Eskom	Technical Specification	Technology

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CONTENTS

1. INTRODUCTION

The emergency diesel generator plant at Kendal Power Station is one of the plants that are running on the already obsolete equipment, specifically the Siemens S5 PLC & Lectron controller technology & other interface components such as protection devices/relays This has resulted in the unavailability of spares and technology support by the relevant OEMs Power plant operations have been left at risk due to the increasing amount of obsolete equipment failures

The diesel generator control system at Kendal Power Station is using the Programmable Logic Controllers (PLCs) on the units, and the station diesel generator is using the old hard-wired control panel "LECTRON III" control system

The objective of this project is to address these issues of obsolescence, limited spares availability and high plant risk of failure by replacing all diesel generator control systems with new OEM technologies & equipment

The new control system will incorporate the existing Kendal DG control and operating philosophy and shall be designed to align to the latest Eskom and National DG standards

As per 240-56227589 (List of Approved Electronic Devices to be used in Eskom), Eskom has approved specific diesel generator controller modules & other relevant devices, hence it a requirement that the latest models of approved devices shall be applied in the implementation of this project

Kendal Power Station requirements for the diesel generator control system upgrade are as follows

- Replace diesel generator protection schemes & control panels
- Replace obsolete controllers incl automatic chop over system
- Assess, refurbish, or replace components of the diesel generator engines (This will be covered in future diesel generator replacement projects)

2. SUPPORTING CLAUSES

2.1 SCOPE

The Scope of *Works* includes the provision for the design, procurement, fabrication, manufacture, factory testing, delivery to Kendal Power Station site, off-loading, storage and preservation, installation, site testing, cold and hot commissioning, project management, quality control, training, document configuration and handover of the new diesel generator control systems for Kendal Units 1-6 diesel generator sets, and the station diesel generator set (i e a total of seven (7) new DG control panels)

2.1.1 Purpose

To provide the minimum technical requirements for diesel generator control system used in Eskom

2.1.2 Applicability

The document applies to Kendal Power Station only

2.2 NORMATIVE / INFORMATIVE REFERENCES

2.2.1 Normative

[1] ISO 9001 Quality Management Systems

[2] ISO 45001 Occupational health and safety (OH&S) management system

[3] 240-62772907 Specification for Stationary Diesel Generator Systems

[4] 240-56227589 List of Approved Electronic Devices to be used in Eskom

[5] 240-56227443 Requirements for Control and Power Cables for Power stations Standard

[6] SANS 8528, Reciprocating internal combustion engine driven alternating current generating sets (all parts)

2.2.2 Informative

[7] 32-9 Definition of Eskom documents

[8] 32-644 Eskom documentation management standard

[9] 240-129144507 Technology Roadmap for Coal Fired Power Station's Common Plant Siemens S5 PLCs

2.3 DEFINITIONS

2.3.1 Classification

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

2.3.2 Malfunction

The termination of the ability of an equipment to carry out intended functions or the execution of unintended functions by the equipment.

2.3.3 Normal supply

Normal supply is when the 380V Unit Diesel Generator Board is supplied with power from either the 380V Unit Board A, the 380V Unit Standby Board, or the 380V Unit Board

2.3.4 Obsolete

No longer supported, having been replaced by something newer and better or more cost effective or profitable Product reached the end of its useful life or end of active support from the OEM

2.3.5 Software Components

Software components may be a combination of Project Data, Application Software, Operating Systems and Firmware on Servers

2.3.6 System

A system is defined as an integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective These pieces include people, hardware, software, firmware, information, procedures, facilities, services and other support facets

2.3.7 Undervoltage condition

An undervoltage condition occurs when the voltage decreases to below 65% of the rated value for a period of more than 500 ms

2.3.8 Upgrade

Raise to a higher standard, in particular improve (equipment or machinery) by adding or replacing components

2.4 ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
C&I	Control & Instrumentation
CoE	Centre of Excellence
CPU	Central Processing Unit
DC	Direct Current
DCS	Distributed Control System
DG	Diesel Generator
ECM	Engineering Change Modification
EDG	Emergency Diesel Generator
EDWL	Engineering Design Work Lead
FD	Forced Draft
FFP	Fabric Filter Plant
Gx	Generation
HMI	Human Machine Interface
HVAC	Heating, Ventilation, and Air Conditioning
ID	Induced Draft
LCS	Local Control Station
LDE	Lead Discipline Engineer
OEM	Original Equipment Manufacturer
P&ID	Piping & Instrumentation Diagram
PEI	Production Engineering Integration
PLC	Programmable Logic Controller
PRV	Pressure Regulating Valve
SAS	Substation Automation System
SCADA	Supervisory Control and Data Acquisition
SOR	Switch Operating Room
SRD	Stakeholders Requirements Definition

2.5 ROLES AND RESPONSIBILITIES

The roles and responsibilities relating to the implementation of the document are as follows

- **Engineering Design Work Lead (EDWL) / Compiler:** This project is led by the Electrical Engineering discipline The role of the project EDWL is to manage the technical integrity of the design and be accountable for the management of the interfaces within the project The project

EDWL is also responsible for the arrangement of the design reviews of this design document and the updating of the document when required

