up of the complete system and its respective components do not take longer than 30 seconds. The *Contract* supplies typical boot up times of other systems of similar size/complexity.

The speed of operation/execution of any operation of any kind is not slower or worse than with a conventional protection, control and automation system implemented via hard wiring instead of Ethernet communications.

As a guideline from IEC 61850-5 Clause 15, during abnormal or emergency loads the substation bus can handle at least two times the loading of the normal load. The *Contractor* demonstrates this specified performance through design consideration and testing during Factory Acceptance Testing. As part of the detail design package to be compiled after *Contract* award, the total system structure as well as detailed calculations of bus loading, reliability and availability is provided to the *Employer* for *Acceptance.*

5.9 AVAILABILITY

The overall substation automation communication system has 99.99 % availability for all protection functions and 99% for all monitoring and control functions. The Mean-Time-To-Failures (MTTF) of all components used to build the SAS is at least 50 years.

The basic philosophy is predisposed towards simplicity. Equipment that may reduce the reliability of the system is duplicated. This includes for example computer hard drives (if provided at all). Devices such as power supplies, communication links, computers (where applicable) and analogue inputs are also designed in such a way that the MTTF defined above may be adhered to.

5.9.1 Redundancy

The following redundancies will be provided in the third-party interfaces:

a) The third-party network equipment will be fully redundant such that:
    - Any single failure in the network will not cause data to be lost.
    - Any single failure in the network and the subsequent transfer to the redundant path will not disrupt the third-party system.
b) All redundant equipment will be hot-swappable, and the running Third-Party system will not be disrupted by the replacement of redundant equipment.

5.9.2 Maintainability

5.9.2.1 General

The third-party interface equipment will not be modified or adapted to such an extent that:

a) Future upgrades to the software and hardware require customisation for the Power Station before implementation.

b) Special adaptation or configurations are required for the implemented design.

Emergency plans will be provided for system failures and faults such that appropriate measures can be taken immediately without having to first analyse the cause of the failure.

5.9.2.2 Life expectancy

a) The design life expectancy of all equipment and software forming part of the SAS is least 15 years. However, a minimum of 7 years will be accepted for HMI.

b) The *Contractor* will provide his latest power plant proven technology for the Works.

c) No unproven technology is provided.

d) All future hardware and software upgrades for the system will be backward compatible with the existing third-party systems.

e) All network, equipment will be available in South Africa as commercially- off- the-shelf (COTS) products.

5.10 CYBER SECURITY

The purpose of cyber security in a power plant is to ensure that the power plant can safely and securely operate regardless of external threats to the SAS.

The 240-129014618 Generation Cyber Security Compliance Guideline shall be applied to power plant automation for the mitigation of cyber risk.

In addition, the following standards shall be part of the OT/IT strategy for this project:

a) 240-55410927 Cyber Security Standard for Operational Technology

b) 240-55863502 Definition of Operational Technology (OT) and OT/IT Collaboration Accountabilities

c) 240-56355910 Management of Plant Software Standard

d) 32-85 Eskom Information Security Policy

IT/OT Eskom network interface requirements to be adhered to.

5.10.1 Functional Requirements

a) All network switches' unused ports will be blocked via the network management system.

b) Access to the network switches will be possible via SAS workstations.

c) USB ports on all the servers and workstations will be software locked to prevent data access via USB storage devices, unless otherwise specified otherwise.

d) As a minimum, software firewalls will be installed on all Engineering Workstations.

e) Host intrusion detection sensors (HIDS) will be installed on all workstations and servers.

f) Antimalware (including antivirus) software will be installed on all workstations and servers. Updates should be able to be done from a central update system.

g) The boundaries of the SAS with any 3rd party systems will be protected via an electronic security perimeter (ESP) as defined in section 5.10.2.

h) All servers and workstations will be installed and have the capability to be regularly updated with the latest OEM approved security patches on all servers and clients. Patch management will be performed preferably from a central update system.

i) OEM-approved updates for firewalls will be installed regularly during the execution of the works to maintain the required protective functionality.

j) Unauthorised access will be denied on all servers and clients' Basic Input Output System (BIOS) through password protection.

k) All servers and workstations are provided with whitelisting software so that only approved applications are allowed to run. Through the whitelisting process, only applications and services that are necessary will be activated on servers such that communication and potential points of attack are restricted to an absolute minimum.

l) All users with extended access rights such as administrators, engineers, etc. are automatically logged off after a pre-defined idle time.

m) All actual security conditions and the initiated and implemented measures will be documented in a uniform structure in a cyber-security manual. The manual lists all points on the issue of cyber security.

n) All access to data and systems will be recorded in access logs.

o) The Contractor implements system hardening of the SAS and its applications as per Eskom's cyber security guideline.

p) The Contractor provides a software facility to perform the comprehensive sanitation of removal media storage.

q) A comprehensive backup system must be provided to create backups of all workstations and servers.

r) The Contractor provides restoration technology that will allow the comprehensive restoration of the SAS data and configurations, including network equipment.

s) Detection of malicious activity and cyber security threats must be alarmed to the system administrator via the relevant workstation(s).

t) The SAS must provide functionality to securely, centrally and remotely manage users and user rights. This must be as per the Eskom cyber security standard for OT.

5.10.2 Electronic Security Perimeter (ESP)

a) The boundaries of the Power Station's SAS system will be protected from unwanted intrusions via a demilitarized zone (DMZ). The vendor's DMZ is configured as per 240-79669677 Demilitarized Zone Designs for Operational Technology.

b) The workstations or servers in the DMZ or buffer zone will be the only means of communication between any 3rd party systems and the SAS.

c) Open 3rd party systems are defined as being any network, system, computer or component with a connection or interface to an external system.

d) The only external network connection the SAS will have will be with the station PIS.

e) The DMZ will be implemented using redundantly configured firewalls.

5.10.3 Firewall Requirements

a) The external facing firewall shall be a Layer 7 UTM (Unified Threat Management) with IPS (Intrusion Prevention System) functionality. The layer 7 UTM and IPS can be on the same security appliance or be separate security appliances.

b) Firewall rules must be implemented according to 240-79669677 DMZ designs for OT.

c) Firewalls should be physically accessible in the event of a cyber-attack. The firewalls should be able to be physically disconnected. The firewall shall also be logically accessible and all relevant interfaces on the firewall, besides the management interface, shall be able to be disabled.

d) Firewall / UTM logs shall be logged locally. These logs must be stored securely.

e) All management connections to the firewall shall be logged. Management of the firewall should only be allowed from specified hosts, or a dedicated management network.

f) As few ports as possible will be opened on the UTMs. Only ports that are needed will be opened.

g) The firewall should be hardened according to 240-129014618 Generation Cyber Security Compliance Guideline.

5.10.4 Certification, Compliance and Assessments

a) The *Contractor's* Technology is certified in accordance with:

   i) IEC 62443-4-2 "Security for industrial automation and control systems Part 4-2: Technical security requirements for IACS components".

   ii) IEC 62443-4-1 "Security for industrial automation and control systems Part 4-1: Secure product development requirements".

   iii) IEC 62443-3-3 "Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels". The certifier also performs vulnerability identification testing.

b) The overall control system design shall be certified in accordance with IEC62443-2-4 and IEC 62443-3-3. The design of the control system solution is IEC62443 Security Level 2 compliant.

5.10.5 Access Control

Access security in the substation communication domain is extremely important and is managed similarly to the office environment. It should be noted that the consequences of a security breach can be severe and could lead to an outage at a specific substation, but also to a network wide outage or blackout should individuals with criminal intent attempt and succeed to breach security of the substation automation and control communication network. This implies that the necessary security levels such as firewalls and virus protection are built into the design by the *Contractor*.

The *Contractor* installs approved Eskom Virus protection programs on all computers, preventing the substation automation network to be infected by viruses and other malicious software. The virus protection will be automatically updated daily through the Eskom LAN.

A suitable security access control process is implemented for the system. This access control system provides access to the substation bus. Each user is issued with a login name and password, which is user selectable after the first login. This ensures for example that only authorised users have the rights to operate switchgear and others are only able to perform monitoring functions.

The *Contractor* derives the suitable access categories for the SAS. The following defines the proposed categories of access and allowable actions per category:

Table 4: Definition of access categories for security purposes

Category 1:	Allow access for the purpose of viewing data, settings, disturbance records, etc. and getting access to the substation SCADA system/HMI excluding the ability to perform any controls. In this level the user is unable to make any changes. This level does not necessarily require a password attached to it; this may be the default view.
Category 2:	Allow the operator to have access to the substation HMI system for the purpose of controlling plant.
Category 3:	Allow the protection staff to have access to protection relay configuration and settings, disturbance records, CM equipment configuration, etc.
Category 4:	Allow communication bus maintenance to be executed (network administrator rights, full access).

It is made clear that the above categories do not reflect any ranking and are not mutually exclusive. For example: protection staff would be provided access to the system for category 1 and 3, operating staff only to category 2, etc. Also, category 1 is not higher than 4, and 4 is not higher than 1.

5.11 SPECIFIC TESTING REQUIREMENTS

The *Contractor* complies with the terms and definitions for testing specified in IEC 61850-10 Clause 3.

The *Contractor* also ensures that the SAS undergoes conformance testing as laid out in IEC 61850-10 Clause 5 and 6. The SAS also undergoes performance testing, which includes communications latency, time synchronisation and accuracy testing as laid out in IEC 61850-10 Clause 8.

The required values of accuracy and allowable error are documented in IEC 61850-5 Clause 11.1.1.4.

For each bus interface type a protocol FAT should be done to prove that both devices concur to the protocol prior to installation and can be used on site.

The *Contractor* also verifies network redundancy switch change-over.

5.12 DOCUMENT LIST

5.12.1 Design Philosophies

The *Contractor* submits the following high-level design documents during tendering stage, forming the basis of subsequent design philosophies and detailed design reports and procedures specified:

a) SAS Architecture
b) High-level Communication Philosophy.
c) Substation Automation System (SAS) LANs and VLANs Configuration Philosophy
d) Data Recovery philosophy that will form the basis of a Disaster Recovery procedure.
e) Basic Failure Mode, Effects & Critically Analysis (FMECA).
f) Basic RAMs Study
g) Alarm Rationalisation and Response Philosophy.
h) Traffic Management and Quality of Service Philosophy.
i) Cyber Security Configuration philosophy
j) Performance verification philosophy according to IEC 61850-10 Clause 3, as specified in Section 5.10.

5.12.2 Detailed design reports and procedures

As a minimum, the *Contractor* submits the documents listed below following an accepted Vendor Document Submittal Schedule (VDSS).

a) SAS Architecture
b) Communication Architecture, including clearly marked VLANs using different colours.
c) Detailed RAMs Study
d) Detailed Failure Mode, Effects & Critically Analysis (FMECA).
e) Disaster Recovery procedure
f) SAS Functional specification
g) Detailed Cyber Security Configuration
h) List of Applicable Software Tools
i) Settings and Configuration files, where applicable (Hard and soft copies).
j) Detailed Application of Traffic Management and Quality of Service.
k) Method statement for the verification of the system performance according to IEC 61850-10 Clause 3, as specified in Section 5.10. The method statement is used to develop a testing procedure.
l) Signal Data Lists for all signals from RTUs (Units and Common Plant), as well as all PA schemes.

5.13 LIST OF DRAWINGS

This is the list of drawings issued by the *Employer* at or before the Contract Date and which apply to this contract.

Note: Some drawings may contain both Works Information and Site Information. All the drawings listed below, are for Matimba Power Station.

Drawing Number	Drawing Description
0.58-60909-01-00	Substation Automation System - Architecture Overview

6. PART 1D: C&I INTERFACE – DESCRIPTION OF THE *WORKS*

6.1 EXECUTIVE OVERVIEW

The *Contractor's* design, engineering, installation, and commissioning is done at Matimba Power Station. The *works* include:

3rd Party System Interfaces to the proposed Substation Automation System (SAS):

- Plant information System (PIS) interface
- Station clocks for time synchronization.

MV Process Switchgear interfaces, of the Common Plant, to the existing Common Plant Control System for the operation, control, protection, interlocking and monitoring of the Process Switchgear.

Electrical Operator Desk (EOD) Control Room Ergonomics requirements of the proposed SAS including display clocks on the EOD wall.

6.1.1 The Scope of the Works Includes:

Engineering, design, procurement, manufacturing, delivery, off-loading at site, storage, installation, testing, commissioning, and as-built documentation for all C&I system and C&I interfaces listed above.

Removal and/or relocation of existing equipment.

Any live Works or Plants to enable effective execution of the above works. The temporary works may include but not limited to:

- Provision, pulling and termination of control cables, to the temporarily installed Switchgear Boards.
- Commissioning of Control systems interface for the temporarily installed switchgear.
- Provision of any special tools, software, and documentation to allow and support installation of temporary switchgear.

6.2 *EMPLOYER'S* OBJECTIVESAND PURPOSE OF THE *WORKS*

6.2.1 Purpose and Objectives of the *works*

The objective of the works includes the interface of the existing third-party systems in order to:

- Provide long term information storage of selected data from the SAS via the existing Plant Information System, as well as
- To enable timestamping at the SAS via the interface to the Unit Process Automation System common network.
- Provide an Interface of the Common Plant Control Systems related to Common Plant process MV switchgear, to ensure remote monitoring and control is achieved for these switchgears from the Outside Plant Control Room (OPCR) Human Machine Interfaces (HMIs).

Standardised and integrated technology platforms and products will be used in the works such the interfaces to the third-party systems are both reliable and maintainable.

Individual components will be maintainable and replaceable online without impacting the running plants.

Only proven-in-use power plant technology is provided for the works.

The objective of the *works* is further to provide the Ergonomic requirements of the Operator workstation HMI equipment installed inside the EOD Control room.

6.3 ENGINEERING AND THE *CONTRACTOR'S* DESIGN

6.3.1 *Employer's* Design

6.3.1.1 Design Interfaces: Third-Party Systems

The *Contractor*'s design interface of the third-party interfaces is provided by the *Contractor*.

The *Employer's* 3rd party systems, to which the *Contractor's* design is to interface to, are described in Section 6.12.

The *Contractor*'s design interface of the common Plant MV process switchgear as per the IO block diagrams in Appendix D3.

The *Contractor*'s design interface of the Common Plant MV process switchgear as per the Limits of Supply and Services in Appendix D4.

6.3.1.2 Design interfaces: Ergonomics of the EOD Control Room Operator Workstation

The Substation Automation System *Contractor*'s design of the EOD Control Room Operator Workstations provided by the SAS *Contractor* as per section 6.15.

6.4 PARTS OF THE WORKS WHICH THE *CONTRACTOR* IS TO DESIGN

6.4.1 Overall Requirements for the *works*

The *Contractor* will provide the whole of the works as defined in this document and the appendices listed in section 6.4.2 except where explicitly stated as otherwise.

The *Contractor* will provide all equipment and services and execute all works to fulfil all requirements specified in this document and the appendices listed in section 6.4.2.

This will include the engineering, design, procurement, manufacturing, delivery, off-loading at site, storage, installation, testing, commissioning, optimisation, and as-built documentation for the interface to the Third-Party systems listed in section **Error! Reference source not found.**.

The *works* will comply with the professional engineering practice and standards for fossil fuel power plants stipulated in the *works* and will be designed for the environmental conditions prevailing at the Matimba Power Station.

The SAS and MV switchgear interface scope will provide all functions related to:

- Monitoring and Control of all relevant MV switchgear from Outside Plant Control Room (OPCR).
- GPS timestamping on the SAS via the new Unit Process Automation System.
- Long term information storage via the existing PIS.

The functions listed above will provide a complete functioning system.

6.4.2 Scope Defining Documents for the *Works*

The *Contractor* will provide the designs and documentation that are defined in this document and also in the following documents:

- Appendix D1: Technical Documentation Index.

The *Contractor* will provide the C&I system interfaces to meet the requirements that are defined in this document and in the following documents:

- Appendix D2: Drive Schedule.
- Appendix D3: Function IO Block Diagrams.
- Appendix D4: Limits of Supply and Services.

The *Contractor* will include for the removal of the existing operator workstations during the replacement of the last substation electrical reticulation switchgear replacement.

6.4.3 *Contractor's* Power Plant Reference Background

The *Contractor* provides the following information upfront during the Enquiry processes:

The Tenderer provides two (2) reference projects whereby the following scope of work was executed as a minimum:

- Interface of field equipment (preferably Medium Voltage switchgear) to ABB P13 PLC's,
- Installation of additional IO Cards on ABB P13 PLC systems,
- All Engineering activities including but not limited to modification to logics, ABB Melody HMI mimics, etc. on ABB P13 and ABB 800XA systems.
- Engineering activities performed by the Tenderer for the third-party systems must include the Application Engineering.

- Engineering activities performed by the Tenderer for the Third-party systems must include the Field Engineering
- Engineering activities performed by the Tenderer for the Third-party systems must include commissioning and testing.

6.5 EXECUTION STRATEGY AND PROCEDURE FOR SUBMISSION AND ACCEPTANCE OF *CONTRACTOR'S* DESIGN

6.5.1 General Requirements

During the project execution, the *Contractor* will:

- Be responsible for carrying out all activities and supplying everything to provide the works;
- Conduct clarifications with the *Employer*, and others;
- Identify and resolve any process control issues that are encountered;
- Identify and resolve any discrepancies, ambiguities and errors encountered with the input documentation;
- Execute and complete all activities defined in sections **Error! Reference source not found.** to 6.5.6;
- Submit and update all engineering deliverables as defined in Appendix D1.

All activities forming part of the project execution methodology shall be reflected on and scheduled according to the Approved Programme.

6.5.2 Upfront Training

6.5.2.1 General

Upfront training will be provided such that the *Employer* is fully conversant with all aspects of the supplied technologies.

This training is provided at the beginning of the project and its objective is primarily to ensure that the *Employer's* Engineering, Operating and Maintenance team involved in the design understand the *Contractor's* technology and general design philosophies prior to reviewing project specific designs.

More on training is detailed in section 3.29.2.

6.5.3 Interfaces to Third-Party Systems

All Third-Party System interfaces will be co-ordinated to ensure the overall design is complete and well-engineered.

6.5.4 Erection and Installation

6.5.4.1 General

The objectives of erection & installation phase will be to:

- During erection & installation, the construction and SIT deliverables defined in Appendix D1 will be updated and submitted.
- Erection & installation will include hold and witness points, whose participants may include:

Erection & installation will include, but not be limited, to the following hold and witness points:

- Quality and inspection tests;

- Site integration testing (SIT).

  For on-site inspections preliminary notification of readiness for hold and witness points will be given at least three weeks in advance.

6.5.4.2 Quality and Inspection Tests

Quality inspections and tests will be carried after erection to verify the compliance of the installation with the approved design.

Eskom authorised representatives can inspect all parts during erection and may be present at any of the quality inspections and tests.

The first type of any erection and installation activity will be approved before any repeat installations of this type of erection and installation activity.

The first type of any erection and installation activity will be used as reference in conjunction with the approved design.

All parts and equipment may be inspected at any stage during its erection. To this end, additional hold and witness points may be specified.

All test equipment will be provided for any inspections and tests.

6.5.4.3 Site Integration Test (SIT)

All Third-Party System interfaces will undergo SIT.

The site integration test will be conducted onsite with all equipment in their final locations.

The SIT will be conducted in compliance with IEC 62381.

During SIT, it will be demonstrated that the Power Station's C&I system meets the requirements of:

- The specification;
- IEC 62381.

6.5.4.4 SIT Completion

Erection and installation will only be considered complete when:

- The quality inspections and tests for all plant systems in the control island concerned have been approved by the Eskom authorised representatives.

The SIT will only be considered passed and complete when:

- All necessary functions according to the SIT procedures and specifications, with the exception of the mutually agreed remaining punch-list items, have been successfully demonstrated and;
- The Eskom authorised representative indicates the SIT as "PASSED" on the signed the SIT certificate.

In the event that the SIT is "FAILED", the SIT will be redone once all defects have been resolved.

6.5.5 Commissioning

6.5.5.1 General

The objectives of commissioning phase will be to:

- Bring into service all equipment such that requirements and performance criteria of the specification are met.

During commissioning, the commissioning and OAT deliverables defined in Appendix D1 will be updated and submitted.

Commissioning will include hold and witness points, whose participants may include the *Employer*;

Commissioning procedures will be provided by the *Employer*

Commissioning will include, but not be limited, to the following hold and witness points:

- Cold commissioning checks;
- Hot commissioning checks;
- Operational acceptance test (OAT).

Commissioning will be conducted in compliance with IEC standard, Commissioning of electrical, instrumentation and control systems in the process industry—Specific phases and milestones, IEC 62337 and IEC standard, Electrical and instrumentation loop check, IEC 62382.

During commissioning, it will be demonstrated that the C&I system interfaces meets the requirements of:

- The specification;
- Detailed design freeze;
- IEC 62337;
- IEC 62382.

Commissioning will include, but not be limited, to the following tests and inspection:

- Testing of all sequences, closed loop controls, and interlocks.
- Tests and inspections defined in IEC 62337;
- Tests and inspections defined in IEC 62382;

Commissioning will be performed in active cooperation with Eskom.

All test equipment and spares required for commissioning will be provided.

6.5.5.2 Prerequisites

The prerequisites for cold commissioning will be as follows:

- The commissioning deliverables defined in Appendix D1 for the applicable plant system submitted and approved.

Cold commissioning will only begin when the prerequisites have been met.

The prerequisites for hot commissioning will be as follows:

- The cold commissioning test report as defined in Appendix D1 for the applicable plant system submitted and approved.

Hot commissioning will only begin when the prerequisites have been met.

The prerequisites to start the OAT will be as follows:

- All control system hardware and software fully connected and communicating in real-time with the plant and field devices;
- Third party systems fully connected and communicating real-time information with the Substation Automation System.
- SIT completion documents package defined in Appendix D1 submitted and approved.
- SIT successfully completed.
- All cold commissioning and hot commissioning checks successfully completed.

The OAT will only begin when the prerequisites have been met.

6.5.5.3 Cold Commissioning Checks

The objective of cold commissioning will be to test the operation of equipment before the process is placed in operation and will be performed without the process in operation.

Cold commissioning tests can be performed using test media.

Cold commissioning will include, but not be limited, to the following tests and inspection:

- Electrical and instrumentation loop check as defined in the IEC standard, Electrical and instrumentation loop check, IEC 62382;
- Documentation checks;
- Visual inspections;
- Function checks;
- Electrical drive tests;

Function checks will include, but not be limited, to the following:

- Measurement loop checks;
- Interlocks, feedbacks and commands of drives;
- Sequence logic operation;
- Analogue control loops function;
- Interfaces to black-boxes.
- LCS function checks.

Valve and damper tests will include, but not be limited, to the following:

- Safety related checks;
- Rotation / direction of motion;
- Special function limits;

All electrical drives will be local and/or remotely operated and will be checked for correct operation.

Electrical drive tests will include, but not be limited, to the following:

- Safety related checks;
- Rotation / direction of motion;
- Protection.

It will be certified that equipment is in a suitable and safe condition for use before it is placed in service. This will include all tests required to ensure safe and accurate measurements such as blow through of measurement lines, pressure testing of measurement lines, filling of reference pots, leak testing, etc.

6.5.5.4 Hot Commissioning Checks

The objective of hot commissioning will be to test and verify the plant while systematically starting up the process such that that at completion of hot commissioning the plant is deemed available for safe plant operation.

In preparation for plant production, hot commissioning will include functional and safety testing while the process is active.

The individual control loops will be pre-tuned to allow for unit synchronisation and initial loading.

All C&I system equipment and the interfaces to black-boxes will be hot commissioned to demonstrate that the requirements of the specification are achieved.

Eskom will be responsible for the preparation of the mechanical and process plant for hot commissioning.

6.5.5.5 Operational Acceptance Test (OAT)

All C&I system equipment will undergo OAT.

The operational acceptance test will be conducted with all C&I equipment fully connected and communicating in real-with the plant and field devices.

Prior to the OAT, the control system will be pre-tuned in order to prevent deviation limits of process parameters from exceeding the maximum permissible values.

During OAT, it will be demonstrated that the C&I system interfaces meets the requirements of The specification:

The OAT will include, but not be limited, to the following tests and inspection:

- Testing of the individual control loops against the acceptance criteria;
- All OAT tests and inspections.

There will be no standing alarms related to cubicle or other C&I system faults at the end of the OAT.

6.5.5.6 OAT Completion

Cold Commissioning will only be considered complete when:

- The cold commissioning test report for all plant systems in the control island concerned have been approved by the Eskom authorised representatives.

The OAT will only be considered passed and complete when:

- All necessary functions according to the OAT procedures and specifications, with the exception of the mutually agreed remaining punch-list items, have been successfully demonstrated and;
- The Eskom authorised representative indicates the OAT as “PASSED” on the signed the OAT certificate.

If the OAT is “FAILED”, the OAT will be redone once all defects have been resolved.

6.5.6 As-built

6.5.6.1 General

The objectives of As-Built phase will be to:

- Verify the As-built documentation baseline of the Third Party System Interface.

For the As-Built, the As-Built documentation package defined in Appendix D1 will be updated and submitted.

6.5.6.2 Completion

Approval of the 'As Built' documentation will be a pre-requisite for the Sectional Completion of the Plant Area concerned.

6.6 COMMISSIONING AND INSTALLATION EQUIPMENT REQUIRED TO BE INCLUDED IN THE WORKS

The *Contractor* provides all specialised test Equipment for inspections and tests during initial installation, replacement, and commissioning.

This is inclusive of all Equipment necessary for the installation, testing, removal, replacement, debugging, troubleshooting, calibration, and commissioning of the control system modules, sub-assemblies, network equipment, and field equipment.

All Equipment used is provided to the *Employer* at completion.

6.7 DESIGN AND AS-BUILT DOCUMENTATION

6.7.1 General Requirements

Soft copies and hard copies of each document specified in Appendix D1 are provided at the stages defined in Appendix D1.

All documentation is accessible in paper form and addressable in databases.

All documentation is in British English.

6.7.2 As-built Documentation Package

3 hard copies and 2 soft copies of As-built documentation are provided by the *Contractor* as part of the works.

The *Contractor* signs of on the completeness of the As Built documentation package.

6.7.3 Computer Aided Design (CAD)

All CAD drawings provided during the various stages of the project can be edited and viewed using Bentley Micro station.

The Bentley Micro station version used is agreed with the *Project Manager*.

6.7.4 Documentation Modification

The *Contractor* provides additional and amended pages, sufficient for all copies of manuals or document sets to ensure that they are complete, inclusive of detail such as final settings and modifications.

The *Contractor* updates the soft copies of all documentation on the engineering system to ensure that they are complete, inclusive of detail such as final settings and modifications.

Amendment information is forwarded to the *Project Manager*, within the period for reply, following receipt of agreement to equipment or system design modifications.

6.7.5 Vendor Document Submittal Schedule

Appendix D1 specifies the following:

- The type of documentation which is provided.
- The native/original format in which the soft copy of the documentation is provided in addition to the .pdf soft copy.
- The limits of supply of the documentation (clarifying the provider and maintainer of the documentation).
- The stage in the project execution during which the documentation is provided as a deliverable.

Appendix D1 defines the type of technical documents that are exchanged during the project execution only. It is not a document index that lists each and every document technical document.

Hardcopies, .pdf soft copies and native/original softs of each document specified in Appendix D1 are provided at the stages defined in Appendix D1.

All documentation submitted by the *Contractor* conforms to all the requirements of the technical documentation index and are in an adequate state of completeness.

6.7.6 Composite and Single Documents

The *Contractor* produces composite document packages consisting of the single documents defined in Appendix D1.

The basic descriptions and minimum expectations of the composite and single documents are described in the sections below in addition to the information provided in Appendix D1.

6.7.7 Technical Documentation Index

The technical documentation index is a comprehensive index and hierarchical view of the entire documentation package provided as part of the Works.

The technical documentation index is created from Appendix D1 and the following principles:

- All composite documents and document sets contain a list of documents within them that defines the documents that make up the composite document and/or document set.

The technical document index contains metadata as defined in VGB R171 e on each document in the document package.

The technical documentation index provides a clear indication of its content and consists of documentation that are specific to this project.

The document synopsis & hierarchy includes the format and layout of each document in the documentation package.

6.7.8 Operating, Maintenance and Training Manuals

The Operating, Maintenance and Training manuals provided as part of the *works* complies with the requirements of the following standards:

- IEC 62079.
- VGB R171 e.

The standard (IEC 62079) prescribes the type of information that is supplied by originators of user information, catalogues and schedules and other product support documentation required by the *Employer*. It also prescribes the quality of documentation that is provided by the *Contractor*.

The manuals are produced based on the agreed manual synopsis which forms part of the technical documentation index.

The manual synopsis is a separate document from the documentation synopsis & hierarchy.

All manuals provided are in British English.

The quantity of manuals provided per unit shall be as follows:

Table 5: Quality of manuals

Manuals	Hardcopy	Soft Copy
Manual Synopsis	1	1
First Draft	1	1
Final Draft/Pre Print Proof	1	1
Final Manual	3	2

The manuals are submitted to the *Project manager* in the electronic format stipulated in Appendix D1.

Manuals for the control and monitoring of the plant using the HMI, which include navigation, alarm handling, normal and out-of-normal operations, plant start-up and shutdowns, are written by the *Contractor*, with the assistance of the *Employer*.

System manuals that describe the design, operating and maintenance philosophies of the C&I system, its sub-systems and components are provided.

A training skills profile report details the required skill profile needed by operating/maintenance staff in order to adequately/safely operate/maintain the plant and Third-Party System Interfaces equipment is provided.

6.7.9 Electrical Hook-ups (Loop wiring drawings)

The *Contractor* provides a detailed electrical hook-up drawing (loop wiring drawing) per drive which show the full wiring details from the source of all related signal(s) through all intermediate equipment (junction boxes, etc…) up to the final termination point of the signal(s) at the Automation Unit I/O modules.
All wiring details are shown including terminal numbers, wire colours, cable KKS, all equipment and signal(s) KKS, channel assignment etc.

6.7.10 Third-Party System Interface Design Specification

6.7.10.1 Plant Coding Philosophy

The *Contractor* produces a plant coding philosophy document which will define the conventions and standards that will be followed for the KKS codification of all components/equipment supplied by the Contractor.
The rules and conventions defined in the plant coding philosophy are based on VGB 106e and the VGB 106e codification application explanations.

6.7.10.2 Signal Description Philosophy

The *Contractor* produces a signal description philosophy which will define the conventions and standards that will be followed throughout the execution of the works for coding and describing of all signals.
The signal description is produced with input from the *Employer* to ensure the existing signal descriptions are maintained as far as possible.

The rules and conventions defined in the signal description philosophy are based on the VGB 106e codification application explanations.

6.7.11 Third-Party System Equipment Schedule

The Third-Party System equipment schedule contains a list of all Network equipment in the third-party systems concerned.

As a minimum, the following characteristics of each equipment are shown:

- Equipment KKS.
- Equipment description.
- Equipment characteristics (IP address, host name, MAC address, etc…).
- Equipment type (server, switch, patch panel, screen, KVM, etc…).
- Room location.
- Product number.
- Reference to product user guides.
- Reference to relevant cubicle drawing/room layout drawing.

6.7.12 Software Inventory

The *Contractor* provides a document listing all software packages indicating as a minimum:

- Software name
- Point of installation
- Version number
- Third-party system

The details of the licensing requirements of the software packages are provided and the numbers of licenses that are provided are included.

A basic list of the software packages that is provided with version numbers and number of licenses is available at basic design freeze. The list will be completed at detailed design freeze.

6.7.13 List of Open Points (LOP)

The *Contractor* is responsible for maintaining a list of all open/unresolved technical issues throughout the project.

The LOP is used to drive resolution of open items and determine which items need to be closed before the next relevant design baseline can be declared.

6.7.14 Recommended Spares Holding Schedule

The recommended spares holding schedule details the recommended optimal spares holing for all types of equipment taking into account the following as a minimum:

- Number of components in the C&I system.
- Criticality of components.
- Mean time to failure of components.

- Lead time for new components.
- Reparability of components.

6.7.15 Network Architecture

6.7.15.1 Physical Network Configuration Drawings

The physical network drawings are generated per Third-Party system interface and indicates the following items as a minimum:

- All components of the system (excluding power supplies) identified by KKS code.
- All components located in their relevant locations i.e., room/cabinet/rack etc.
- Indicate cable types and the network to which they belong.
- Physical connection details of all components indicating:
- Port numbers.
- Cable/wire numbers.
- Patch panels.
- Wiring terminals.

6.7.16 Cabling Design Specification

6.7.16.1 Cabling Functional Specification

The cabling functional specification document describes the following as a minimum:

- Methodology followed for cabling designs.
- Installation of cabling within cabinets.
- Installation of cabling on racking.
- Use of redundant process and network cable routes.
- Copper and fibre cable specifications.
- Testing of cabling.

6.7.16.2 Cable Block Diagram

The cable block diagram shows a simplified (single line) representation of main racking and network cabling routes between major elements.

Details of critical cables that need to follow different routes will be shown on this document.

The cable block concept supports the functional distribution concept.

6.7.17 Cyber Security Design specification

6.7.17.1 Cyber Security Manual

The cyber security manual details how the Third-Party System interfaces security will be monitored and maintained.
The security manual will define regular operation and monitoring procedures and describe in detail the actions and steps required to ensure the Third-Party System interface security is never compromised.

6.8 CONTRACTOR'S PROCUREMENT OF PLANT AND MATERIALS

All warranties for the equipment, standard software and application software provided are included as part of the works.

All warranties are in the name of the Matimba Power Station.

6.9 SPARES AND CONSUMABLES

6.9.1 Maintenance Spares

The *Employer* or *Others* will maintain the Third-Party System Interface that form part of the *works* after the Defects date.

The *Contractor* makes recommendations and supplies a spares list based on critical components.

An important consideration is the number of spares to be held in stock. The Contractor is to include only the minimum necessary spares to ensure the shortest possible MTTR. Noncritical components that can be purchased "off the shelf from the OEM" will not be considered for inclusion in the spares held by the *Employer*.

6.9.2 Commissioning Spares

The *Contractor* keeps sufficient spares to maintain the whole of the *works* up to the Defect date.

The commissioning spares to include any equipment supplied by *Subcontractors*.

6.10 CONSTRUCTION

6.10.1 Work to be done by the Completion Date

On or before the Completion Date the *Contractor* shall have done everything required to provide the Works.

The *Project Manager* cannot certify Completion until all the work has been done and is also free of Defects which would have, in his opinion, prevented the *Employer* from using the works and Others from doing their work.

Acceptance of the As-built' documentation is a pre-requisite for completion of the works.

6.10.2 Upfront Training Completion

The *Contractor* provides the upfront training for the works as specified in section 6.5.2.

6.10.3 Site Integration Test (SIT) Completion

The *Contractor* provides the SIT for the works as specified in section **Error! Reference source not found.**.**Error! Reference source not found.**

The *Project Manager* accepts the SIT completion documentation provided by the *Contractor* as part of the works.

The SIT completion documentation provided by the *Contractor* is as specified in Appendix D1.

6.10.4 Cold Commission Completion

The *Contractor* provides the cold commissioning of the Unit as specified in section **Error! Reference source not found.**.

The *Project Manager* accepts the cold commissioning output documentation provided by the *Contractor* as part of the works.

The cold commissioning output documentation provided by the *Contractor* is as specified in Appendix D1.

6.10.5 Operation Acceptance Test (QAT) Completion

The *Contractor* provides the OAT for the works as specified in section **Error! Reference source not found.**.

The *Project Manager* accepts the OAT completion documentation provided by the *Contractor* as part of the works.