- **Lead Discipline Engineer** Coordination, integration and interfacing of all design related activities and deliverables within their disciplines throughout the project life cycle To provide input to this design document as well as reviewing the design
- **Discipline Engineering Manager/Functional Responsibility** Establish and implement strategy for design work of discipline Provide technical oversight and resources to support the project Define resource competence for functions related to lead and system engineers needed for the project Manage resource in the discipline to meet project staffing level requirements
- **Group Engineering Manager/ Authoriser** Review and authorise the Technical Specification
- **Client (Kendal Power Station End Users / relevant departments):** The role of the Clients is to review and give inputs to this document
- **System Engineer** An appropriate and qualified site/plant-based discipline or System/Plant Engineer, who has the training, technical qualification and expert knowledge of the plant or systems affected The System Engineer ensures that design review and design optimisation is performed as per the requirements, technical standards and regulatory constraints for their assigned system

Furthermore, design review procedure 240-53113685 defines roles and responsibilities which are applicable in the development of this design phase

2.6 PROCESS FOR MONITORING

This document will be approved following a Technical Specification Review that will be performed as per the Design Review Procedure 240-53113685

2.7 RELATED / SUPPORTING DOCUMENTS

Refer to Appendix A

3. *EMPLOYER*'S REQUIREMENTS

3.1 OVERVIEW

The Scope of *Works* includes the provision for the design, procurement, fabrication, manufacture, factory testing, delivery to Kendal Power Station site, off-loading, storage and preservation, installation, site testing, cold and hot commissioning, project management, quality control, training, document configuration and handover of the new diesel generator control systems for Kendal Units 1-6 diesel generator sets, and the station diesel generator set

3.2 *EMPLOYER*'S OBJECTIVES

The objective of this project is to satisfy the following requirements, as a minimum

a) The newly introduced system shall yield improved plant performance, availability and reliability by ensuring suitable control, protection, interlocking and monitoring of the emergency diesel generator plant
b) To resolve the existing issues of obsolescence & limited spares availability
c) To upgrade the control system to latest codes & standards
d) The system shall be easily maintainable by making use of a modular design
e) To maintain and improve the current operating, alarm and control philosophy for the plant/unit after upgrade
f) To occupy the existing footprint as per room layout in Appendix A

g) Extend the life expectancy of the respective plant
h) Ensure that the equipment is of a high-quality standard
i) Ensure selection technology options are in line with best industry practise and as per latest standards

3.3 BATTERY LIMITS

The project scope is limited to diesel generator control system/panel (**0BMY*)

The batteries and battery charger is ***excluded*** from scope

3.4 SYSTEM DESCRIPTION

3.4.1 System Identification

The system covered by the *Works* is the DG control system which is broken down as follows with the relevant KKS numbers

a) Diesel generator control panel (****0BMY***)
   - Diesel Generator Relay Panel (****0BMY01***)
   - Diesel Generator Synchronising Panel (****0BMY02***)
b) Cabling & wiring

The scope should be read in conjunction with the existing plant data supplied in Appendix A

Where additional information is required, the *Contractor* collects all data for the design, to enable the completion of the *Works*

All drawings from the *Employer's* for the *Works* are provided as input for the *Contractor* to validate and update the designs for detail design purposes

3.4.2 Diesel Generator System Description

A network of essential boards (3 3kV and 380V) is used to ensure that the supply to essential equipment is available during normal and emergency conditions The diesel generators (DG) are used as the last resort to restore power to the essential boards during total loss of supply The control system establishes the loss of supply, ensure that the diesel generator is started and perform the switching sequence of the breakers to provide a supply to the essential board It also closes the correct feeder circuit breakers to provide a supply to the boards that are supplied from the essential board

The purpose of the essential boards is to

- Provide power to auxiliaries which need to prevent a unit trip when the main power supplies fail
- Provide power to UPS's and battery chargers
- Ensure the main turbine and generator is in a state of readiness to restart, by providing power to auxiliary systems during total power failure

Kendal Power Station consists of six unitised 3 3kV diesel generators, and one 3 3kV station diesel generator, all rated 1250kVA 1500rpm, 218 7A each The DG supplies the 380V diesel generator board via a transformer, which reduce the voltage from 3,3kV to 380V Each DG set is supplied with an independent control system consisting of a DG control panel, which includes a relay panel and a synchronising and mimic panel This DG Control Panel is equipped with Programmable Logic Controller (PLC) that supervises and controls engine functions and alarms The DG control panel also includes various controls, protection relays, meters, an alarm annunciator, synchroscope and synchronising check relays, and live mimic panel which show the statuses of the various incoming circuit breakers of the 380V Diesel Generator Board

The Siemens S5's was installed in the early 90's and has been in operation ever since On the station side, the Lectron III controller has been in operation since the station was built in the 80's This has resulted in the unavailability of spares and technology support by the relevant OEMs Power plant operations have been left at risk due to the increasing amount of obsolete equipment failures

The DG control system interfaces to the following sub-systems

- Diesel Generator Engine
- Alternator
- Lubricating system,
- Exhaust system
- Fuel Tank
- Heaters
- Air, Oil & Fuel Filters
- Exciter
- Power, Control and Signal cabling
- Diesel Generator and rotor protection equipment (including CT's)
- Engine Protection Equipment
- Switchgear

3.4.3 Diesel Generator Control System Description

3.4.3.1 DG Control Panel Overview

The existing control system consists of a Diesel Generator Control Panel (*0BMY), which includes a Relay Panel and a Synchronising and Mimic Panel

The Diesel Generator Control Panel is equipped with Programmable Logic Controller (PLC) that supervises and controls engine functions and alarms This panel also includes various controls, indications, measurement and an alarm annunciator

The PLC controls the start-up, speed set point, shutdown and automatic rundown of the Diesel Generating set This control system also controls the excitation set point of the diesel generator under load conditions, so as to limit voltage fluctuations