The OAT completion documentation provided by the *Contractor* is as specified in Appendix D1.

6.11 PLANT AND MATERIALS STANDARDS AND WORKMANSHIP: C&I SYSTEM INTERFACE REQUIREMENTS OF THE C&I WORKS

The *Contractor* provides the whole of the works as defined in this Works Information except where explicitly stated as otherwise.

The C&I system interface will consist of Common Plant Control System interface, Third Party interfaces, Field Equipment, Cabling & Associated Infrastructure, Cyber Security, Removal of Equipment, Quality and Performance and the Power Distribution System.

The Common Plant Control System interface will be provided as defined in section 6.11.

The Third-Party System interface will be provided as defined in section 6.12.

The Unit Power Supply will be provided as defined in section 6.12.

The Unit Power Distribution will be provided as defined in section 6.12.8.

The Unit Cabling & Associated Infrastructure will be provided as defined in section 6.11.1.

The system-wide concepts pertaining to cybersecurity and plant control will be provided as defined in section 6.12.9.

6.12 COMMON PLANT CONTROL SYSTEM INTERFACE

All Medium Voltage Process Switchgear listed in the Drive schedule in **Error! Reference source not found.** are interfaced to or provided according to the Function IO Block and Limits of Supply and Services diagrams provided in **Error! Reference source not found.** and **Error! Reference source not found.**, respectively.

The *Contractor* provides field equipment interface in accordance with the Limits of Supply and Services diagrams provided in **Error! Reference source not found.**.

The LOSS diagrams are not to be considered as detail design documents; for their purpose is to demarcate the responsibilities for the various stages of the project from basic engineering up to and including commissioning; with the aim of indicating the physical interface point between the *Contractor*, *Employer* and Others.

The *Contractor* is responsible for managing, designing, clarifying, and finalising the physical interface points and physical interface requirements at the demarcation point when interfacing to equipment supplied by the *Employer* or Others.

The *Contractor* provides MV process Switchgear interface to the Common Plant Control System in accordance with Function IO Block Diagrams provided in **Error! Reference source not found.**.

The Function IO Block Diagram indicates the binary and analogue inputs and outputs to and from the Common Plant Control System for the applicable Common Plant Process Switchgear.

Contractor provides required IO cards required to interface the MV Process Switchgear of the Common Plant Control System.

Contractor does all required logic changes to align with the philosophies provided by the process owner during execution.

Contractor performs all required changes on the existing common plan t control system HMIs to align with the proposed operating and control philosophy provided by the *Employer* during execution.

6.12.1 Cabling and Associated Infrastructure

6.12.1.1 General

The *Contractor* provides cabling and associated infrastructure in accordance with the Limits of Supply and Services diagrams provided in **Error! Reference source not found.**.

Trunk cabling termination to the Common Plant Control System follows existing termination design.

6.12.1.2 Cabling Scope Definitions

The *Contractor* provides all trunk cabling and cable racking as part of the Works.

The scope of trunk cabling is defined as being all cabling between the Switchgear and the automation System(s).

The scope of the cable racking is defined as all racking, conduit, trunking etc. – including the racking supports.

6.12.1.3 Cabling Requirements

Cabling installation is provided in accordance with standards, 240-56355815 – Control & Instrumentation Field Enclosures and Cable termination Standard and 240-56355754 – Field Equipment Installation standard, in Appendix 15.

Internal cores of all multi-core cables are colour coded.

All cables as a minimum are insulated with flame-retardant, low halogen PVC outer sheath.

The routes for cabling and racking are of a consistent and integrated design, that takes into account different cabling and racking routes for common modes of failure.

Cabling is provided in accordance with the following technical guidelines and specifications:

- 240-56356411 - Fire Barrier Seals for Electrical Cable Installations at Power Plants Standard.
- 240-56227443 - Requirements for control and power cables for power stations.
- ISO 898-1 - Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws, and studs.
- ISO 898-5 - Mechanical properties of fasteners made of carbon steel and alloy steel - Part 5: Set screws and similar threaded fasteners with specified hardness classes.
- SANS 10142-1.
- SANS 1411 (parts 1-7).
- SANS 1574.
- SANS 60794-1-1.
- IEC 61238-1.

All cables provided are secured with suitable cable glands, straps, or clamps on racks, in cubicles, switchgear rooms, etc.

Durable cable numbering/labelling is provided for all cables entering the cubicles, the numbering /labelling is such that maintenance on cables is easily achieved.

A cabling design philosophy is provided by the *Contractor* for approval by the *Project Manager*, prior to finalisation of the cabling design. This is to ensure a consistent design philosophy is applied throughout the design.

6.12.1.4 Cable Schedules

Accurate records are kept in Cable Schedules by the *Contractor* for all cabling forming part of the Works.

The cable schedules are provided inclusive of origin, location details, revision, target, type, size, and termination details.

Termination schedules are provided for all cables.

6.13 THIRD-PARTY SYSTEM INTERFACE TO SUBSTATION AUTOMATION SYSTEM

6.13.1 General

The Third-Party Interfaces to the Substation Automation System (SAS) will consist of the Plant Information System Interface, Time synchronisation interface (for GPS time stamping), Electronic Security Perimeter (Cyber Security), Power Distribution, Cabling and associated infrastructure, Availability, Maintainability will be discussed in the sections below.

6.13.2 Plant information system (PIS) interface

6.13.2.1 General

The PIS (Plant Information System) is the central database repository for the long-term storage of all plant information produced at Power Station Power Station. This will include plant information generated by the Power Station's C&I system and 3rd party systems.

The PIS consists of the following components:

- PIS database(s) which contain all plant information stored by the PIS.
- PIS server application(s) via which the PIS clients and other users of plant information communicate with the PIS database(s).
- PIS data collectors which collect information from the existing Electrical Station Control System.
- PIS user interfaces which are the human interfaces via which the information stored in the PIS database(s) is accessed and manipulated.
- PIS clients which are computers on the Station LAN via which the PIS user interfaces are accessed.

Existing PIS Description:

The existing PIS is the SAM Visual Automation (VA) Historian which uses the following:

- VAView Version 5,
- The current data collectors (Siemens XU units) are located at the EOD equipment room.
- Each data collector interfaces to the VA network via a firewall located within the EOD Equipment Room.

The PIS Network is a TCP/IP Ethernet network.

6.13.2.2 PIS Interface to Substation Automation System

The *Contractor* is to interface the Power Station C&I System to the existing PIS. The Interface is as per **Error! Reference source not found.**.

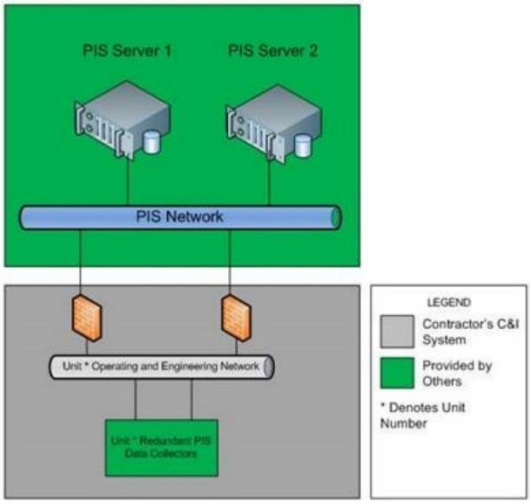

Figure 1: PIS interface scope

The Interface to the PIS Network from the SAS Operating and Engineering network is to be redundant.

The PIS data collectors and its interfaces to the PIS Network will be redundant.

Interface is to be implemented through a firewall provided by the *Contractor*.

The interface point into the PIS Network will be provided by the existing PIS OEM also referred to as “Others” as illustrated in **Error! Reference source not found.**. The interface point is either a firewall or network switch located within the EOD equipment room.

The *Contractor* is responsible for engineering the interface up to the interface point such that the Substation Automation System operating and engineering network and PIS network interface is compatible with the existing installation of the PIS.

The *Contractor* is responsible for co-ordinating the commissioning and testing of the entire interface from the SAS to the PIS user interfaces.

All hardware and software required to achieve this interface is installed by the *Contractor* up to the interface point.

The current PIS accepted KKS coding scheme is to be maintained so as to not negatively impact other systems interfaced to the PIS.

The PIS data collectors shall run on the SAS servers or it can be a separate server provided by *Others* and installed in the control system network cabinets in the EOD Equipment room.

Modifications to the PIS Network hardware and software is provided by the PIS OEM.

PIS clients are defined as being computers on the Station LAN via which the PIS user interfaces will be accessed.

6.13.2.3 Contractor's Background Record in Installation and Modification of SAM Visual Automation (VA)

The tenderer shall provide evidence of at least 1 project implemented successfully by the tenderer which includes as a minimum the following scope of work:

- Installation and modifications to Visual Automation (VA) network equipment including data collectors compatible with existing VA Plant Information System.
- Modifications, removal, and additions to the VA system tag databases.

The project summary should include project name, project detail/summary, reference contact details as a minimum.

6.13.3 Unit process automation system interface

6.13.3.1 General

The Unit Process Automation System is the Main Control System used to monitor, control, and protect the Unitised Mechanical and Electrical plant equipment.

The Unit Process Automation System common network, as illustrated in **Error! Reference source not found.** below, consists of the following components:

- Common Network. This network is common to all units and exchanges information between various common C&I systems.
- Power Supplies.
- Redundant GPS time stamping system.

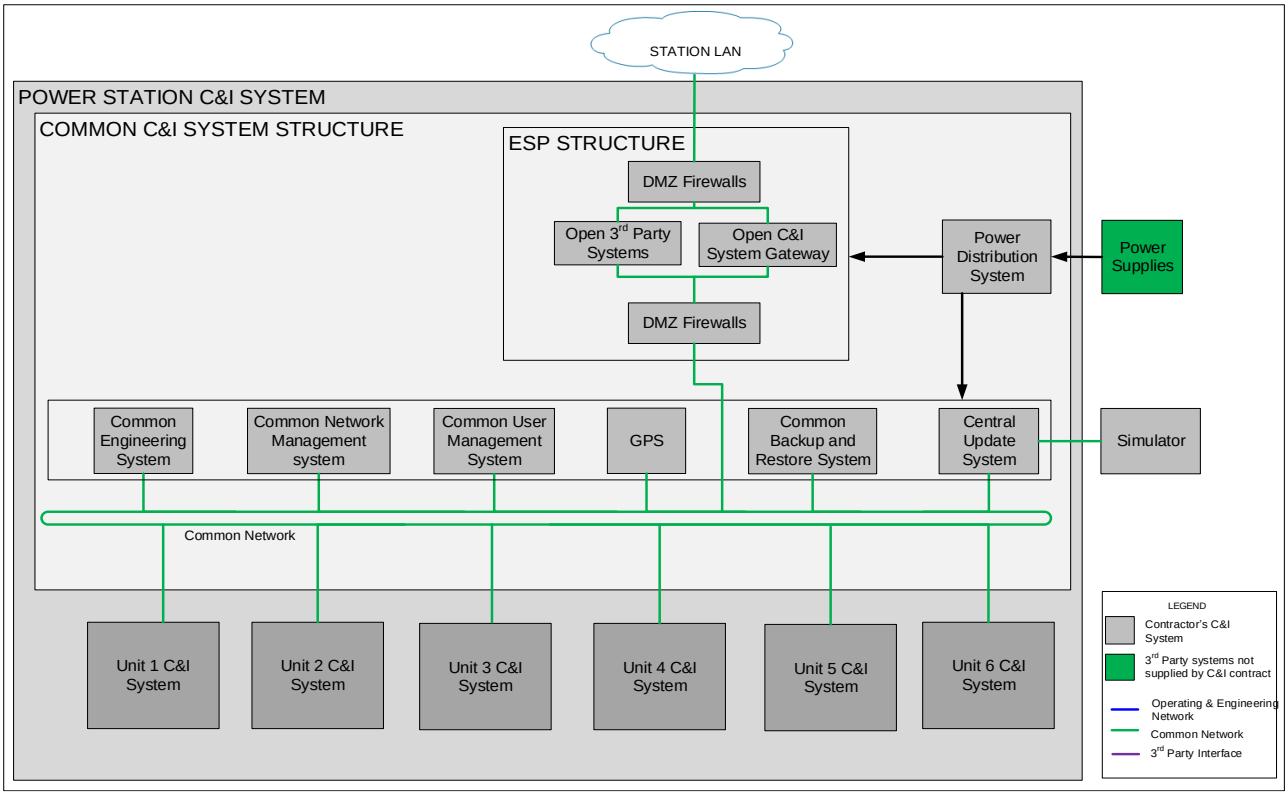

Figure 2: The unit process automation system's common network

The Unit Process Automation System, including the GPS time sync system, will be installed as part of the C&I Replacement project.

6.13.3.2 GPS interface to proposed Substation Automation System

The *Contractor* is to interface the Substation Automation System to the Unit GPS system via the Unit Process Automation System. The Interface is as per Figure 2.

The Interface between the Unit Process Automation System common network and the SAS to retrieve GPS time stamping is to be redundant.

The interface is implemented through a firewall provided by the *Contractor*.

The *Contractor* is responsible for engineering the interface up to the interface point such that the Unit Process Automation System Common network and the SAS Operating and engineering network interface is compatible.

The *Contractor* is responsible for co-ordinating the commissioning and testing of the entire interface from the SAS to the Unit GPS time sync system.

All hardware and software required to achieve this interface is installed by the *Contractor* up to the interface point.

In the event of the installation of the SAS prior to the execution of the Unit C&I replacement project, the *Contractor* is to provide a temporary GPS time stamping system.

6.13.4 Network Switches

6.13.4.1 Functional Requirements

All network switches will be managed network switches.

All network switches will be SNMPv3 compatible.

All network switches will be IPv6 compatible.

All network switches will have redundant power input ports.

Any network switch not located in a network cabinet will be of industrial Ethernet type and suitable for an uncontrolled & harsh environmental condition.

6.13.4.2 Locations

All network switches will be securely mounted in the network cabinets.

Redundant network switches will not be located in the same network cabinet.

6.13.5 Network Cabinets

6.13.5.1 General

The following types of equipment will be located in network cabinets unless specified as otherwise elsewhere in this document:

- GPS sync system interface equipment.
- PIS interface equipment

6.13.5.2 Physical Specifications

For easier cable management, all connectors on rack mounted components will be rear facing in the network cabinet as long it does not compromise the efficiency of the airflow through the network cabinet or devices themselves.

Each network cabinets will have the following characteristics:

- Front and rear access via double cabinet doors.
- There must be no open spaces between the rails and sides of the rack enclosure. This ensures the network cabinet air flow is managed correctly.
- Blanking panels are installed on all unused slots to manage air flow efficiency and reduce hot spot temperature in the network cabinet.
- Flexible brushes or shields must be used to prevent air leakage from cables via cable entries.
- Internal cable management systems are used for both horizontal and vertical cable management.
- Network cabinets must have sufficient depth to allow free air flow around cables in rear.

Any cable cut-outs beneath the network cabinet will be sealed to prevent air leakage using raised floor grommets.

6.13.5.3 Locations

All Third-Party system interface network cabinets will be installed in either the Unit and/or the EOD equipment room(s).

Network cabinets with redundant equipment will be physically separated within the same room to the maximum extent possible.

6.13.6 Network Cabling, Storage Network Cabling and Associated Infrastructure

The network cabling, storage network cabling and associated infrastructure will be provided in accordance with the requirements of section 6.11.1

Additionally, the network cabling and associated infrastructure will be provided in accordance with the following specifications (latest versions will be adhered to):

- ANSI/TIA-942-2005 and addendum ANSI/TIA-942-2-2010.
- ANSI/TIA 568-C.0-2009 and addendum ANSI/TIA 568-C.0-1-2010.
- ANSI/TIA 568-C.1-2009.
- ANSI/TIA 568-C.2.
- ANSI/TIA 568-C.3.
- ANSI/TIA 569-B and addendum ANSI/TIA-569-B-1-2009.
- ANSI-J—STD-607-A-2002

6.13.7 OPC Interfaces

All OPC interface(s) will not be implemented using direct DCOM due to inherent DCOM stability and security issues.

The implementation of any OPC interface will not in any way compromise the cyber security of the Power Station’s THIRD-PARTY systems.

OPC interface(s) will be implemented using either of the following communication methods:

- OPC via Tunnelling.
- OPC/XML.

Software required to ensure the stability and security of the OPC interface(s) will be installed and configured on all relevant servers.

OPC interface(s) will be implemented redundantly such that in the event of a failure in the primary system the swap over to the secondary system is “bumpless” with no data loss.

The OPC interface(s) will use a local transaction approach to protect the OPC interface from network irregularities.

6.13.8 Power Distribution

6.13.8.1 General

All Third-Party systems that require a 220VAC supply will be powered from the SAS Distribution System.

6.13.8.1.1 Functional Requirements

The equipment will be rated for the total load and fault currents, to prevent overheating during short circuits, before the power supply is successfully isolated.

If the load requires single phase supply, then a two pole MCB with an auxiliary contact will be provided.

If the load requires three phase supply, then a three pole MCB with an auxiliary contact will be provided.

If the load requires three phase and neutral supply, then a four pole MCB with an auxiliary contact will be provided.

The *Contractor* does wiring & termination as per drawing 0.00-10341-03-0: MV & LV Switchgear Wiring & Termination.

The *Contractor* will provide Lugs & Terminals as per drawing 0.00-10341-01-0: MV & LV Switchgear Lugs & Terminals.

The *Contractor* provides Pre insulated Lugs & Sleeves as per drawing 0.00-10341-02-0: MV & LV Switchgear Pre insulated Lugs & Sleeves.

The *Contractor* will use the Circuit function letter as per drawing 0.00-10341-04-0: MV & LV Switchgear Circuit Function letters.

The *Contractor* will provide labels & Nameplates as per drawing 0.00-10341-06-0: MV & LV Switchgear labels & Nameplates.

The internal power distribution system within the automation cabinets and network cabinets is fully within the *Contractor’s* scope of work.

6.13.9 Cyber Security

6.13.9.1 General

The purpose of cyber security in a power plant is to ensure that the power plant can safely and securely operate regardless of external threats to the Third-Party systems.

In addition to the requirements defined in this section, the measures described in VGB-R 175 e IT security for power plants will be applied to the Third-Party systems to ensure the overall security of the systems. Refer to section 4.10 for detailed requirements on cyber security.

6.13.9.1.1 Functional Requirements

All network switches’ unused ports will be blocked via the network management system.

Access to the network switches will be possible via workstations within the Power Station’s Third-Party Systems.

USB ports on all the servers and workstations will be software locked to prevent data access via USB storage devices, unless otherwise specified otherwise.

As a minimum, software firewalls will be installed on all Engineering Workstations.

Host intrusion detection sensors (HIDS) will be installed on all workstations and servers.

The individual HIDS for each Third-Party system will be centrally managed from the network management system.

Antimalware (including antivirus) software will be installed on all workstations and servers.

The individual antivirus software on all workstations and servers will be centrally managed from the central update system. This includes the automatic updating of the virus definition or signature files.

The boundaries of the SAS with open Third-Party systems (which includes the station LAN) will be protected via an electronic security perimeter (ESP) as defined in the section **Error! Reference source not found.**).

All users with extended access rights such as administrators, engineers, etc. are automatically logged off after a pre-defined idle time.

All actual security conditions and the initiated and implemented measures will be documented in a uniform structure in a cyber-security manual. The manual lists all points on the issue of cyber security.

All access to data and systems will be recorded in the access logs.

The *Contractor* provides an application that automatically identifies critical cyber assets and automatically captures data from cyber assets and produces an inventory report.

The *Contractor* provides a software facility to perform the comprehensive sanitation of removal media storage (USB, hard-drives etc.).

To ensure the adequate maintenance and management of cyber security throughout the lifecycle of the station a plan must be provided as part of the design. The plan encapsulates the procedures and guidelines relevant to Cyber Security and defines the necessary intervals for tests and risk assessments.

Detection of malicious activity and cyber security threats must be alarmed to the system administrator via the relevant workstation(s).

6.13.9.2 Electronic Security Perimeter (ESP)

The boundaries of the Power Station's Third-Party systems will be protected from unwanted intrusions via a demilitarized zone (DMZ). The vendor's DMZ is configured as per 240-79669677 Demilitarized Zone Designs for Operational Technology standard and the remote access configuration must comply with the 2-373 IT and OT Third Party and Remote Access Standard.

The DMZ will be implemented using redundantly configured Unified Threat Managers (UTM).

The *Contractor* shall supply a data diode to be used for one-way communication in order to prevent external access.

Redundant configured UTMs will be provided between:

- Open 3rd party systems and the buffer zone.
- The Third-Party system and the buffer zone.

The functions provided by each UTM will include – but will not be limited to – the following:

- A firewall with deep packet inspection.

- Network antivirus protection.
- Network intrusion detection system (NIDS) – a network sensor for detecting attacks, rogue systems and unauthorized traffic in the network.
- An intrusion prevention system.
- IPSec VPN gateway for secured access between the Power Station's C&I system and any authorised external device in the open 3rd party system.
- Security event management console – for the monitoring, control, alarm management, analysis, storage and reporting of security and performance information.
- Supports backup and restoring of the configuration settings.

As few ports as possible will be opened on the UTMs. Only ports that are needed will be opened.

The security event management console and all other UTM functions are accessed through the common engineering workstations.

6.13.9.3 Cyber Security Certification, Compliance and Assessment

The *Contractor's* Technology is certified in accordance with:

- IEC 62443-4-2 "Security for industrial automation and control systems Part 4-2: Technical security requirements for IACS components".
- IEC 62443-4-1 "Security for industrial automation and control systems Part 4-1: Secure product development requirements".
- IEC 62443-3-3 "Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels". The certifier also performs vulnerability identification testing.

The overall control system design shall be certified in accordance with IEC62443-2-4 and IEC 62443-3-3. The design of the control system solution is IEC62443 Security Level 2 compliant.

6.13.10 Availability

6.13.10.1 Redundancies

The following redundancies will be provided in the third-party interfaces:

- The third-party network equipment will be fully redundant such that:
- Any single failure in the network will not cause data to be lost.
- Any single failure in the network and the subsequent transfer to the redundant path will not disrupt the third-party system.

All redundant equipment will be hot-swappable and the running Third-Party system will not be disrupted by the replacement of redundant equipment.

6.13.11 Maintainability

6.13.11.1 General

The third-party interface equipment will not be modified or adapted to such an extent that:

- Future upgrades to the software and hardware require customisation for the Power Station before implementation.

- Special adaptation or configurations are required for the implemented design.

Emergency plans will be provided for system failures and faults such that appropriate measures can be taken immediately without having to first analyse the cause of the failure.

6.13.11.2 Life Expectancy

All equipment will be supported and maintainable until the end of the year 2050.

The Contractor will provide his latest power plant proven technology for the Works.

No unproven technology will be provided.

All future hardware and software upgrades for the system will be backward compatible with the existing third-party systems.

All network, equipment will be available in South Africa as commercially- off- the-shelf (COTS) products.

6.14 REMOVAL OF EXISTING EQUIPMENT

6.14.1 General

The decommissioning of the old systems, equipment, and components to be in accordance with procedure 240-164751654.

The *Contractor* is responsible for the decommissioning and removal of existing Electrical Reticulation Control system equipment upon completing the replacement of the last substation switchgear, i.e., when all reticulation switchgear has been integrated onto the proposed SAS.

Due to the Multiple Unit Trip risk associated with the decommissioning of the existing electrical reticulation control system, these systems will only be removed once all reticulation switchgear is monitored and controlled via the proposed SAS.

All removed equipment is transported to the areas specified by the *Employer*. All such areas are located within the boundaries of the Power Station.

All equipment and material that is removed is deemed re-usable and remains the property of the *Employer*.

Where field equipment and/or cabling have been removed, the area needs to be made good in accordance with the requirements of the *Project Manager*.

The term “making good” refers to the following:

- The removal of all the equipment and components. These include signal cabling, conduit, trunking, racking, supports and support frames, bolts, transducer racks, enclosures, instrumentation, etc.
- Trunk cabling from the old process MV switchgear to the Common Plant Control System is removed. Cables which cannot be removed shall be agreed with the *Employer*. Cables identified not be removed shall be cut back to the area where access is restricted, cut off on both ends, sealed or capped, labelled and secured.
- All areas where equipment was removed on the plant are made neat by means of closing of holes, grinding of old anchor points and welding, repainting and resurfacing.
- The interface point between the new system and existing equipment or plant is made neat and functional to prevent weak points in the final delivered product e.g. the fixing of brackets and supports of interface boxes, covers, locking nuts etc.
- The removal of equipment is co-ordinated with the *Project manager* to protect 3rd Party Systems from damage.

The *Employer's* procedures for disposal of different materials are required to be followed. The *Contractor* works closely with the *Employer's* Safety, Health and Environmental representative when disposing materials.

The *Contractor's* removal, decommissioning or demolition activities do not impact the operation of the running plant.

Check sheet(s) will be produced by the *Contractor* documenting each part of the plant that is removed as part of the works. This list will be signed off by both the *Contractor* as well as the *Project Manager*.

6.15 PLANT AND MATERIALS STANDARDS AND WORKMANSHIP: ERGONOMICS REQUIREMENTS OF THE EOD CONTROL ROOM OPERATOR WORKSTATIONS

The Substation Automation System *Contractor* appointed for package 1C provides the whole of the works as defined in section 4 of the Works Information except where explicitly stated as otherwise.

6.16 EOD CONTROL ROOM

6.16.1 General

The existing EOD control room will remain as-is with the installation and decommissioning the Operating systems of the proposed and the existing electrical reticulation control system operator stations respectively.

6.16.2 Furniture

All existing furniture will be utilised as far as possible for the project.

6.16.3 EOD Control Suite

The installation of the new operator systems will comply with 240-56355808 Ergonomic Design of Power Station Control Suites Guideline.

The *Contractor's* work for the EOD control room will include the following:

- Layout of the Contractor's equipment within the available space taking into account existing equipment within the room that will remain and equipment that is indicated to be relocated/moved.
- Relocation of existing operator interface peripherals in order to optimise the spacing utilisation of the operator desk.
- Design, supply, installation and commissioning of all cabling including power cabling and associated infrastructure for the equipment in the room.
- Design, supply, installation, and commissioning of any special isolation required for electromagnetic interference.
- Sealing of all cable entries into and out of the room with an approved fire seal.

The *Contractor* provides all proposed layout, including both existing and new equipment, to the *Employer* to review and accept.

6.17 OPERATOR WORKSTATIONS – PHYSICAL SPECIFICATIONS

Three operator workstations, each with four screens, will be provided along with computer and peripherals (screens, mice, keyboards and KVM modules).

The operating screens will have the following specifications:

- The minimum size is 24".
- The screens are full HD LED screens.

- The life expectancy of the screens is a minimum of 5 years of continuous use (24/7).

Each Operator Workstation computer will have the following specifications:

- 19" rack mounted.
- Use dedicated workstation hardware.
- Rated for continuous use (24/7).
- Redundant network ports with redundant connections to every applicable network.
- Redundantly configured hard drives via a suitable RAID configuration.
- Redundant power supplies.

A KVM module is defined as being a device or set of devices that allows the input/output devices of a workstation – i.e., the keyboards, video monitors and mouse – to be physically removed from the workstation computer such that workstation computer will be remotely accessed.

KVM modules will not be shared between workstations, i.e., the remote connection between each workstation computer and its input/output devices is implemented via its own set of KVM modules.

Each workstation's KVM module(s) will have the following specifications:

- Is of industrial type and rated for continuous use (24/7).
- Does not degrade the video quality as displayed on the screens nor does it introduce any operating delay.
- The KVM modules in the desk are securely fastened and physically secured to prevent tampering.
- The KVM modules in the network cabinet are rack mounted and physically secured to prevent tampering.

6.17.1 Operator Work Stations – locations

The operator workstation computers and peripherals will be located inside the EOD Control Room on the existing Operator Desk.

At most, two Unit Operator Workstation computers will be located in the same network cabinet.

6.17.2 Printer

The *Contractor* will provide a printer for logs, reports and hard copies of displays and other documents on request by the operators, engineers and maintenance personnel as per the Works.

Printer will be configurable to manage print requests from operator workstation within the EOD Control Room.

The printer provided will be colour laser printers with A3 and A4 printing capabilities with their own stands.

6.18 WALL-MOUNTED MIMIC OR EMERGENCY DISPLAY PANEL

The *Contractor* will update the currently installed wall mounted mimic or emergency display panel with latest designed mimic or panel displays –the *Contractor* will reconstruct or update the wall mounted mimic to reflect latest Electrical reticulation designs of the *Contractor*.

6.19 HEALTH AND SAFETY RISK MANAGEMENT

The *Contractor* shall comply with the health and safety requirements contained in Annexure B to this Works Information.

6.19.1 General

In carrying out its obligations to the *Employer* in terms of this contract, which obligations include, amongst others, providing the *works*; using Plant, Materials and Equipment; and whilst at the site for any reason, the *Contractor* is the "*Employer*" in terms of the Occupational Health and Safety Act (OHSA), No. 85 of 1993, in respect of its activities and in relation to its employees, agents, Sub-Contractor /s and mandatories.

The *Contractor* does not consider itself under the supervision or management of the *Employer* with regard to compliance with the Safety Health and Environmental requirements.

Furthermore, the *Contractor* does not consider himself to be a subordinate or under the supervision of the *Project Manager* in respect of these matters. The *Contractor* is responsible for the supervision of its employees, agents, Sub-Contractor s and mandatories and takes full responsibility and accountability for ensuring that they are competent, aware of the Safety Health and Environmental requirements, whilst executing the *works* in accordance with the Safety Health and Environmental requirements. The *Contractor* ensures compliance with, amongst others:

a) The provisions of the Occupational Health and Safety Act, No. 85 of 1993 and all applicable regulations (as amended), binding in terms thereof;
b) The latest versions of standards, procedures, specifications, rules, systems of work and requirements of the *Employer*, copies of which will be provided to the *Contractor* on request;
c) The Health, Safety and Environmental Plan inclusive of a Traffic Management Plan prepared by the *Contractor* in accordance with the *Employer*'s Safety Health and Environmental Specification.

The documentation referred to in paragraphs 2.3.1 is collectively referred to as the Safety Health and Environmental requirements and forms a part of the contract Works Information.

The *Contractor* ensures that its employees, agents, Sub-Contractor s and mandatories comply with the provisions of the Occupational Health and Safety Act, No. 85 of 1993, and all applicable regulations binding in terms thereof as well as the *Employer*'s Safety Health and Environmental Specification whilst making use of plant, materials and equipment and whilst at the Site for any reason whatsoever.

The *Contractor* implements a comprehensive health, safety and environmental management system, based on the ISO 45001 and ISO 14001 requirements and incorporate the applicable Eskom requirements into their system for utilisation at the project. The Client expects the *Contractor* to engage in safety culture initiatives in line with the Eskom SHEQ Policy and value, Zero Harm.

The *Contractor* must fulfil a role of a *Principal Contractor* in accordance with the OHSACT 85 of 1993, and Construction Regulation 7 (CR 7). Should the *Contractor* appoint Sub-Contractor (s), *Contractor* must carry responsibilities of a client as per Construction Regulation 2014.

The *Contractor* must ensure that all statutory appointments and appointments required by the management system are in place, and that all appointees fully understand their responsibilities and are trained and competent to execute their duties. The *Contractor* supervises the execution of their duties by all such appointees.

The *Contractor* appoints a person, qualified and competent in accordance with the safety health and environmental requirements, as the liaison with the *Employer*'s Project Safety, Health and Environmental Manager or delegated person for all such matters as pertaining related to safety, health and the environment. The *Contractor* must ensure that such a person is contactable 24 hours a day, and is registered with a

registered professional council approved by the Principal Director of the Department of Labour, as per the requirements of the latest Construction Regulations, inclusive of all exemptions and amendments pertaining thereto. As a minimum the appointed Safety Practitioner must have a National Diploma – Safety Management or Environmental Health and be registered with SACPCMP as Construction Safety Officer (CHSO).

The *Employer*, or any person appointed by the *Employer*, may at any stage during the period of this contract:

- Conduct health and safety audits regarding all aspects of compliance with the SHEQ Requirements, at any off-site place of work, or the site establishment of the *Contractor.*
- Refuse any employee, Sub Contractor or agent of the Contractor access to the premises if such person has been found to commit an unsafe act or any unsafe working practice or is found not to be qualified or authorised in terms of the SHEQ Requirements;
- Issue the *Contractor* with a stop order should the *Employer* become aware of any unsafe working procedure or condition or any non-compliance with any provision of the SHEQ Requirements.

The *Contractor* hereby indemnifies the *Employer* and holds the *Employer* harmless in respect of any and all loss, costs, claims, demands, liabilities, damage, penalties or expenses that may be made against the *Employer* and/or suffered or incurred by the *Employer* (as the case may be) as a result of, any failure of the *Contractor* , its employees, agents, Sub-Contractor s and mandatories to comply with their obligations, and/or the failure of the *Employer* to procure the compliance by the *Contractor* , its employees, agents, Sub-Contractor s and/or mandatories with their responsibilities and/or obligations in terms of or arising from the Occupational Health and Safety Act, No. 85 of 1993 and regulations.

6.19.2 SHE Induction and Access to Site

All the employees of the *Contractor* must attend an Eskom SHEQ induction course provided by the Client before commencement of the contracted work or before they will be allowed to work on the Site. It is the responsibility of the *Contractor* to ensure that all employees have attended the safety induction. *Contractor* must further develop and train all its employees on company specific SHEQ induction. Proof of yearly induction should be easily identifiable/available at all times.

The Contractor to ensure that all employees have valid Medical Certificate of Fitness before induction. Only once this induction has been received, will each employee receive a site access permit.

6.19.3 Life Saving Rules

The *Contractor* must comply with Eskom's Lifesaving rules. Violation of these rules will be viewed in a serious light and the consequences will be dealt with via the respective disciplinary processes.

Five Life Saving rules have been developed that will apply to all Eskom Employees, agents, Contractor s, Consultants, suppliers and visitors. Failure to adhere to these rules will be considered a serious transgression. These rules are being implemented to prevent serious injury or death of any employee, labour broker or *Contractor* working in any area within Eskom.

Eskom Life-saving Rules are non-negotiable health and safety rules, which must not be broken under any circumstances. It must be highlighted that Eskom takes a ZERO TOLERANCE stance to violation of these rules. These rules are applicable to any person entering Eskom sites.

The rules are as follows:

Rule 1	**OPEN, ISOLATE, TEST, EARTH, BOND AND/OR INSULATE BEFORE TOUCH** Any person who performs work on an electrical installation must ensure that it is isolated, tested and earthed before starting any work. (That is plant, any plant operating above 1000 V) No person may work on any electrical network unless: • He / she is trained and authorised as competent for the task to be done. • A pre-task risk assessment to identify all risks and hazards must be conducted prior to any work commencing. • An equi-potential zone is created for each worker on the job site by earthling, bonding and/or insulating according to approved divisional procedures. • All conducting material is connected together, all staff onsite wear electrical safety shoes and insulating techniques are applied according to standards. • The authorised person (Team leader) has certified and shown all team members that the apparatus is safe to work on. He / she is trained and authorised as competent
Rule 2	**HOOK UP AT HEIGHTS** Working at Height is defined as any work performed above a stable work surface or where a person puts himself/herself in a position where he/she exposes himself/herself to a fall from or into. A pre-task risk assessment to identify all risks and hazards must be conducted prior to any work at height commencing.
Rule 3	**BUCKLE UP** Seatbelts must be used at all times whilst driving. No person may drive any vehicle on Eskom business and/or on Eskom premises: Unless the driver and all passengers are wearing seat belts.
Rule 4	**BE SOBER** No person is allowed to be under the influence of intoxicating liquor or drugs while on duty. Under-the-influence' means the use of alcohol, drugs and /or a controlled substance to the extent that: • the individuals faculties are in any way impaired by the consumption or use of the substances or; • the individual is unable to perform in a safe, productive manner or; • the individual has a level of any such substance in his body that corresponds with or exceeds accepted medical/legal standards or; • the individual has a level of alcohol in his body that is greater than 0,00 % blood alcohol concentration. • Any level of an illegal substance in the body' irrespective of when the substance was used

Rule 5	**PERMIT TO WORK** Where an authorisation limitation exists, no person must work without the required Permit to Work (PTW). • Work is as defined in the Plant Safety Regulations (OHS) and Operating Regulations for High Voltage Systems (ORHVS) of Eskom. • A Risk Assessment must be carried out jointly by the Authorised (AP) and Responsible Person (RP) on all work before it commences. • The PTW must be issued by an AP, in accordance with the PSR. • The PTW must be accepted in writing by an authorised RP. • The PTW must be shown to everyone working on the job and the risks explained. • The RP must ensure that all staff working on that job are entered on a Workers' Register and the risks explained to each one. • The RP must ensure that the conditions of the PTW are enforced for the duration of the work.