The Diesel Generator Synchronising and Mimic Panel consist of a synchro-scope and synchronising check relays, and live mimic panel which shows the statuses of the various circuit breakers The bus-bars, incoming voltages and frequencies are indicated on this panel

A summary of the control and operating philosophy is discussed in Section 3 4 3 2 below

3.4.3.2 Control & Operating Philosophy

3.4.3.2.1 Unit

The configuration of the 380V unit diesel generator system is shown diagrammatically below

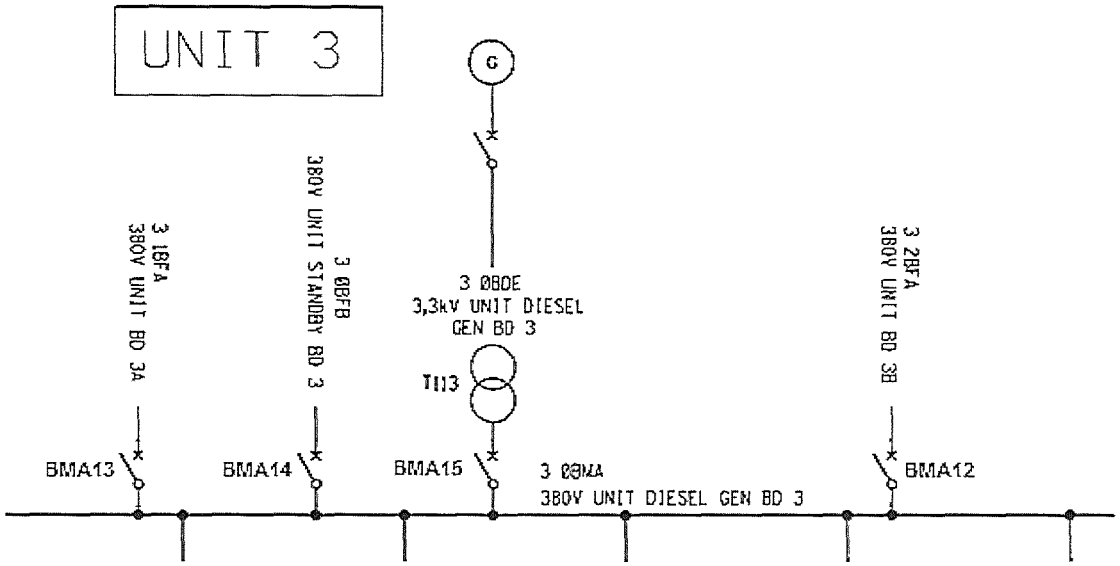

Figure 1 380V Unit Diesel Generator Board 3 (0.64/12388 Sheet 2)

The 380V diesel generator board (*0BMA) has been designed to enable an automatic changeover to be initialised between any one of the following sources of supply when the busbar voltage is lost

1 380V Unit Board *A
2 380V Unit Standby Board *
3 380V Unit Board *B
4 The 3 3kV unit diesel generator
5 The transfer from the station diesel generator to supply a unit (not available / no loop cable connected)

(= unit number)*

The voltage of the incomers to the 380V unit diesel generator board is monitored by the PLC When an undervoltage condition exists on the busbars, the relevant breaker feeding the 380V unit diesel generator board (*0BMA) will trip To re-energise the 380V unit diesel generator board, one of the breakers *0BMA13, *0BMA14, or *0BMA12 would be pulsed to close, provided supply is "healthy" The breaker which will be pulsed is determined by the availability of the supply, as well as the priority of the supply If the 380V unit diesel generator board cannot be energised from one of the above-mentioned supplies (i e normal supplies), a pulse to start the unit diesel generator will be issued While the unit diesel generator is starting and running up to speed, the control system will continuously monitor all the possible supplies and send a close pulse to the first healthy supply

Once the unit diesel generator is up to speed and has reached the rated voltage and frequency, the supply will be considered healthy, after which breaker *0BMA15 would be enabled for closing If any of the alternative supplies become healthy before breaker *0BMA15 is closed, the 380V unit diesel generator board will be energised by the control system closing the respective breaker, and an automatic rundown of the unit diesel generator will take place after a period of 10 minutes

Upon the return of an alternative supply, while the Unit Diesel Generator is feeding the 380V unit diesel generator board, the respective breaker needs to be synchronised onto the 380V unit diesel generator board, after which the unit diesel generator will be de-loaded, breaker *0BMA15 opened, and an automatic rundown of the diesel machine will be carried out after 10 minutes The diesel generator supply will need to synchronize to a healthy supply available before the breaker of that supply is closed This is a requirement for the controller to be able to synchronize with the main busbar as well as other alternative supply inputs

Electrical interlocking is to prevent paralleling any of the 380V incoming circuit breakers onto the 380V unit diesel generator board (*0BMA), other than the synchronised supply The closing of any one 380V incoming circuit breaker onto the 380V unit diesel generator board busbars will automatically block a closing signal to all the other 380V incoming circuit breakers

3.4.3.2.2 Station

The configuration of the 380V station diesel generator system is shown diagrammatically below