6.19.4 OHS/SHEQ Policy

The *Contractor* must have an OHS/SHEQ Policy authorised by their Chief Executive (OHS Act Section 16(1) appointee) that clearly states overall SHE/Q objectives and commitment to improving Safety and Health of its employees. The Policy should outline the arrangements for carrying out and reviewing that policy

Eskom has a SHEQ Policy (32-727) that clearly states the policy principles by which Eskom operates and the commitment to SHEQ excellence and is authorised by the Chief Executive.

Contractor must support Eskom SHEQ policy.

6.19.5 Mandatory agreement

In terms of sections 37(1) and 37(2) of the OHSA, the *Employer* is relieved of any and all of its responsibilities and liabilities pertaining to the activities performed by the *Contractor* (and its employees, agents, Sub-*Contractor* s and mandatories) relating to the *works*; the use of plant, materials and equipment; and whilst at the Site for whatsoever reason.

The *Contractor* confirms that he has been provided with sufficient information regarding the health, safety and environmental arrangements applicable to the *works*; the use of Plant, Materials and Equipment, as well as at the Site.

Prior to the *Contractor* commencing with any operations/ activities relating to the *works* and/or prior to gaining access to the Site, the *Contractor* concludes a written mandatory agreement with the *Employer* in terms of section 37(2) of the OHSA and 5(1)(k) under the construction regulations. The aforementioned agreement constitutes a record of the written arrangements and procedures between the *Contractor* and *Employer* regarding health and safety. A signed copy of this agreement is submitted to the Client prior to commencement of any activity on site. The *Contractor* must ensure that a section 37(2) agreement is signed between them and all their appointed Sub-Contractor *(s)/*suppliers for the contract.

6.19.6 Compensation of Occupational Injuries and Diseases Act (COIDA) and UIF requirements

The *Contractor* must be registered with an employment compensation commissioner and submit proof of registration and letter of good standing with the compensation fund or with a licensed compensation insurer for his company based on South African legislative requirements. This must remain valid for the duration of the contract and must be the responsibility of the *Contractor* to ensure validity. The Letter of Good Standing must reflect the name of the *Contractor*.

6.19.7 Legal and Other requirements

It is required that all *Contractor* s on the project comply with the relevant applicable legislation, specifications and standards in accordance with the scope of the project:

As a minimum but not limited to the following:

- The Constitution of the Republic of South Africa (particularly Section 24 of the Bill of Rights)
- Occupational Health and Safety Act 1993 (Act 85 of 1993) and its Regulations
- Compensation for Occupational Injuries and Diseases Act 130 of 1993
- Any other applicable South African legislation (local, provincial and National)
- Applicable South African National Standards (SANS)
- Applicable international standards
- Relevant *Employer* Procedures and standards
- ISO 45001 - *Contractor* must use as guidelines.
- Disaster Management Act 57 of 2002: Regulations issued in Terms of Section 27(2) of the Act
- Applicable COVID-19 directives
- Local Authority By Laws

It is the duty of the *Contractor* to ensure that they are familiar with the necessary OHS legislation required. Applicable Acts/regulations should be displayed or available for employees, client and inspector when required.

When there is an amendment to the Acts and/or to the Regulations, the OHS plan must be reviewed, updated accordingly and send through to the *Employer*. Changes must be communicated to all relevant employees.

6.19.8 *Contractor*: Details, Accountabilities and Responsibilities

The *Contractor* carries primary accountability and responsibility for the health and safety of his/her employees within his/her working area, as contemplated by Section 37(2) of the OHS Act No. 85 of 1993 and Regulations. None of the additional safety requirements specified by the *Employer* reduces the *Contractor*'s accountability and responsibility for the health and safety of his employees within his working area.

The *Contractor* must have a disciplinary process and an organisational structured procedure to deal with employees who have transgressed organisational and legal requirements.

The *Contractor* must provide a list of names and contact telephone numbers of all his employees on site. This list must be updated as and when new employees commence on site.

The *Contractor* must keep a record of all employees, including date of induction, relevant skills and licenses, and be able to produce this list at the request of the relevant officials. These records must be filed in the OHS File. Every employee must undergo site induction provided by the *Employer* before commencement of the contracted work. Only once this induction has been received, will each employee receive a site access permit.

Employees are responsible for their own health and safety and that of their co-workers in their respective areas of work on the project.

Employees must be made aware of their responsibilities during induction and awareness sessions some of which are:

- Familiarising themselves with their workplaces and health and safety procedures;
- Working in a manner that does not endanger them or cause harm to others;
- Keeping their work area tidy;
- Reporting all incidents/accidents and near misses;
- Protecting fellow workers from injury;
- Reporting unsafe acts and unsafe conditions;
- Reporting any situation that may become dangerous;

- Carrying out lawful orders and obeying health and safety rules;
- Declaring to the *Employer* if taking medication which may have intoxicating effects.

- If an employee has a reasonable belief that the work to be undertaken is likely to endanger him/her or any other person/s due to sub-standard acts or conditions, inadequate precautions or a lack of protective equipment or clothing, He / She has the right to refuse to work and must report such situation to the *Employer.*
- An employee does have the right not to work in any area or perform any task where that employee has reasonable justification to believe that the work situation presents a serious danger to his/her health and safety, organizational assets or the environment.
- It must be highlighted to all employees, that anyone who becomes aware of any person disregarding a health & safety notice, instruction or regulation must immediately report this to the person concerned. If the person persists, stop the person from working and report the matter to the *Employer* Site / Project Manager immediately.

The *Contractor* appointed personnel must be registered in their respective levels as professionals in terms of the legislative requirements (SACPCMP).

OHS professionals (which include Safety Officers) are required to register as professionals with the SACPCMP.

In addition, the *Contractor:*

- Ensures that all statutory appointments (as required in terms of the Occupational Health and Safety Act, No. 85 of 1993 and all applicable regulations binding in terms thereof, as amended) and other appointments required in terms of the *Employer* 's Safety Health and Environmental Specification, are in place and that all appointees are cognisant of their duties and responsibilities in terms of such appointments;
- Ensures that such appointees execute their duties and responsibilities as required by such an appointment;
- Ensures that all personnel brought by itself onto site (including employees of Contractors and Sub-Contractors) are suitably qualified and trained for the performance of the task, duties and functions, which will be allocated to them;
- Immediately reports any occupational or other injuries, near miss events, property damage, environmental related incidents as well as any potential threat to the health and safety of individuals at the *works* or on the site, as soon as he becomes aware thereof, to the *Project Manager*;
- Complies with the *Employer*'s Environmental, Occupational Health & Safety Incident Management Procedure - 32-95, relating to the reporting and investigation of incidents. The classification of incidents contained in such document are considered final and must be applied by the *Contractor* relating to any incidents/ injuries relating to its employees, agents, *Contractor* s, Sub-Contractor s and mandatories whilst on Site;
- Conducts a risk assessment regarding the utilisation of Personal Protective Equipment (PPE) and thereafter ensure that PPE of good quality is issued (at its own cost) to its employees, agents, *Contractor* s, Sub-Contractor s and mandatories prior to such individuals accessing the site, alternatively performing activities related to the *works* at the site, as specified in the Eskom PPE Specification.

6.19.9 SHE Organogram

The *Contractor* is required to compile their company organogram for the contract, highlighting the reporting structure from their Senior Management down to their project employees. This diagram must be kept up to date, a copy of which must be given to the client and copy filled in the relevant project SHE files.

6.19.10 Annexure B: *Employer* SHE rules and requirements

Annexure B is the acknowledgement of Eskom's SHE rules, and requirements form signed and submitted by the *Contractor* /Consultant.

6.19.11 Health and Safety file

The *Contractor* must compile a SHE (health and safety) file as per Eskom Matimba Power Station Project's safety file requirements. The *Contractor* must also ensure that the health and safety file; which must include all documentation required in terms of the provisions of the Act and these Regulations; is opened and kept on site and made available to an inspector, client or client agents upon request.

The *Contractor* at the end of the project must submit health and Safety file.

6.19.12 Cost allocation for OHS Compliance

The *Contractor* must ensure that there is provision for the cost of Occupational Health and Safety measures.

Note: the costing for OHS must not be provided as a lump sum but detailed, that is itemised based on the overall scope of the project (i.e.) Medical surveillance (Medicals), Training, provision of PPE, COVID-19 compliance, safety equipment purchases, resources etc.

6.19.13 Personal Protective Equipment (PPE)

In terms of Section 8 of the OHS Act, the duty of the *Employer* is to take steps to eliminate or mitigate (hierarchy of control measures) any hazard or potential hazard to the safety or health of employees before resorting to PPE.

Contractor's employees on site, including visitors, must use SANS approved risk based PPE at all times, as a minimum:

- Head protection hard hat (with chin straps);
- Steel toe capped safety boots;
- Eye protection. Wearing of impact Safety Spectacles with side shields. Prescription glasses must comply with the same standard or cover impact safety spectacles must be worn over them;
- Long sleeved and long pants protective clothing;
- High visibility vests;
- Dust mask and/or Cloth masks;
- Refer to General Safety Regulation 2 of the OHS Act.

The *Contractor* must ensure that his employees understand why the personal protective equipment is necessary and that they use them correctly. Training should be provided to employees on the use, care, replacement and limitation of the provided PPE. Records of training must be kept and made available to the *Employer /Client* or inspector upon request.

Strict non-compliance measures must be administered to any employee not complying with the use of PPE and that employee must be removed from the Site.

Note: Certain areas will be subjected to specific/extra PPE requirement.

6.19.14 Emergency Care

The *Contractor* must develop emergency procedure in line with Eskom Matimba Emergency Protocols. *Contractor* must further ensure that Emergency response service is available at all times to attend to any emergency cases that may arise during the duration of the contract.

The *Contractor* must be responsible to familiarise himself with local municipal disaster management portfolios.

A list of emergency numbers must be displayed at notice boards and public areas for ease of access to all employees and visitors. The *Contractor* must ensure that his employees are familiar with the emergency numbers. Emergency numbers will also be part of the OHS induction.

Contractor must have one first aid box for the first five (5) persons and thereafter one for every 50 or team of workers on site or part thereof. There should be a trained and appointed person to render first aid service when required. The first aider(s) must be in possession of a first aid level two (2) training as minimum requirement as per Eskom Emergency planning procedure 32-123.

More first aid boxes must be provided if the risks, distance between work teams or workplace requirements require it (it should be available and accessible for the treatment of injured persons at that workplace).

Minimum contents of a first aid box: (Refer to GSR 3 Annexure of the OHS Act)

A prominent notice or sign must be erected in a conspicuous place at a workplace (SANS1186 approved signs to indicate location of first aid boxes), indicating where the first aid box or boxes are kept as well as the name and contact details of the First Aider of such first aid box or boxes.

The *Contractor* must ensure that alternative arrangements must be made for possible incidents occurring after normal working hours.

6.19.15 Medical Programmes

The *Contractor* must ensure that the employees are registered on a medical surveillance programme and are in possession of a valid medical fitness certificate, completed in South Africa. The certificate of fitness should be relevant to the type of work (risk based) that the employee will be exposed to. This will require each employee to have a risk based person job specification that will be used as a basis for medical examination.

The *Contractor* must ensure that his employees have undergone pre-entry medical examination before starting work on site, no employee will access site without a valid medical fitness certificate. Periodic medical examination must be done for all employees as work progresses. Upon completion or as and when employees' leave the project, an exit medical examination must be done for all employees involved in the project.

6.19.16 Health Pandemics and Disaster Management

The *Contractor* must ensure proper management and control of any disaster and or pandemics that may come forth during the course of the contract.

The Contractor must ensure compliance to all COVID-19 regulations and requirements. A COVID-19 Management plan and risk assessment should be conducted, and appropriate measures taken to minimise exposure to COVID-19. Any new developments regarding COVID-19 and latest updates should be communicated to the employees and visitors to raise awareness.

6.19.17 OHS Plan

The *Contractor* must provide and demonstrate to the Client a suitable and sufficiently documented health and safety plan, based on the Client's health and safety specification contemplated in regulation 5(1)(b) provided by the Client.

The *Contractor* must use the applicable OHS information to develop a suitable and sufficient OHS plan, which will indicate to the Client the level of compliance to the OHS requirements. The occupational health and safety plan must identify each activity to be undertaken by the *Contractor*, the foreseeable internal and external hazards, the specific precautions and controls that are necessary to ensure that the works proceeds safely and without risks to health or adjacent operations.

Upon discussions with the *Contractor,* a final accepted OHS plan would be signed and approved.

The plan must demonstrate management's commitment to OHS.

The safety plan must be reviewed to ensure that it fully addresses all the issues and complies with the requirements of the OHS Specifications and contract. If necessary, the *Contractor* must amend the OHS Plan as required by the Client.

6.19.18 Hazard Identification and Risk Assessment

It is a legal requirement in terms of Section 8 (2)(d) of the OHS Act for an Employer to continuously carry out risk assessments, to establish which risks and hazards are attached to the health and safety of persons due to any work which is performed, any article or substance which is, handled, stored, transported.

The *Contractor* must prepare and provide to the Client a Baseline Risk Assessment as well as activity based risk assessments for an intended work (scope of work).

In addition, the *Contractor* must ensure that:

- As far as is reasonably practicable, the safety and absence of risks to health in connection with the production, processing, use, handling, storage or transport of articles or substances is maintained;
- As far as is reasonably practicable, all hazards pertaining to the health and safety of persons and harm to the environment that are attached to any work which is performed, any article or substance which is produced, processed, used, handled, stored or transported and any plant or machinery which is used in its business, is clearly identified and, as far as is reasonably practicable, further establishes what precautionary measures should be taken with respect to such work, article, substance, plant or machinery in order to protect the health and safety of persons, and provides the necessary means to apply such precautionary measures;
- Such information, instructions, training and supervision as may be necessary to ensure, as far as is reasonably practicable, the health and safety at work of its employees, agents, Sub-Contractor s and mandatories is provided;
- As far as is reasonably practicable, no employee, agent, Sub-Contractor and mandatory performs any work or produces, processes, uses, handles, stores or transports any article or substance or operates any plant or machinery, unless the precautionary measures have been taken;
- Such measures as may be necessary in the interest of health and safety are enforced; Work is performed and that plant, materials or equipment is used under the direct supervision of a person trained to understand the hazards associated with it and who has the authority to ensure that precautionary measures required by the *Employer* are implemented; and
- All employees are informed of the scope of their authority as contemplated in OHSA.

6.19.19 Fire Protection

The *Contractor* complies with the requirements of the *Employer*'s Safety Health and Environmental Specification, pertaining to fire protection. The *Contractor* ensures that adequate firefighting apparatus is provided at all his work sites, and that his staff is trained in the use of this apparatus.

Precautions are taken to prevent any occurrence of fires or explosions while carrying out any work near flammable gas and liquid systems.

Any tampering with the *Employer*'s Fire Equipment is strictly forbidden. All exit doors, fire escape routes, walkways, stairways and stair landings are kept free of obstruction, and not be used for work or storage at any time. Firefighting equipment remains accessible at all times.

6.19.20 Radiographic Examinations

If radiographic tests are carried out in the plant, the danger area must be evacuated with the exception only of authorised radiographic workers, and thereafter barricaded. Compliance is according to Regulatory, Eskom's Safety Health and Environmental Specification.

The relevant warning signs at the lockout gates (Barricading) are bolt secured and not by wire or any other means, which could be removed while radiographic tests are in progress, the area is barricaded and access is restricted until the radiographic process is complete. The radiographic technicians ensure that all the lockout gates (Barricading) are opened/removed on completion of the tests.

When radioactive source (density tests) is brought onto site, the *Contractor* needs to inform the Client Agent/Manager in advance so that the Responsible Protective Officer (RPO) is informed. The *Contractor* must comply with all the said regulations before access is allowed onto the site.

If radioactive sources want to be stored at the site, approval needs to be obtained from the RPO. A proper storage area will be identified by the RPO and the *Contractor* will ensure that all the necessary signs are erected to warn the employees. Radiation awareness will also be done to all employees.

6.19.21 Behavioural Based Safety Observation (BBSO)

Contractor must incorporate BBSO or VFL programmes within their Health and Safety Management System.

The objective of behavioural safety observations is to assess and address the actual safe and unsafe behaviours of people in the workplace; as well as workplace conditions - which are caused by the actions or non-actions of employees, *Contractor* or their personnel.

6.19.22 Employees' Right of refusal to work in an unsafe situation

Employees have a duty to take reasonable care of their own as well as other person's health and safety at work and to cooperate with the Employer, carry out lawful orders, including reporting unsafe situations and incidents.

Refer to Eskom Procedure 240-43848327- Employees' right of refusal to work in an unsafe situation. The aim of the procedure is to ensure that an environment is created that promotes zero harm by empowering employees and *Contractor* s to take responsibility for their own safety and that of others.

6.19.23 OHS Audits

During the course of this contract, the Contractor must be subjected to scheduled or monthly audits by the client to monitor compliance.

Eskom reserves the right to monitor and conduct unannounced audits to ensure compliance and provide assurance to the Client representatives and their key stakeholders.

6.19.24 Incident management

All incidents reporting, recording, classification and investigation will be done according to the requirements set out in the Eskom document 32-95 (latest revision).

The Contractor must report and investigate all incidents/accidents as required in terms of the legislation.

6.19.25 OHS Performance Status Reports

The *Contractor* must provide OHS statistical and Non-statistical reports, dashboards, presentations on weekly and monthly basis.

6.19.26 Meetings

The Contractor must attend the monthly safety meeting scheduled by the Client. Ad-hoc meetings must be scheduled to address any Health and Safety related issue.

6.19.27 Work Co-ordination/interface Process

Work coordination process is designed for monitoring and coordination of activities for Contractor s working within the same area. It allows work to proceed without risk to the health and safety of Principal Contractor's personnel, visitors, and client personnel.

The following must be taken into consideration:

- Whenever there is more than one Contractor working in one area, there must be a documented interface process;
- Where there are agreements between different Contractor s, those agreements must be written and signed off by the Client/Project manager;
- It is crucial that there is link between the risk assessment required for the permit to work in terms of PSR and the task risk assessment, as these risk assessments identifies critical controls required to execute the work.

6.19.28 Housekeeping

The *Contractor* must maintain a high standard of housekeeping within the site. Prompt disposal of waste materials, scrap and rubbish is essential.

The Client requires the Contractor to conduct housekeeping on a daily basis and perform housekeeping inspections (at least weekly) to ensure maintenance of satisfactory standards. The *Contractor* must document the results of each inspection and must maintain records for viewing.

Housekeeping must be done before and after every shift. After completion of every task, the Contractor must conduct a proper housekeeping and keep evidence of housekeeping in that area.

Note: Nails protruding through timber must be bent over or removed so as not to cause injury.

In cases where an inadequate standard of housekeeping has developed, compromising the health, safety and cleanliness, all employees has the responsibility to bring it to the attention of the Client. The Client will have the authority to instruct the suspension of relevant works until the area has been tidied up and made safe. Neither additional cost nor extension of time to the Contract must be allowed as a result of work stoppage.

Emphasis on housekeeping and general safe guarding on construction site CR 27 and stacking and storage on construction site CR 28 is mandatory and must be complied with at all times.

6.19.29 Inspection Colour Codes

The below table should be used for colour coding on site for monthly and quarterly inspections on tools and equipment. Material to be used on colour coding should be cable ties. The colour coding should be implemented as soon as on the first day of the respective month. Previous month colour coding should be removed and replaced with new ones for the present month. Wrong colour coding on tools and equipment must be deemed as proof that inspection was not conducted for the month on that particular item. Colour coding does not replace the need of daily inspection checklist being conducted daily and kept in the file on site.

Monthly Inspection Colour lode			**Quarterly Inspection Colour Code**	
January	Blue	Blue	January	Green
February		White	February	
March		Black	March	
April	Grey	Grey	April	Red
May		White	May	
June		Black	June	
July	Pink	Pink	July	Blue
August		White	August	
September		Black	September	
October	Brown	Brown	October	Yellow
November		White	November	
December		Black	December	

6.19.30 Work Stoppage

The temporary stoppage of an activity/activities or task(s) may be due to SHE concerns, including the following circumstances which must not warrant any financial compensation:

- Ad hoc safety intervention by Eskom management: All work of a similar nature may be stopped as the result of an occurrence of a serious incident. The *Contractor* must be required to comply with, and/or verify, the conditions stipulated in the work stoppage instruction pack and;
- Ad hoc safety intervention by any person, especially SHE functionaries, may be due to unsafe work or unsafe behaviour by the *Contractor*. The conditions that gave rise to the work stoppage will determine the corrective measures to be taken urgently to protect the health and safety of employees and protect the environment and plant or equipment, etc.

NOTE: *Work stoppages that are initiated due to SHE related incidents must not warrant any financial compensation claim lodged against Eskom*.

Further note Eskom do have two compulsory work stoppages per annum. Safety discussions will be held on those days and no financial compensation claim lodged against Eskom. This is in line to support our safety culture of Zero Harm.

6.19.31 Hours of Work

All work conducted on site must fall within the legal requirements in accordance with the Basic Conditions of Employment Act.

The *Contractor* will notify their Eskom responsible manager/supervisor of any work that needs to be performed after hours according to the agreed arrangements. (The application needs to be submitted timeously). Where applicable, the notification should include proof of application, for overtime, to the Department of Employment and Labour and/or the letter of approval from the Department of Employment and Labour.

6.19.32 Project Close-out

On completion of the project or service rendered, the appointed *Contractor* (s) must close out their project documentation and OHS files and handover to the Eskom Project Manager. All required documentation must be submitted and handed over using relevant medium as per the procedure (Project Closeout and H&S documentation, 348-9942695). A checklist must accompany the submission to verify that all documents are submitted/or handed in to the *Employer*.

6.20 Environmental constraints and management

The contractor shall develop a site based Environmental Management Program (EMPr) for the project and implement such EMPr

A suitably qualified individual shall be responsible for the roles of environmental management, in accordance with the EMPr, IEA Eskom Waste Procedure and other related permit/ procedures within Eskom. This position shall be designated the “Environmental Officer” (EO). The EO shall have as a minimum, a Diploma in Environmental Management (NQF level 4) and related qualification from a recognised institution to be accepted by the *Project Manager.*

Appointment letter and CV of the environmental officer with minimum of 3 years’ experience in construction environment with knowledge of implementation of Waste Use License, Waste license, Environmental Authorizations, and other environmental related permits. Candidate must have practical knowledge on ISO 14001:2015, environmental law and auditing. Recently certified copies of qualifications and CV.

The duties of the EO shall include but not limited to:

- Liaison with *Employer*’s environmental staff.
- Monitoring of all of the *Contractor*’s activities for compliance with the various environmental requirements.
- Instituting remedial action in the event of non-compliance.
- Implementation and management of environmental protection measures.
- Reporting of environmental incidents and routine reporting of environmental activities,
- Participate in all environmental audits and inspections,
- Compile environmental report/s and submit to the *Employer’s* environmental staff respectively.

Construction Layout Diagram or Map: The Contractor shall provide a detailed final site construction layout diagram or map, for approval by the Client, prior to commencement of construction. All available biodiversity information and conditions set out in the EMPr, and Specialist reports shall be used in the finalisation of the layout. Existing infrastructure must be used as far as possible.

The *Contractor*'s rates tendered shall cover all costs that will be incurred to comply with all requirements of the EMPr and Waste Management such as Bill of Quantities, Provide environmental costing estimation. e.g., land rehabilitation, waste bins, spill kits, drip trays etc. (broken down costs).

(i) Special attention is drawn inter alia to the following aspects:
- Site demarcation: The *Contractor* shall demarcate the camp site, be restricted to that specific area and take full responsibility to restore the area to its original condition before the contract commenced.
- Waste management: The *Contractor* shall dispose of all waste off-site at a licensed waste disposal facility and submit proof to Eskom. Permits and By-Laws must be requested from the local authority/municipality.
- Sanitation: The *Contractor* shall provide appropriate enclosed temporary sanitation facilities and must have obtained safe disposal certificates.
- Dust control: The *Contractor* shall be responsible to apply effective dust control measures, such as the equipment's to maintain dust fall-out monitoring.
- Re-vegetation: The *Contractor* shall be responsible to re-vegetate the locations of trial pits, boreholes, roads and tracts through the veld, the camp site and any area of activity related to the works, as may be required.
- Fire prevention: It shall be the responsibility of the *Contractor* to prevent veld fires at all times during the contract Riverbank / riverbed rehabilitation: It shall be the responsibility of the *Contractor* to rehabilitate the riverbank / riverbed where the river(s)/stream(s) were entered and where work was performed
- Storm water management: The *Contractor* shall be responsible to design and implement effective control measures to prevent siltation and erosion of the nearby streams.

(ii) The Contractor shall take adequate steps to educate all members of his workforce as well as his Supervisory staff on the relevant environmental laws and regulations. The Contractor shall supplement these steps by prominently displayed notices and signs in strategic locations to remind personnel of environmental concerns.

6.20.1 Method Statements

The *Contractor* shall submit within 14 days before the starting date a Method Statement containing details of all site layouts and environmental protection measures proposed to the *Project Manager* for review and acceptance. Provide scope related Method Statements/ Procedures/Works Instructions detailing the way the Tenderer will comply with Environmental management Requirements.

These shall include but not limited to:
- Site establishment layout;
- Site drainage management;
- Workshops' storage areas layout;
- Pollution prevention measures;
- Oil separator design;
- Fuel storage and dispensing area and bund design;
- Refuse dump design (where applicable);
- Temporary access roads.
- Waste Management plan;
- Chemical and Hydrocarbon Management
- Refuelling procedure or plan
- Environmental Incident Management plan
- Waste Management plan
- Rehabilitation plan

In addition, the *Contractor* shall provide detailed method statements on how he intends to carry out the *works*; this shall apply to all and any part of the *works* as provided in the *conditions of contract*

6.20.2 Protection of Rivers, Streams and Watercourses

- All rivers, streams and watercourses shall be protected from direct or indirect spills of pollutants such as garbage, sewage, cement, oils, fuels, chemicals, aggregate tailings, wash and waste water or organic material resulting from the *Contractor's* activities. In the event of a spill prompt action shall be taken to clear polluted or affected areas.
- The *Contractor* shall not work within river banks, flood lines, streams, watercourses and wetlands without the written acceptance of the Project Manager as required for the execution of the work.
- The contractor shall determine the 1:100 years flood line from the stream, wetlands and the watercourse

6.20.3 Refuse and Waste Control

- The management of solid waste on Site shall be strictly controlled and monitored. Only licenced waste disposal landfill sites shall be used.
- The quantities of waste generated on Site shall be minimised;
- Labelled recycling bins shall be used and waste separated where possible. In addition, a recycled-material collection schedule shall be established and the bins shall be collected regularly;
- Eating areas for the construction staff shall be designated and supplied with waste bins.
- No on-site burying or dumping or unauthorised burning of any waste materials, vegetation, litter or refuse shall occur;
- Bins provided will be sufficient to store the solid waste produced on a daily basis;
- The bins should be emptied at least once a day;
- Waste from bins may be temporarily stored on Site in a central waste area that is weatherproof and scavenger-proof and which the Project Manager has accepted;
- All solid waste shall be disposed of off site, at a licenced landfill site. The Contractor shall supply the Project Manager with a certificate of disposal; and
- Waste shall be separated into domestic waste, building/construction rubble, scrap metal, oil and grease and hazardous waste and dealt with in the following manner:

6.20.4 Domestic Waste

- Metal refuse bins or equivalent plastic refuse bins, all with lids, shall be provided by the Contractor for all construction sites. Refuse shall be collected and removed from all facilities on the site at least twice per week. Domestic Waste shall be transported to the accepted refuse disposal site off site in covered containers or covered trucks.

6.20.5 Organic waste

- Refuse from food preparation and eating areas shall be collected and removed daily. Organic waste shall be disposed of as per Domestic Waste and Waste Manifest supplied to the Project Manager.

6.20.6 Building/Construction waste

- Inert building/construction rubble shall be disposed at a nearest licenced landfill sites and waste manifest supplied to the Project Manager.

6.20.7 Scrap metal

- Scrap metal shall be disposed off-site at a nearest licenced scrap metal recycling facilities. Paper trail to be supplied to the Project Manager.

6.20.8 Hazardous waste

- All hazardous waste shall be disposed of in a licenced hazardous waste landfill site and waste manifest supplied to the Project Manager.

6.20.9 Protection of Flora

- The removal, damage and disturbance of indigenous flora are prohibited.
- At the commencement of the contract, the Project Manager will identify to the Contractor indigenous flora or any rare or endangered flora that shall be preserved. The Contractor shall thereafter demarcate such and undertake all necessary measures to ensure the protection of such flora, including replanting and any special care required in accordance with the EMPr.
- The use of herbicides is prohibited unless approved by the Project Manager.

6.20.10 Protection of the Fauna

- The Contractor shall protect fauna living within the Site and shall ensure that hunting, snaring, poisoning, shooting, nest raiding or egg-collecting and disturbance does not occur.
- The Contractor is to ensure that his employees are instructed not to feed wild animals.
- The use of pesticides is prohibited unless accepted by the Project Manager.
- No domestic pets or livestock are permitted on Site.

6.20.11 Preservation of Topsoil

- The Contractor shall remove and stockpile topsoil in accordance with the EMPr - Clearing of site, or as directed by the Supervisor, in quantities sufficient for reinstatement, in accordance with the EMPr. Topsoil shall be removed from, inter alia, working areas (including quarry pits) and relevant areas of the permanent works, construction, haul and other access roads and such like, all as directed by the Supervisor.

6.20.12 Erosion Control and Storm water Management

- The Contractor shall include in the design of the works measures to prevent erosion resulting from his actions on the Site. The Contractor shall take appropriate and active measures to prevent erosion resulting from his works, operations and activities which shall be agreed with the Supervisor even when such potential erosion may take place or occur beyond the limits of the site because of the actions of the Contractor. Such measures shall include properly constructed watercourses, energy dissipaters, establishment of temporary vegetation as specified in the EMPr, to counter erosion and avoid discharges into water courses, wetlands, agricultural lands, etc.

6.20.13 Spoil Dumps and Stockpiles

Where there is a requirement for spoil dumps and stockpiles, the *Contractor* shall:

- Obtain written permission from the *Supervisor* to create the spoil dump and stockpiling;
- Submit a Method Statement for acceptance by the *Supervisor*;
- Ensure that topsoil that would have been buried as a result of the spoil dump is moved to one side and replaced over the spoil dump on completion;
- Ensure that any rare local plant species as identified by the *Supervisor* that would have been buried or destroyed are replanted over that spoil dump or elsewhere as directed by the *Supervisor*;
- Ensure that drainage is provided to control ground water exit gradients within the spoil dumps such that migration of fines is kept to a minimum;
- Ensure that surface water runoff is conducted through or over or around the spoil dumps to prevent erosion damage resulting from storm water runoff;
- Ensure that perimeter drainage channels are provided, and lined with rock or other suitable material to prevent scour, so that runoff will be collected and conducted past the spoil dumps;

- Rehabilitate the surface of the spoil dump as specified in the EMPr and

6.20.14 Natural Features and Heritage Resources

- The *Contractor* shall not deface, paint, damage or mark any national features (e.g. rock formations) situated in or around the Site for survey or other purposes unless accepted by the *Project Manager*. Any contravention of this Sub-Clause will require the item to be restored/ rehabilitated at the *Contractor's* cost. The *Contractor* shall ensure that should any archaeological finds be made during the construction excavations, the *Contractor* shall inform the *Project Manager* immediately in order to reach agreement regarding proper procedures to minimise damage and or effect salvage operations of the findings.
- All heritage resources to be affected by the Project shall be treated and managed in accordance with the National Heritage Resources Act 25 of 1999 and the National Monuments Act 28 0f 1969.
  - Remedial action in the event of non-compliance;
  - Implementation and management of environmental protection measures; and
  - Reporting of environmental incidents and routine reporting of environmental activities.

No measurement or payment will be made against any items for the rehabilitation of the *Contractor's* working and accommodation areas (including the areas designated for the *Supervisor's* use) or for rehabilitation of areas used for temporary roads. No overhaul will be paid for work within the Site.

Provide a **baseline environmental aspect and impact register** identification covering the contractor scope of work with proposed mitigation measures. This must include all products and services procured through 3rd parties and referring to the relevant environmental legislations/requirement.

6.21 Quality Management requirements

6.21.1 General

The Contractor conforms to ISO 9001:2015 Quality Management System requirements and the Eskom Supplier Contract Quality Requirements Specification (QM 58 revision 3) shall be applicable during the entire contract duration including the defects periods.

Within thirty (30) days of Contract Award, the Contractor must submit the following documentation for review and acceptance by the Employer:

a. A detailed Contract Quality Plan indicating how Quality will be managed on site. (Refer to page 08 – 10 of 28 of Document Identifier: 240-105658000, QM 58). The plan must provide detail information on how the Contractor will manage quality on all contract activities starting from the Engineering Phase (bullet 3.3.1 of QM 58), Fabrication, Construction, Commissioning and Handover.
b. Quality Control Plans or and Inspection and Test Plans of all contract activities that the Contractor will be performing from Engineering phase to handover. (Refer to page 10 - 13 of 28)
c. Data book index for review and acceptance by the Employer at erection check stage prior to the commencement of the commissioning phase.
d. A copy of a valid ISO 9001 certificate, quality manual and the associated system and procedures for review and evaluation.
e. A copy of the CV's of the Quality Manager and Supervisor that will be fulltime in the project to be evaluated and accepted by the Project Manager Procedure for the management of the Contractor's subcontractors indicating how suppliers are identified, assessed, qualified and monitored.

No work shall commence before the documents on (a);(b); (d); (e) and (f) are submitted, reviewed and accepted by the Employer.

6.21.2 Quality responsibility

a. The Contractor is responsible for the quality of the output and will take accountability for any poor service or product.
b. The Contractor is responsible for defining the level of QA/QC or inspections during the project and this should be submitted to the Employer for review and acceptance. .
c. The Contractor is responsible for defining the level of QA/QC or inspections to be imposed on his sub-contractor and suppliers of material. This level should be based on the criticality of the equipment, and this should be submitted to the Employer for review and acceptance.
d. The QCP/ITPs must be incorporated into the programme submitted at tender stage and during execution.