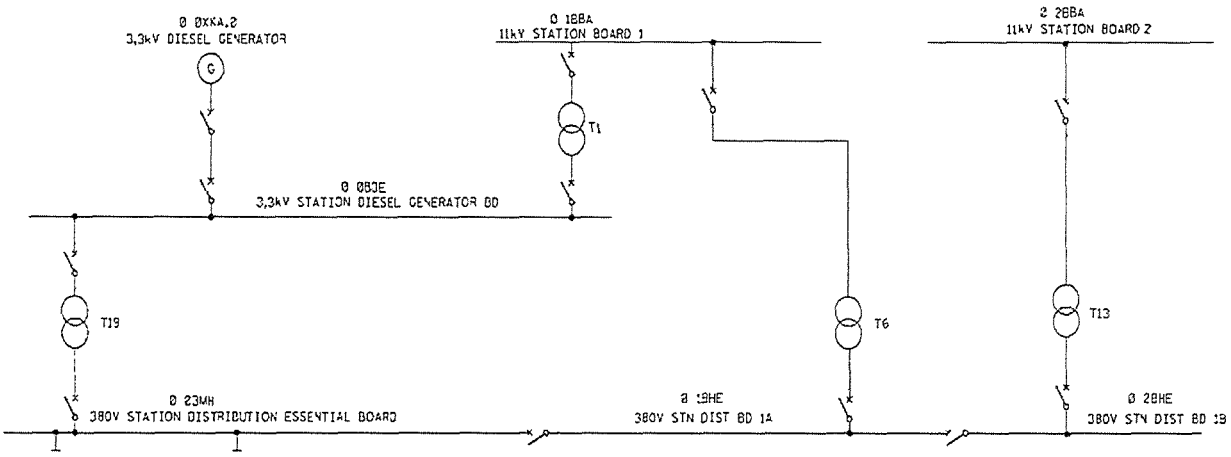

Figure 2 Station Diesel Generator Reticulation (0.64/12388 Sheet 2)

The 3 3kV Station DG Board has 2 incoming supplies

1 11kV Station Board 1
2 3 3kV Diesel Generator

The 380V Station Distribution Essential Board receives supplies as follows

1 3 3kV Station DG Board
2 380V Station Dist Board 1A via 11kV Station Board 1
3 380V Station Dist Board 1B via 11kV Station Board 2

3.4.3.3 Control System Interfaces

The following sections identifies all existing interfaces to the unit and station diesel generator control systems As far as practically possible, the new controllers will be implemented with the existing interfaces being retained Depending on the type of controller procured, the OEM/supplier will assess these interfaces and propose any further modifications required to ensure compatibility

3.4.3.3.1 Controller Inputs & Outputs (I/O's)

Refer to Appendix A Drawings & Supporting Documentation

- 19 64/33129 Sheet 5 - Unit diesel generator PLC indication / interface diagram
- 0 64/19718 Sheet 6 – Station diesel generator Lectron III control panel interface diagram

All the I/O's in abovementioned "as-built" drawings, will be retained as far as possible

All control and test functionality, viewing of measurement parameters & alarms are only possible locally at the DG control panel

Only the following outputs from the controller are linked to the Unit Control Room and EOD

- Fuel Alarm
- Diesel Generator System Unhealthy Alarm
- 380V Chop-over System Unhealthy Alarm
- Alarm panel active
- 380V Board Under voltage Alarm

3.4.3.3.2 Mimic Panel

The live mimic panel shows the statuses of the various circuit breakers A mimic is still required as part of the replacement and will be in the form of an LCD/LED display

Refer to Appendix A

- 19 64/33129 Sheet 26 - Unit diesel generator mimic layout
- 0 64/19718 Sheet 0 (Cover Sheet) – Station diesel generator mimic layout

3.4.3.3.3 DG Protection Schemes

The different protection schemes used for the diesel generators provide protection against electrical damage, and are as follows

- Switch-onto-standstill
- Reverse power protection
- Undervoltage
- Overvoltage
- Underfrequency
- Overcurrent and earth fault
- DC fail
- Winding temperature
- Differential Protection
- Negative Phase Sequence

The operation of any of the abovementioned protection will disconnect the diesel generator from the system

Refer to Appendix A for more details on the existing ASEA protection schemes

- 19 64/33129 Sheet 2 - Unit diesel generator trip & protection circuit and the interface to the DG control panel
- 0 64/19718 Sheet 2 – Station diesel generator protection & metering schematic diagram
- 0 64/19362 Sheet 1 - The existing diesel generator protection panel arrangement and material/device types
- 0 64/19362 Sheets 2 – 12 - The Asea diesel generator protection schematics These obsolete protection devices will be replaced with new technology devices as per 240-56227589 "List of Approved Electronic Devices to be used in Eskom"

3.4.3.3.4 Alarm Screen

The existing unit diesel generator alarm screen layout is provided in Appendix A (19 64/33129 Sheet 13) These alarm, critical condition & functional indication outputs will be retained and be part of the new control panel

The following ***alarms*** are annunciated on the unit control panel

- *0BMA 12/13/14/15 switchgear discrepancy
- *0BMA 12/13/14/15 fails to close
- 380V DG BRD switchgear unhealthy
- 380V DG BRD 220V DC fail
- 380V DG BRD control lock-out
- 380V DG BRD cable volts unhealthy
  - The incoming cable from the 380V Unit board A (*0BMA13)
  - The incoming cable from the 380V Unit board B (*0BMA12)
  - The incoming cable from the 380V Standby board (*0BMA14)
- 3 3kV switchgear unhealthy
- 3 3kV breaker unhealthy
- 3 3kV voltage unhealthy
- Fuel filling pump CB off (Unit 1 & the Station Diesel Generator only)
- Oil priming pump CB off
- Control panel DC fail
- Fuel level< 50%
- Oil pressure low - stage 1
- Engine temperature high - stage 1
- Emergency stop pushbutton activated
- Emergency start activated
- 24V battery charger fails
- Transformer winding temperature high
- DG fails to start

The following ***critical conditions*** will initiate an instantaneous trip when the 380V unit diesel generator board is fed from normal supplies, or a time delay will become active before a shutdown will be initiated if the unit diesel generator is feeding the 380V unit diesel generator board

- Radiator low water level
- Oil pressure low stage 2
- Engine temperature high stage 2
- Fuel level < 10%

The following ***functional indications*** inform the operating personnel of the actions which are taken by the control system at a specific moment

- Fuel solenoid activated
- Diesel Generator start
- Oil priming pump running
- Fuel filling pump running (Unit 1 and the Station Diesel Generator only)
- Fuel level > 95%
- Lower speed
- Raise speed
- Lower excitation
- Raise excitation
- PLC healthy

3.4.3.3.5 Cables and Terminations

All existing control cables will be tested and re-used as far as practically possible Any defective control cables will be replaced with new

Refer to Appendix A for existing termination schedules

- 19 64/33129 Sheet 14-24 - Unit diesel generator control panel cable and termination schedule
- 0 64/19718 Sheet 7 – Station diesel generator control panel terminal strip

3.4.3.3.6 Diesel Generator Auxiliaries

The new control system will be capable of communicating with the existing instrumentation and field devices as far as practically possible Where incompatibility issues exist between the new control system and existing field devices, the supplier will propose the relevant modifications required

There are difficulties to obtain diesel generator auxiliaries equivalent spares on the market The specification for existing diesel generator auxiliaries and field devices are as follows

- 380V, 0 74kW Oil Priming Pump Motor
- 380V, 0 74kW Cooling Water Circulation Pump Motor
- 380V, fuel pump motor
- 220V Air Cooler solenoid valve
- 230V, 4kW engine heater element x 2
- 230V, 500W, 1 5A alternator heater element
- 24V starter motors x 2
- 24V alternator x 1
- 24V electrical Governor
- 24V solenoid
- Oil pressure sensor/switch
- Temperature sensor/switch
- Water temperature sensor/switch,
- Radiator water level sensor/switch
- Oil filters,
- Fuel filters,
- Air filters,
- Alternating Voltage Regulator (AVR),
- Electrical and mechanical speed devices,
- Speed detection sensors/switches,
- Fan belt,
- Solenoids
- Relays
- Local indicators, etc

It is recommended that a separate project is registered to issue RFQ (Request for Quotation) on the market to evaluate availability of spares and obtain quotation for supply of auxiliary spares The RFQ feedback shall determine if it's feasible to reinstate the auxiliaries to original design base or recommend a complete replacement of the diesel generators

Refer to Appendix A for details on the DG auxiliaries' schematic diagrams

- 19 64/33129 Sheet 1 - Unit diesel generator auxiliaries schematic
- 0 64/19718 Sheet 4 - Station diesel generator auxiliaries schematic

3.4.3.3.7 Circuit Breakers

The 380V incoming circuit breakers *0BMA12 to *0BMA15 are Siemens circuit breakers namely 3WNI 6 Size II

The existing unit diesel generator circuit breaker/board schematics is provided in Appendix A (19 64/33129 Sheets 7-10)

The contractor will be tasked to perform a retrofit on the LV breakers and install new MV breakers associated with the chop-over system on all units The contractor will propose a detailed design for review and approval before implementation

3.4.3.3.8 Diesel Generator Rooms

The existing station diesel control panel in the station diesel generator room shall be replaced with new control panel which has built-in synchronisation functionality and it shall be positioned in the same position where the existing control panel is positioned

Similarly, the existing units control panels in the unit diesel generator rooms shall be replaced with new control panel which has built-in synchronisation functionality and it shall be position in the same place where the existing control panel is positioned

Refer to unit diesel generator room layout (0 64/20763) and station diesel generator room layout (0 64/17040) in Appendix A

There is an issue of ash/dust ingress in the unit DG rooms, however, new control panels to be appropriately rated for the harsh environment (i e dust and ash) as specified in Technical Schedule A&B in Appendix D

3.4.3.3.9 Diesel Generator Data

The DG's are manufactured by Hawker Siddeley (Pty) Ltd The ratings of the generator are as follows

Table 1 Kendal Diesel Generator Data

Description	Rating
Engine Model Number	Mitsubishi S16N-PTA
AC Generator/Alternator Spec	BS 5000 Part 3
RPM	1500
Voltage (kV)	3 3
Current (A)	218 7
Phase Connection	Star
Rating	Continuous
Ambient Temperature (°C)	40
Power Factor	0 8
Rect DC kW	8 33
Rect DC Voltage (V)	92 5
Rect DC Current (A)	90