6.21.3 Reporting

The Contractor submits on a monthly basis, a quality report as per Eskom Supplier Contract Quality Requirements Specification (QM 58) and includes the following:

a. A register of Defects with those older than 30 days being flagged, and an explanation attached
b. Updated QCP / ITP Register
c. QA monthly report summary
d. Planned and completed OFFshore inspection dates
e. Inspections completed / outstanding
f. Register of accepted Defects or Concessions
g. Project Quality progress report
h. The Contractor submits the following when requested by the Employer:
i. Additional Inspection & Test plans (ITP's)
j. Method statement for critical activities
k. Organograms (changes only with the Project Manager's acceptance)
l. Copy of all work instructions and procedures when requested by the Project Manager.
m. Welding procedures and qualification of welders

6.21.4 Quality requirements

6.21.5 Overview

1) The fundamental objective of the set of quality requirements stated within this transaction is to ensure that the Contractor produces goods/products/services that the Employer are wholly satisfied with whilst ensuring that work is done right the first time. To achieve this, the Contractor shall ensure that three approaches are taken. These are as follows:

   a) Ensuring that the Contractors Quality Management System (QMS) is set up and maintained

   b) Quality Assurance

   c) Quality Control

   These are broad areas each with numerous requirements.

2) The Contractor is fully responsible and wholly accountable for Quality of their work. An example of this is that the Contractor has its own Quality Controllers performing formal inspections/intervention according to the Quality Control Plans.

3) The Contractor shall comply with all requirements specified in the Eskom standard, 240-10565800 "Supplier Quality Management: Specification" [1]. It is of utmost importance that this standard be complied with.

6.21.6 Codes, Standards and Documents to be complied with

The Contractor shall comply with the following documents as well as all documents referenced therein:

[1] 240-105658000 “Supplier Quality Management: Specification” (QM 58)

[2] ISO9001:2015 “Quality Management Systems – Requirements” (Take note that the level of compliance to this standard are determined by [1] above and section 1.3 below)

[3] ISO10006:2003 “Quality Management Systems – Guidelines for Quality Management in Projects”

[4] 240-134232676 “Data book Review and Final Submission Process”

[5] ISO 10005 – Quality Management – Guidelines for Quality Plan

[6] 240-106628253 “Standard for Welding Requirements on Eskom Plant”

[7] 240-83539994 “Standard for Non-Destructive Testing (NDT) on Eskom Plant”

[8] Pressure Equipment Regulations (PER)

[9] SANS 347 “Categorization and conformity assessment criteria for all pressure equipment”

6.21.7 Quality Management System Requirements

1) Category 1 The Contractor shall ensure that a Quality Management System is setup and fully maintained during the entire duration of the contract. The Contractor shall submit a copy of the latest ISO 9001 certificate or certificate applicable. The QMS shall comply with the latest ISO 9001 standard or any applicable certificate of quality management system (latest applicable revision) and the Contractor shall comply with the requirements of 240-105658000 “Supplier Quality Management: Specification”. Compliance to Category 1 requirements is mandatory.

6.21.8 Quality Assurance Requirements

1) The Contractor shall ensure that Quality Assurance is performed at all levels and phases of work carried out for the Employer.

2) The Contractor shall use processes to ensure that quality is built into their products/services i.e. its business processes are organized such that quality is built into the process of producing goods and rendering services. The Contractor shall work according to processes.

3) The Contractor shall ensure that it can be relied on to deliver quality goods and services without the need for the Employer to have to inspect all the time.

4) The Contractor shall provide a proposed Quality Table of Payments (Quality Payment Schedule) showing the relationships between Bill of Quantities/Activity Schedule Items, Client Acknowledged Programme Items, Inspection & Test Plans/Quality Control Plans (ITPs/QCPs), Sign off by the Employer’s Quality department and proposed Payment (Proforma Invoices) which will attest to the works having been done to required quality. This table shall be reviewed, Employer comments addressed by the Contractor and approved by the Employer within 30 days of contract award.

The Contractor shall keep the Quality Table of Payments (Quality Payment Schedule) updated with progressive Employer sign-off (as the work is done and payments applications are submitted). This means that as the Contractor completes an activity and has the related ITP/QCP signed by the Employer, the Contractor shall bring the Quality Table of Payments to the Employer’s Quality representative to sign off for that activity.
The updated Quality Table of Payments shall accompany all payment applications (proforma invoices). The Contractor shall attach the signed (or partially signed if applicable) ITPs/QCPs to the payment application. Payment will only be made if the ITPs/QCPs are signed by the Employer.

6.21.9 Quality Control Requirements

1) Quality Control is a product oriented set of activities for ensuring quality in products/services. These activities focus on inspection and identifying defects before these reach the Employer.

2) The Contractor shall ensure that Quality Control is performed at all levels and phases of work carried out for the Employer.

3) The Contractor shall comply with all requirements specified in section 3.4 of the Supplier Quality Management Specification [1].

4) The Contractor shall complete Quality Control Plans (QCPs) and Inspections and Test Plans (ITPs) (at a check sheet level) before contract award. These shall be reviewed and Employer comments addressed (by the Contractor) and signed off by the Employer within 30 days after contract award.

5) The QCPs and ITPs must include those for sub-contractor work.

6) The QCPs and ITPs shall be reviewed and signed off by the Contractors Engineering, Construction and Quality personnel. There shall be three review and sign off sections. These are at pre-work, during work (interventions) and post work (final sign off).

7) The QCPs and ITPs show each activity/requirement of the Works Information.

8) One of the earliest/first activities on the QCP/ITP shall be “Approval of the QCP/ITP” and this is a hold point hence if it is not signed by the Employer then work cannot continue.

9) The Contractor shall submit a QCP/ITP register which includes columns for Programme item, Related QCP/ITP, Date of Submission and Completion/Sign-off Date of QCP/ITP.

10) All QCPs/ITPs may be reviewed and modified by the Employer at any time.

11) The project programme shall show all quality intervention points such as witness, hold, verification, surveillances and review points. These shall be updated if changes are made to the programme.

12) The Contractor shall make use of the Kusile Project RFI/PA001 Process to request the Employers personnel to perform inspections. The Contractor shall ensure that all inspections have been “Passed” by their in house quality control representative prior to requesting the Employers personnel to perform any inspection.

13) In the event of poor quality, re-work or incidents where products inspected by the Employer fail to meet requirements, the Contractor shall receive a Non-conformance (NCR) if deemed so by the Employer. The Contractor shall be liable for the Employers costs of re-inspection as well as be liable to pay penalties as specified in this contract.

1.1.1.1 Inspections

14) The Contractor shall be responsible for the inspection of all the Works that is performed and the Employer only verifies that the Works is acceptable.

15) The Contractor conducts all inspections in accordance with the accepted QCP / ITP.

16) The Contractor provides suitably qualified personnel to conduct on-and-offsite inspections

17) The Contractor ensures that all Works are inspected and approved before the Employer is invited for the inspections.

18) The Contractor provides a minimum of 5 working days’ notice for local inspections (onsite and offsite) and 21 working days’ notice for foreign inspections. The notice contains copies of the Contractor’s inspection reports.

19) For onsite inspections, the Contractor shall send a Request for Inspection (RFI) reminder 4 hours prior to the inspection so that the Quality Department may mobilise to perform the inspection. This shall be done via the Communication Interface Memorandum. This is over and above the aforementioned 5 working days' notice period.

20) Damages as a result of the Contractor's failure to comply with the inspection requirements as specified in this section will be borne by the Contractor and no compensation event or variation order will arise out of this.

21) The Contractor shall provide all tools and equipment required by the Employer's inspectors/Quality Controllers to perform any verification during the inspection for example measuring equipment etc.

6.21.10 Quality Plan

1) The Contractor shall submit a Quality Plan within 30 days of contract award for acceptance by the Employer.

2) The Contractor shall comply with all requirements specified in sections 3.2, 3.3 and 3.4 of the Supplier Quality Management Specification.

3) The Contractor shall submit a detailed contract organogram showing the quality personnel to be used in the Contract. The Contractor shall provide CVs of the quality management employees who will be responsible for quality on site.

6.21.11 Quality Documentation Requirements

1) For all products and services, the Contractor shall submit the following quality documents as a minimum:

   a) Data book Index for acceptance by the Employer
   b) List of data books
   c) Method statement (describing how work will be executed)
   d) Equipment list
   e) Drawings
   f) ITP/QCP Register
   g) ITPs, QCPs and check sheets
   h) Inspection notifications accompanied by their inspection report
   i) Updated onsite, off site and offshore inspection schedules
   j) Inspection and or factory acceptance test dates as applicable
   k) Inspections completed / outstanding.
   l) Inspection and test reports
   m) Weekly and monthly contract quality progress report
   n) Materials used
   o) Material certificates
   p) Data sheets
   q) Equipment list
   r) Welding documents (if applicable) include Welding Procedure Specification (WPS), Procedure Qualification Record (PQR), welder qualifications, Welding Procedure Qualification Record (WPQR), welding consumables and all other documents required by relevant welding standards
   s) Quality Plan (as earlier described)
   t) Non-conformance and Defects registers and reports

2) The Contractor shall submit a Quality file with 30 days of contract award. The Contractor shall maintain this file throughout the duration of the contract. This file shall contain all Quality documentation and records.

3) The Contractor shall submit data books for all work for acceptance by the Employer if applicable. These are defined as follows:

H1 – Fabrication
H2 – Construction
H3 - Commissioning

4) The Contractor shall submit data books in accordance with the Employers requirements. The Employers requirements vary depending on the type of component or system hence the Contractor shall modify the data books to meet the requirements of the Employer.

5) The Contractor shall submit 2 hard copies of data books and one software copy (on a DVD/CD).

6) Components may only be released for delivery to site once the H1 data book(s) has been accepted by the Employer if applicable.

7) Commissioning may only commence once the H2 data book(s) has been accepted by the Employer if applicable.

8) The Contractor shall ensure that all data book(s) have been submitted to and accepted by the Employer as per the Employers requirements and meet the time frames specified by the Employer.

9) Failure of the Contractor to submit data book(s) and obtain the Employer's approval at 100 % work completion shall affect payment.

10) Failure of the Contractor to submit H1 data book(s) and obtain the Employer's approval prior to construction will affect payment.

11) Failure of the Contractor to submit H2 data book(s) and obtain the Employer's approval prior to Commissioning will affect payment.

12) Failure of the Contractor to submit H3 data book(s) and obtain the Employer's approval prior to takeover will affect payment.

13) Failure of the Contractor to submit all data book(s) and obtain the Employer's approval will prevent take-over of the Works by the Employer.

14) The Employer has 21 days to review a data book from the time the Contractor transmits the data book to the document controller until feedback is received.

15) The Contractor shall specify the review status and discipline on the transmittal when transmitting data books to the Employers Doc control.

6.21.12 Contract Execution

1) Correspondence shall be directed to the Employer, and periodic quality review meetings shall be convened by Employer with the Contractor.

2) The mandatory quality review meetings are to be convened by the nominated project quality manager or his/her representative for the Contractor.

3) Quality Management employee's responsibilities shall include but are not limited to the following:

a) Implementation of the QMS on site
b) Administration of QA/QC systems on site
c) Verification of approval status of Subcontractor's QCP and procedures
d) On-and -offsite inspections
e) Co-ordination, inspection and verification of the Employer's intervention points

f) Review of Contractor testing and inspection documents (procedures, test results)
g) Weekly and monthly progress reporting on quality performance

4) The Contractor shall comply with section 5 of the Supplier Quality Management Specification.

5) Monthly quality performance and management reports shall be prepared by the Contractor during contract execution. The content of these reports shall be agreed by the Employer when submitted to the Employer on a monthly basis.

6.21.13 Quality Reporting

1) The Contractor shall submit a monthly quality report, on the last working day of the month. The report includes but not limited to the following:

a) A register of NCRs and defects
b) Updated QCP / ITP register
c) QA monthly report summary
d) Planned and completed local and foreign inspection dates
e) Completed and outstanding Inspections
f) Audit findings report

6.21.14 SUPPLIER QUALITY PERFORMANCE MONITORING PHASE

1) During the contract execution phase, the Contractor shall be monitored by the Employer for performance on quality-related aspects. The outcomes of such monitoring will enable the Employer to take any appropriate actions pertaining to the Contractor.

2) The monitoring shall be carried out periodically by the Employer or at predetermined intervals during the execution of a contract.

3) The monitored key performance areas include the following:

a) Quality
b) Delivery
c) Design
d) Cost
e) Management system

4) Subsequent key performance indicators associated with these areas will include the following:

a) Nonconformity monitoring
b) Audit and assessment evaluation scoring
c) Management system compliance and accreditation
d) Achievement of delivery targets as per contractual agreements
e) Process improvements
f) Corrective and preventive action response and closure

6.21.15 PRESERVATION, SHIPPING AND TRANSPORTATION TO BE ADDRESSED

1) The Contractor is responsible for ensuring that all products are preserved in their appropriate manner as described in their specifications or in Eskom preservation, shipping and transportation procedures as applicable.

2) The Contractor shall submit the preservation, shipping and transportation procedures to the Employer for review and acceptance.

3) The Employer may choose to witness the packaging, loading and offloading of the products depending on their criticality, this will be indicated in the intervention points on the QCP / ITP document.

4) The Contractor shall ensure that all storage requirements for products are properly implemented to preserve the products against adverse conditions, deterioration, damages, etc. Storage and preservation procedures for the different products must be submitted to the Employer for review and acceptance.
5) The Employer may request to inspect the stored products at any given point during the storage period of the product.
6) Requirements for preservation, shipping and transportation are addressed in 240-105658000 [1]

6.21.16 GENERAL QUALITY REQUIREMENTS

1) The Contractor shall comply with all requirements specified in section 6 of the Supplier Quality Management Specification.
2) All documents shall be approved by the Employer. If the Employer is dissatisfied with a document then it is the Contractors responsibility to ensure that the Employers requirements are met.
3) All planning Quality Assurance and Quality Control documents shall be submitted for approval by the Employer within 30 days of contract award.
4) The Contractor shall make use of qualified and experienced Quality Controllers to ensure that products/services are of a high quality prior to inspection by the Employers quality representative(s).
5) The Contractor shall ensure that all defects and NCRs are addressed correctly and timeously.
6) Defects and NCRs shall be closed within a time frame or period specified or accepted by the Employer.
7) When NCRs and Defects notifications are issued, the Contractor shall acknowledge receipt within (5) working days and include the Root cause(s), Correction(s) and Corrective action(s) and proposed implementation dates to the Employer as per the contract response period.
8) The corrective actions will include the implementation and completion dates. Progress on all NCRs and Defect notifications issued to the Contractor must be reported to the Employer on weekly basis.
9) The Contractor’s quality manager keeps a register of all NCRs and Defect notifications issued.
10) Deviations from the Contract are treated as a non-conformance.
11) Records of NCRs and Defect notifications are kept and form part of the data book records.
12) During the contract execution phase, the Contractor will be monitored by the Employer for performance on quality related aspects. The monitoring will be in the form of audits and assessments. The Employers quality department will be involved in every assessment to ensure that all NCRs and Defects raised are closed or the necessary penalties are implemented as stipulated contractually.
13) The Contractor is accountable for the quality of the output and liable for any failures.
14) The interventions points include all witness, hold, verification, surveillances and review points required by the Employer. The Contractor’s failure to allow the intervention points will constitute a non-conformance. The Employer has the right to approve or reject intervention points and may add or remove these points as desired.
15) The Contractor shall only be paid subject to meeting and Employer approval of all quality requirements and three copies of the data books accepted by the Employer.
16) The Contractor shall provide all information, material and records required to comply with the Eskom Quality Management System and such further information, material and records as may be requested by the Employer from time to time.
17) The Contractor shall ensure that no inspections are missed and all schedules are observed.
18) The Contractor shall comply with all relevant Eskom governance documents (codes, standards etc.) whether specified in this contract or not.
19) The Contractor shall make use of an Authorised Certification Authority such as SABS to certify Contractor QMS if applicable.
20) The Contractor shall make use of Recognised International Accreditations such as SANAS which accredits the Authorised Certification Authority if applicable.
21) The quality requirements shall be met by the contractor and all sub-contractors.
22) The Contractor shall ensure that all measuring and test equipment is calibrated at all times and proof thereof must be readily available.

6.22 Programming constraints

6.22.1 General

The *Contractor* submits a single programme that incorporates the programmes of all of his sub-*Contractor* s. The interface points between his different sub-*Contractor* s as well as the interface points between the individual sub-*Contractor* s and the *Contractor* are to be clearly identified.

Project Key Milestones (Refer to C1.2 Contract Data Part 1 of *Project Management* and Construction Contract) as supplied by the *Project Manager*, are incorporated into the programme as per the NEC Core Clause 31.2.

6.22.2 Details of the *Employer* and Others who will be occupying the working areas at the same time

In cases where other *Contractor's* are working in the same area as part of the work of this contract, the *Contractor* co-ordinates his work with the Project Manager to maintain harmonious working conditions on Site.

During the progress of the works the *Contractor* provides access to others who also execute work in the same area, on an as and when required basis.

The *Contractor* makes his own assessment of the problems and difficulties which may be encountered for providing access to and interfacing with others (this includes access difficulties experienced during construction or commissioning phase).

No extra payment or claim of any kind on account of providing reasonable access is allowed.

6.22.3 Computerised Planning and Reporting

The *Project Manager* does not intend duplicating the *Contractor's* programming and planning, however, portions or high level extractions of the Accepted Programme may be used in the Employer's internal master project programme for control purposes.

The *contractor* shall submit the Programme on the Eskom approved planning tool (Primavera P6) as per Planning & Scheduling Work Instructions for Procurement Process – 240-162814767 together with a 2 copies in PDF format.

The works is to be completed within accepted durations that are in consistence with key dates provided in the contract data by the *Employer*.

Assign Resources to all activities (Schedule should reflect the resources needed to do the work and resource levelling to be done.

The *Contractor* submits updated computer files on a monthly basis, or at any other time as required by the *Contractor* or as instructed by the *Project Manager*.

The updated computer file shows the logic and all filters and layouts used in the programme. Primavera Project Planner (version 15.1) has been adopted by the *Employer* for all planning, progress monitoring and reporting on the Matimba Projects.