3.5 *CONTRACTOR*'S DESIGN

The *Contractor* shall fulfil the following scope requirements as part of the *Works*

a) Engineering and design of a complete control system based on the existing philosophy (Section 3 4 3 2), existing interfaces (Section 3 4 3 3), and 240-62772907 - Specification for stationary diesel generator systems, for Kendal Units 1-6 diesel generator sets, and the station diesel generator set (i e a total of seven (7) new DG control panels)
b) Supply approved devices as stipulated in 240-56227589 - List of Approved Electronic Devices to be used in Eskom
c) Perform all activities from system engineering through technical clarification, detailed design, procurement, manufacture, factory testing, delivery, off-loading, storage and preservation, installation, site testing, commissioning, project management, quality control, training, configuration documentation and handover to the *Employer*
d) Verify and identify all scope requirements for the control system, as part of the *Contractor*'s engineering and design effort, in order to meet the functional and performance requirements of the *Works*
e) The *Contractor* shall also show compliance with the requirements as listed in Technical Schedule A&B in Appendix D
f) The technical schedule A&B must be completed and supplied as part of the tender If there are any deviations, the tenderer to submit a list of deviations for assessment
g) Comply with all other codes & standards listed in Appendix E for the new diesel generator control system & interfacing equipment
h) Test existing control cables and re-use as far as practically possible Ensure all cables are marked for ease of disconnection and reconnection *Contractor* to verify and use cable schedules provided by the *Employer*
i) Replace defective control cables with new
j) Provide new control cables where required for interfaces of the diesel generator control system
k) Implement all cable and wiring terminations
l) Upgrade protection devices within the local DG control panel with new equivalent & compatible technology devices
m) Monitoring, alarms, indications, and protection functions, as listed in Section 3 4 3 3, and technical schedule A&B, shall be made available on the local DG control panel Where additional features are required as per [3], the control system must be capable of accommodating these additional requirements as per the standard This is to "future-proof" the control system for any upcoming upgrades on the generator and auxiliary systems to align with latest standards
n) The new control system shall be capable of communicating with the existing instrumentation and field devices as far as practically possible Where incompatibility issues exist between the new control

system and existing field devices, the *Contractor* proposes, for *Employer*'s approval, the relevant modifications required

o) Configure the new logics and program the controller

p) Supply all hardware, software, licensing and copyright agreements to enable the operation of the system(s) as specified by the *Works*

q) All new equipment installed shall be properly bonded to the existing earth mat Earth continuity test shall be conducted on newly installed equipment for quality controls

r) Equip with a new technology control panel that will be capable of interfacing to a SAS network, in compliance with SANS 61850

s) In addition to requirements above, the control system shall have the following features and capabilities, as a minimum

- Built-in synchronising capabilities, governor control, and AVR control
- Data logging & event logging (access to historical alarms and operational status)
- Trending capability
- All data (events) shall be date and time stamped
- Remote communication (via RS232, RS485, Ethernet protocols) for incomer breaker statuses, alarms and monitoring The existing alarms and monitoring interfaces shall be retained as a minimum, to the Electrical Operating Desk (EOD) and respective control system
- Configurable via PC
- Be able to perform periodic testing of the DG in test mode as per Employer's philosophy

t) The *Contractor* shall submit all documentation as specified in the VDSS (Appendix B) throughout the life cycle of the project

u) In the event of a conflict between requirements as specified in the *Works* and the relevant standards, the *Employer* decides which shall apply The *Contractor* clearly states in writing any deviation from these Absence of such statements is interpreted to mean that the offer is in compliance with these requirements

v) General safety design and installation requirements are to be as follows

I Do not mount electrical equipment on removable walkways or structures

II Shroud or shield live parts of electrical equipment mounted in enclosures to prevent unintentional contact by personnel

III Lockable enclosures shall have provision for securing by means of padlocks

IV Electrical installations shall be such that they are "fail safe" (i e , the failure of the Plant or any circuit stops the associated equipment in a safe state)

w) Based on the civil & structural loads from the new panels (if greater than the old panel or requires a new footprint within the room), the *Contractor* determines the live load imposed on the floors and

confirms if they will be able to withstand the load or not The *Contractor* designs and constructs the necessary strengthening and support system to safely support the loads

3.6 DOCUMENTATION MANAGEMENT REQUIREMENTS

3.6.1 Document Management

All documents supplied by the *Contractor* shall be subject to the *Employer*'s approval The language of all documentation shall be in English All documentation shall be controlled and managed in accordance with Document and Records Management Procedure (32-6)

3.6.2 Document Identification

The *Contractor* is required to submit the Vendor Document Submission Schedule (VDSS) as per agreed dates to the delegated *Employer* Representative The *Employer* will pre-allocate document numbers on the VDSS and send back to the *Contractor* through the delegated *Employer* 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 shall indicate the format of documents to be submitted

3.6.3 Document Submission

All project documents must be submitted to the delegated *Employer* 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 and hard copies and both copies must be delivered to the *Employer* Representative with a transmittal note The process for submission of documents shall be agreed before the design work commences

In addition, the *Contractor* shall 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

3.6.3.1 Electronic Submission (SharePoint Transmittal)

Where applicable and contractually agreed, e-mail submissions can be used, as well as other submission methods employed in the relevant project e g dropbox, google cloud, etc

3.7 CONFIGURATION MANAGEMENT REQUIREMENTS

3.7.1 Plant Coding Allocation

The allocation of functional location (FLOC) codes shall form part of the detail design phase Where applicable, the allocation of functional location codes and cable numbers will be allocated on the following drawing types

- Plant layout/general arrangement
- Switchgear schedules

- Switchgear Layout/general arrangement
- Cable block diagrams
- Network topologies
- C&I cabinets and module layout
- Wiring diagrams
- Logic diagrams
- etc

FLOC's shall also be carried over and used in manuals, QCP's, lists and (at a later stage in the project) in certificates, performance tests, etc FLOC labelling shall be done by the Contractor, where such labelling will be done strictly according to the Kendal Functional Location coding and labelling standard *1017822

3.7.2 Configuration Item (CI) identification

- Functional Location Code (Supplied by Eskom)
- Component Description (Supplied by Contractor)
- Part Number (Supplied by Contractor)
- Serial Number (Supplied by Contractor)
- Specification Document (Supplied by Contractor)
- The procurement specification for each component (Supplied by Contractor)
- The information required on the cataloguing form for items designated for spare holding where applicable (Supplied by Contractor)