The *Contractor* obtains this software and applies it for the planning and control of the works in line with the accepted Work Breakdown Structure (WBS).

6.22.4 Additional Programme Requirements

The *Contractor* uses the Critical Path Method (CPM) technique for programme and planning.

The programme shows the actual critical path clearly. The preparation of the programme contains a programme basis document. This basis document describes the programme and planning methodology, format, project execution philosophy, resource assumptions, qualifications and any other items that may have a substantive impact on the schedule.

The contractor to ensure there is a planner/scheduler on site on full time basis (CV of a contractor planner to be submitted).

The programme layout takes into account the accepted WBS, reflecting the manner in that the works are to be performed and how control data is summarised, reported and monitored.

The minimum requirements for the WBS for the Matimba Refurbishment Project are as per the Works Information.

The following levels of programme are to be used for this project for dynamic integrated project control:

- Management level programme (Level 1)
- Project level programme (Level 2)
- Control level programme (Level 3)
- Discipline speciality programme (Level 4)

The *Contractor* submits the level 3 programme with the tender documentation. The level 4 programme is to be submitted within one month following contract placement.

6.22.5 Management Level Program (Level 1)

The management level programme is used to establish work goals and overall time frames for the works. It is a statement of project objectives recorded in graphic form. The management level programme defines:

- Established goals or major milestones key dates;
- The duration of major operations and their relationship to one another;
- Identified Long Lead material items;
- Responsibility assignments for accomplishing project objectives.

6.22.6 Project Level Program (Level 2)

A "rolled up" programme from the control level programme is produced. It is separated by Unit, plant area and by Phase (Project Management, Procurement, Construction and Commissioning).

6.22.7 Control Level Program (Level 3)

The project level programme is prepared representing the significant work activities and deliverables associated with the works. The end product is a time scaled bar-chart schedule developed through use of a logic network. This programme is separated by Unit, by plant area, by Phase, by WBS.

The work within each plant area is broken down by Project Management discipline, procurement of tagged equipment and bulks, construction by *Contractor*, and commissioning & start-up. The control level programme is resource-loaded. It forms the basis for progress measurement, progress curves and histograms for each discipline within a plant area.

6.22.8 Discipline Specialty Program (Level 4)

The need for supplemental or discipline speciality programme is dependent upon the requirements and/or circumstances of the contract.

The discipline speciality programme developed and maintained by the *Contractor* is generated for tracking and control of various activities and deliverables for all phases of the contract. This programme is usually formatted as a spreadsheet or database report utilising the WBS structure.

This programme typically represents day-to-day tasks which are work unit based and become summarised in the Level 3 activities. Resource information for manpower, Plant, Material and Equipment and reflected in the resource histograms is to be provided by the *Contractor*.

6.22.9 Submission of Revised Programmes and Progress Reporting

The *Contractor* submits two hard copies and one electronic copy in Primavera, of each revised programme and progress report to the *Project Manager* for acceptance. All formally issued reports are to follow the progress reporting requirements as stated below.

6.22.10 Weekly Status Reports

A weekly status report is submitted by the *Contractor* to the *Project Manager*. This report is less formal than the monthly report and is used as a tool for the day-to-day management of the project. Contents of a weekly report may include the following items:

- The updated Primavera programme
- Programme summary narrative
- Progress and performance summaries
- Schedule rolling horizon
- Sectional Completion and Key Milestone status

6.22.11 Monthly Progress Report

The contents of the report may vary from month to month depending upon the phase of the project and/or the items of management focus. However, the basic framework of the report consists of the following:

- Executive summary (narrative identifying major movement within the reporting period).
- Revised Programme indicating, actual progress of work against last Accepted Programme.
- A one-month look ahead work window.
- Activities completed during current reporting period per discipline, including the activities of the Employer and Others.
- Activities in progress during current reporting period per discipline, including the activities of the Employer and Others.
- Activities undertaken during next reporting period per discipline, including the activities of the Employer and Others.
- Status overview by unit, by plant area, by phase.
- Key issues / Items of concern and corrective actions.
- Progress curves and tabular progress reports.
- Cost and Cash flow.
- Cost curve 'S-curve'.
- Early warning log.
- Compensation event log.
- General planning report (computer generated).
- Critical activities report.
- Updated summary of ham mocked report (computer generated).
- Key event report (computer generated).
- Report selecting all of the activities of the Employer and Others - (computer generated).
- Updated bar charts.
- Updated resource schedule and histogram (If changed).
- Updated activity schedule (If changed and if applicable, Option A).
- Forecast rate of payment schedule updated with actual progress.
- Statement and report on works ahead and behind progress.
- The monthly progress reporting cycle is based on a month end “cut-off”.

6.22.12 Meetings

Meetings are held fortnightly between the *Project Manager* and the *Contractor* (and any other co-opted members). The venue for these meetings is as determined by the *Project Manager* at the inaugural meeting. The Project Manager writes the minutes of these meetings. Any action of the *Project Manager*, *Supervisor*,

Contractor and Adjudicator implied in the minutes of meeting are to be confirmed by a separate communication given in accordance with this contract.

The *Contractor* reports the overall progress and as a minimum requirement, the following is addressed:

- *Contractor's* current activities progress and planned finish dates.
- *Contractor's* planned start and finish dates for the works.
- *Contractor's* and *Project Manager's* programme agenda compared for problematic differences.
- The progress of any other relevant activities.
- To discuss any technical or commercial issues.

6.23 *Contractor*'s management, supervision and key people

The *Contractor* will provide the *Employer* and the *Project Manager* with an organogram showing the key people and the roles and responsibilities.

The organogram provided must show clear reporting lines between individuals, including individuals from Sub-Contractors or joint ventures.

The *Contractor* provides the following key personnel as a minimum:

- Project Manager (Registered with the South African Council for Project and Construction Management Professionals (SACPCMP)
- Project Engineer (Registered with the Engineering Council of South Africa)
- Project Planner
- Quality Manager
- Safety Manager (Registered with SACPCMP)
- Safety Representatives (Registered with SACPCMP)

The *Contractor's* key personnel must be solely dedicated to the Contract/Project to perform their roles in accordance with the project requirements. During execution, the *Contractor* provides full-time personnel on site to perform roles in accordance with the project requirements.

6.24 Invoicing and payment

Within one week of receiving a payment certificate from the *Project Manager* in terms of core clause 51.1, the *Contractor* provides the *Employer* with a tax invoice showing the amount due for payment equal to that stated in the *Project Manager's* payment certificate.

The *Contractor* shall address the tax invoice to Eskom Holdings SOC Ltd and include on each invoice the following information:

Name and address of the *Contractor* and the *Project Manager;*
The contract number and title;
Employer's order number;
Contractor's VAT registration number;
The *Employer*'s VAT registration number 4740101508;
Description of service provided for each item invoiced based on the Price List;
Total amount invoiced excluding VAT, the VAT and the invoiced amount including VAT; (add other as required)

Invoices to Eskom Holdings SOC Ltd must be submitted electronically.

Details on how to submit invoices and additional information:

- All Electronic invoices must be sent in PDF format only.
- Each PDF file should contain one invoice; or one debit note; or one credit note only as Eskom's SAP system does not support more than one PDF being linked into workflow at a time.

- If there is Cost Price Adjustment (CPA) on the invoice, it is recommended that the supplier issues a separate invoice for CPA so that if there are any issues on the CPA the rest of the invoice can be paid while resolving the CPA issues.
- Email address for invoice submission: invoicesgrpcapitalOTH@eskom.co.za

If the Contractor does not provide a tax invoice in the form and by the time required by this contract, the time by when the Employer is to make a payment is extended by a period equal in time to the delayed submission of the correct tax invoice.

6.25 Insurance provided by the Employer

6.25.1 As stated in the *Employer`s* Construction All Risk Insurance Policy is available on request from Eskom Group Insurance, to be dealt with in accordance with ECC3 Core Clause 87.1, 87.2 and 87.3 and additional requirements are also stipulated in the Z Clauses.

6.25.2 The insurance policies and procedures will form part of the Contract Data and any reference to this will be contained in the Contract Data.

6.26 Contract change management

6.26.1 The *Contractor* or the *Project Manager* notifies each other of any event which may lead to a change in agreed terms of this contract. Changes are be dealt with in accordance with the conditions set out in the Contract Data and NEC3 ECC.

6.26.2 All project changes, impacting Scope, Cost and Time, follow the internal Governance committee processes (Technical, Investment & Commercial) for approval and is the responsibility of the *Project Manager.*

6.27 Provision of bonds and guarantees

6.27.1 The form in which a bond or guarantee required by the conditions of contract (if any) is to be provided by the *Contractor* is given in Part 1 Agreements and Contract Data, document C1.3, Sureties.

6.27.2 Performance bonds are to be dealt with in accordance with the NEC3 ECC Secondary Clause X13 and the additional requirements as stipulated in the Z clauses.

6.27.3 The *Employer* may withhold payment of amounts due to the *Contractor* until the bond or guarantee required in terms of this contract has been received and accepted by the person notified to the *Contractor* by the *Project Manager* to receive and accept such bond or guarantee. Such withholding of payment due to the *Contractor* does not affect the Employer's right to termination stated in this contract.

7. PROCUREMENT

7.1 Supplier Development, Localisation and Industrialisation (SDL&I)

The *Contractor* complies with and fulfils the *Contractor's* obligations in respect of the SDL&I in accordance with and as provided for in the *Contractor*'s SDL&I Compliance Schedule stated below:

7.1.1 Local Content and Production (Designated Sectors)

Commodity	Components	Local Content Threshold
Steel products and components for construction	Racking	100%
Electrical cables	Cabling	90%
PPE	Reflector Vests, Jackets, Boots, G Textiles, Clothing, Leather & Footwear, etc.	100%
Air Insulated MV Switchgear components (7.2kv to 12kV)	Air Insulated MV Switchgear components	50%
	Instrument transformers	15%
	Busbars	5%
	Housing	25%
	Switching Devices	5%

The following documents will be required to be stored in the Contractor's Contract d

- (F1) - SBD 6.2 Declaration Form
- (F2) - Annexure C (Local Content Declaration-Summary Schedule
- (F3) - Annexure D-Imported Content Declaration – Supporting Schedule to Annexure C
- (F4) - Annexure E-Local Content Declaration- Supporting Schedule to Annexure C.

7.1.2 Contractor's Skills Development Goals (CSDG)

Skills Type	Number of learners	Intake	Outcome
Method 1: Graduates in Electrical Engineering	10	S4	National Diploma Electrical
Method 2: Artisans (Electrical)	15	N6/NCV Level 4 Electrical/ TVET College Graduates	SETA Trade Test Certificate
Total	25		

The above-mentioned Skills are a guideline. The actual skills/trade type may be negotiated. However, expenditure of 0.25% of the Acceptable Contract Amount in accordance with the CIDB CSDG is a Condition for Contract Award.

The Tenderers are free to propose any other relevant Skills Development that will be feasible and benefit the previously disadvantaged communities. This may even include Workplace Integrated Learning (WIL) from the TVET Colleges within the Waterberg District Municipality Area.The Skills Development beneficiaries will represent the population demographics of the Waterberg District Municipality and preference should be given to the residence of the Waterberg District Municipality Area.

7.1.3 National Industrial Participation (NIP):

NIPP is a programme that seeks to leverage economic benefits and support the development of South African industry by effectively utilizing the instrument of government procurement. The NIPP programme is mandatory on all government and parastatal purchases or lease contracts (goods and services) with an imported content equal to or exceeding US$5 million.

The programme is targeted at the South African and foreign industries, enterprises, and suppliers of goods and services to government / parastatals, where the imported content of such goods and services equals to or exceeds US$5 million. The first customer of NIPP is the South African industry that benefits through the NIPP business plans which, when implemented generate new or additional business activities through one or more of the following: investment, export opportunities, job creation, increased local sales, SMME and BEE promotion, R & D and technology transfer.

Companies with a NIPP obligation are required to sign this obligation agreement with The Department of Trade, Industry and Competition (the DTIC) before the contract with Eskom Holdings SOC Ltd, as a purchasing entity, is signed. The obligation agreement governs the relationship between the dtic and supplier. It defines the NIPP obligation value/s, requirements to fulfil the NIPP obligation, performance milestones, performance monitoring processes and the NIPP credit allocation criteria

It is applicable and the Contractor will have either obtained an exemption from the Department of Trade, Industry and Competition (DTIC) or entered into a NIP Obligor Agreement with the DTIC.

This part is not managed by Eskom in this Contract. However, Eskom reserves its right to obtain a copy of the NIP Obligor Agreement from the DTIC.

7.1.4 Job Opportunities and Upskilling of Employees

The Contractor to indicate and commit to number of Jobs to be created and/or retained due to this contract.

Number of Jobs to be created	Number of Jobs to be retained

The Contractor should ensure that all its General Workers and Semi-Skilled Workers and at least 30% of the skilled workers are recruited from within Limpopo Province.

The *Contractor* shall keep accurate records and provide the *Project Manager* with reports on the *Contractor*'s actual delivery against the above stated SDL&I. The Contract shall submit SDL&I Quarterly Reports as scheduled using the Reporting Template that is provided by the Employer

The *Contractor*'s failure to comply with his ASGI-SA obligations constitutes substantial failure on the part of the *Contractor* to comply with his obligations under this contract.

7.2 SUBCONTRACTING

Tenderers must subcontract a minimum of 10% of the contract value with the following designated groups or categories:

a) an EME or QSE, which is at least 51% owned by Black people.
b) an EME or QSE, which is at least 51% owned by Black people who are youth,
c) an EME or QSE, which is at least 51% owned by Black people who are women.
d) an EME or QSE, which is at least 51% owned by Black people with disabilities.

e) an EME or QSE, which is 51% owned by Black people living in rural or underdeveloped areas or townships.

Once agreed upon, the Contractor will subcontract and / or procure some of its material/goods/services within the Waterberg District Municipality Areas.

Herewith listed below are possible scope/opportunities for subcontracting and local procurement:

- ✓ Supply of Cables and Cabling,
- ✓ Labour and Tools Hire,
- ✓ Site Establishment Containers,
- ✓ Welding and mechanical consumables,
- ✓ Transportation of both Labour and Material,
- ✓ Accommodation,
- ✓ Entrance and Exit Medical Surveillance Services,
- ✓ Supply of consumables, etc.

7.3 Contractual Requirements

7.3.1 B-BBEE Requirement

- The Contractor is expected to maintain or improve their B-BBEE Recognition Level for the duration of the contract.

7.4 SD&L Performance Bond

- The Contractor shall submit an SDL&I Performance bond equivalent to 0.25% of the Contract Value and shall only be released to the Contractor upon fulfilment of all SDL&I Obligations.
- The reduction of the percentage and release of the Performance Guarantee in tranches, proportionate to SDL&I's obligations' fulfilment, may be negotiated as an incentive to commit to SDL&I Undertakings mentioned above or that may be suggested by the Contractor.

7.5 Reporting and Monitoring

- The suppliers shall on a quarterly basis submit a report to Eskom in accordance with Data Collection Template on their compliance with the SDL&I obligations described above.
- Eskom shall review the SDL&I reports submitted by the suppliers within 30 (thirty) days of receipt of the reports and notify the suppliers in writing if their SDL&I obligations have not been met.
- Upon notification by Eskom that the suppliers have not met their SDL&I obligations, the suppliers shall be required to implement corrective measures to meet those SDL&I obligations before the commencement of the following report, failing which Retention clauses shall be invoked.
- Every contract shall be accompanied by the SDL&I Implementation Schedule which must be completed by the suppliers and returned to SDL&I representative for acceptance 28 days after contract award. This will be used as a reference document for monitoring, measuring, and reporting on the supplier's progress in delivering on their stated SDL&I commitments.

8. SUMMARY LIST OF APPENDICES

No	APPENDIX	DESCRIPTION
01	Appendix A2	TECHNICAL SCHEDULE A AND B
02	Appendix A3	LIST OF SWITCHGEAR BOARDS WITH TECHNICAL REQUIREMENTS
03	Appendix A4	LIST OF SWITCHGEAR SCHEDULES
04	Appendix A5	EXISTING SUBSTATION LAYOUT DRAWINGS
05	Appendix A6	PROPOSED SUBSTATIN LAYOUT DRAWINGS
06	Appendix A7	SCHEDULE C – TYPE TESTING REQUIREMNETS
07	Appendix A8	VENDOR DOCUMENT SUBMITTAL SCHEDULE
08	Appendix A9	CONTRACTUAL DATES PER SWITCHGEAR BOARD
09	Appendix A10	CURRENT TRANSFORMER SCHEDULE FOR LARGE MOTORS/ DIESEL GENERATORS
10	Appendix A11	PROPOSED SINGLE LINE DIAGRAMS
11	Appendix A12	LIST OF SPARESTEMPLATE
12	Appendix A13	COMPLIANCE SCHEDULE
13	APPENDIX B1:	APPENDIX B1: COMPLIANCE SCHEDULE
14	APPENDIX B2	TECHNICAL SCHEDULE A AND B
15	APPENDIX B3	QUANTITY OF PROTECTION SCHEMES REQUIRED
16	APPENDIX B4.1	C&I INTERFACE SIGNALS FOR MV SWITCHGEAR
17	APPENDIX B4.2	C&I INTERFACES FOR MV SWITCHGEAR DESCRIPTIONS
18	APPENDIX B5	LV SWITCHGEAR INCOMERS AND BUS SECTIONS LIST AND IED QUANTITIES
19	APPENDIX C1	COMPLIANCE SCHEDULE
20	APPENDIX C2	TECHNICAL SCHEDULE A AND B
21	APPENDIX C3	SAS DRAWING
22	APPENDIX D1	TECHNICAL DOCUMENTATION
23	APPENDIX D2	DRIVE SCHEDULE
24	APPENDIX D3	FUNCTIONAL IO BLOCK DIAGRAMS
25	APPENDIX D4	LIMITS OF SUPPLY AND SERVICES