3.7.3 Drawing Requirements

a) The *Contractor* supplies reproducible drawings according to the Vendor Document Submittal Schedule (VDSS) in Appendix B
b) All drawings shall be drawn natively in Microstation (version to be confirmed with Employer)
c) Drawings shall strictly comply with 240-86973501-Eskom Drawing Standard
d) All new drawing numbers must be requested from the Eskom drawing office
e) It is the Contractors responsibility to ensure all drawings are "As Built" before the works is commissioned
f) All approved "as-built" drawings shall be handed over before commissioning of the Works
g) All final drawings shall be handed over as follows and accompanied by an updated master document register
   - Electronic Microstation natively drawn drawing file
   - Signed hard copy, approved by design engineer, accepted by Project/System Engineer and authorised by functional Eskom Line Manager (for new drawings)
   - Scanned electronic file of the signed drawings in pdf format
   - Electronic files may be supplied on CD or DVD
h) Eskom Kendal Power Station drawing office personnel shall be available to assist the Contractor with any drawing related queries
i) All drawings shall be submitted to the Kendal drawing office for quality check before hand-over It is recommended that the Contractor send a sample drawing for each drawing type to the drawing office, to ensure the correct standard is followed before creating all drawings

3.7.4 Manuals

Maintenance Manuals shall include as a minimum

- Table of Content
- Overview
- Proposed maintenance strategy
- Maintenance procedures
- Proposed spares holding
- Illustrated parts catalogue

Operating Manuals shall include as a minimum

- Table of Content
- Overview
- Operating philosophy
- Operating procedure (commissioning, stand-by, start-up, running, shut-down, etc)
- Standard isolation procedure
- Alarm response procedure

Technical Manuals & Records shall include as a minimum

- Design data e g drawings, layouts, arrangements, lists, schedules, etc
- Reports e g Configuration audit/verification reports, performance reports, progress reports, FAT, SAT, commissioning, etc
- Installation instructions with drawings or pictures
- Software codes, logics, etc
- Certificates e g testing
- Signed QCP's

All above manuals shall be supplied in electronic format as well as 3 hardcopy sets Software codes to also be supplied on USB

3.7.5 Transmittal Management

Transmittal Management for Technical Documentation Work Instruction 240-122887026 shall be adhered to

3.8 DESIGN REVIEWS

a) The *Contractor* shall hold a design review as part of the compliance review of the plant, allowing the *Employer* to gain a clear understanding of the overall design
b) The review shall be after the completion of the design and the preliminary outline drawings
c) The *Contractor* shall make available the calculations and information for the detailed design verification

3.8.1 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 conducts 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

3.8.2 Engineering Change Procedure

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

3.9 TRAINING

The *Contractor* is required to provide training to Eskom operating, maintenance and engineering staff The *Contractor* supplies all training material The training shall include both theoretical and practical (on-the-job) training

The *Contractor* shall provide multiple sets of training classes to cater for day and night shift workers

3.10 TEST AND COMMISSIONING

Testing and Commissioning of the upgraded diesel generator control system shall be performed to ensure that the system shall meet the functional requirements and performance criteria required for the plant as stipulated in the diesel generator standard [3] The following functions in addition to the tests stipulated in [3] shall be performed

3.10.1 Checking the hardware

Each sensor is connected to a specific input and each final control element to an output During engineering process, addresses and wires must not be mixed up The sensors and final control element placing should be checked (that they are where they have to be in the automated system)

During checking procedure, the outputs are set in a test mode The final control elements must then meet the specified requirements (functions)

If changes are made, then the documentation (allocation list, drawings, etc) must be updated to respond to "as-built"

3.10.2 Transferring and testing the software

All available off-line and practical controller program testing tools should be used to find program faults

The input signal changes are to be simulated to verify how the outputs will react Some controllers offer simulation inside the controller i e the entire program is executed in a controller without the real inputs and outputs being connected

The program and system functions are to be tested manual operation, setting, individual monitoring programs etc

The system should be commissioned step-by-step Important aspects of commissioning and fault detection are the test functions of the programming system, such as the single-step mode or the setting of stop points The single-step mode is recommended, whereby the program in the controller memory is executed line-by-line or step-by-step In this way, any program faults which may occur in the program can be immediately located

3.10.3 Optimisation of the entire system

The programs often require improvement after the first test run It is recommended that any corrections or modifications are made not just in the controller user program, but are also taken into account in the documentation

3.10.4 Commissioning of the entire system

Once the final status of the controller user program and the documentation is established, all the controller functions need to be executed step-by-step again

If no faults are detected in the entire system commissioning, then the system is ready to be handed over to the client

4. AUTHORISATION

This document has been seen and accepted by

Name	Designation
Malibongwe Mabizela	Kendal Engineering Manager
Remember Sigawuke	Electrical Engineering Manager
Pranesh Bhugwandin	Manager - PTM
Ayanda Mahlobo	System Engineer – Electrical Engineering
Niven Moodley	Senior Engineer – Electrical Engineering
Johannes Geldenhuys	Senior Advisor - PTM
Mhlengi Phiri	Technician - PTM
Jan Meyer	EMD Tech Support

5. REVISIONS

Date	Rev.	Compiler	Remarks
October 2021	0 1	E Kisten	First draft Written for the purposes of Unit 3 replacement
November 2021	0 2	E Kisten	Updated after Switchgear Replacement Project basic design baseline which includes a basic design for the DG control system To include all units and station DG control systems
January 2022	0 3	Nathi Mkhize	Final Document Written for the purposes of Unit 3 replacement

6. DEVELOPMENT TEAM

The following people were involved in the development of this document

- Eugene Kisten
- Nathi Mkhize

7. ACKNOWLEDGEMENTS

- Prishen Pather
- Eugene Kisten
- Mhlengi Phiri

APPENDIX A: DRAWINGS & SUPPORTING DOCUMENTATION

DWG NO.		REV	TITLE
0 64	19718	1	3 3KV STATION DIESEL GENERATOR CONTROL PANEL 00BMY ARRANGEMENT
0 64	19718	2	3 3KV STATION DIESEL GENERATOR PROTECTION AND METERING CIRCUITS SCHEMATIC DIAGRAM
0 64	19718	3	3 3KV STATION DIESEL GENERATOR TRIPPING CIRCUIT SCHEMATIC DIAGRAM
0 64	19718	4	3 3KV STATION DIESEL GENERATOR AUXILIARIES SCHEMATIC DIAGRAM
0 64	19718	5	3 3KV STATION DIESEL GENERATOR SPEED CONTROL CIRCUIT SCHEMATIC DIAGRAM
0 64	19718	0	3 3KV STATION DIESEL GENERATOR MIMIC DIAGRAM 00BMY (COVER SHEET)
0 64	19718	6	3 3KV STATION DIESEL GENERATOR LECTRON III CONTROL PANEL AND ENGINE WIRING SCHEMATIC DIAGRAM
0 64	33129	1	UNIT 3 UNIT DIESEL GENERATOR AUXILIARIES
0 64	33129	2	UNIT 3 UNIT DIESEL GENERATOR PROTECTIION AND TRIP CIRCUIT 30BMY01
0 64	33129	4	UNIT 3 3 3KV UNIT 2 DIESEL GENERATOR PROTECTION AND METERING
0 64	33129	6	UNIT 3 UNIT DIESEL GENERATOR CONTROL AND SYNCHRONISING DOOR
0 64	33129	7	UNIT 3 UNIT DIESEL GENERATOR 30BMA12
0 64	33129	8	UNIT 3 UNIT DIESEL GENERATOR 30BMA13
0 64	33129	9	UNIT 3 UNIT DIESEL GENERATOR 30BMA14
0 64	33129	10	UNIT 3 UNIT DIESEL GENERATOR 30BMA15
0 64	33129	11	UNIT 3 3 3KV UNIT DIESEL GENERATOR BREAKER
0 64	33129	12	UNIT 3 DIESEL GENERATOR TRANSFER BREAKER KEY DIAGRAM
0 64	33129	13	UNIT 3 UNIT DIESEL GENERATOR ALARM SCREEN
0 64	33129	15	UNIT 3 UNIT DIESEL GENERATOR 30BMY02 CABLE DETAIL SCHEDULE
0 64	33129	16	UNIT 3 UNIT DIESEL GENERATOR 30BMY02 CABLE DETAIL SCHEDULE
0 64	33129	17	UNIT 3 UNIT DIESEL GENERATOR 30BMY02 CABLE DETAIL SCHEDULE
0 64	33129	18	UNIT 3 UNIT DIESEL GENERATOR 30BDE01 CABLE DETAIL SCHEDULE
0 64	33129	19	UNIT 3 UNIT DIESEL GENERATOR 30BDE03 CABLE DETAIL SCHEDULE
0 64	33129	20	UNIT 3 UNIT DIESEL GENERATOR 30BMA12 CABLE DETAIL SCHEDULE
0 64	33129	21	UNIT 3 UNIT DIESEL GENERATOR 30BMA13 CABLE DETAIL SCHEDULE
0 64	33129	22	UNIT 3 UNIT DIESEL GENERATOR 30BMA13 CABLE DETAIL SCHEDULE
0 64	33129	23	UNIT 3 UNIT DIESEL GENERATOR 30BMA15 CABLE DETAIL SCHEDULE
0 64	33129	24	UNIT 3 UNIT DIESEL GENERATOR 30BMA15 CABLE DETAIL SCHEDULE
0 64	33129	26	UNIT 3 DIESEL GENERATOR MIMIC
0 64	33129	3	UNIT 3 UNIT DIESEL GENERATOR CONTROL PANEL AND ENGINE WIRING
0 64	33129	5	UNIT 3 UNIT DIESEL GENERATOR (PROGRAMMABLE LOGIC CONTROLLER) PLC INDICATION DIAGRAM
0 64	33129	14	UNIT 3 UNIT DIESEL GENERATOR 30BMY01 CABLE DETAIL SCHEDULE
0 64	33129	25	UNIT 3 DIESEL GENERATOR SINGLE LINE DIAGRAM
0 64	19362	1	DIESEL GENERATOR PROTECTION LAYOUT DRAWING MATERIAL LIST
0.64	19362	2	DIESEL GENERATOR PROTECTION AC CONNECTIONS CIRCUIT DIAGRAM
0 64	19362	3	DIESEL GENERATOR PROTECTION DC TRIP CIRCUIT DIAGRAM

0 64	19362	4	DIESEL GENERATOR PROTECTION DC TRIP CIRCUIT DIAGRAM
0.64	19362	6	DIESEL GENERATOR PROTECTION TRIP/ALARM FLAG RELAYS CIRCUIT DIAGRAM
0 64	19362	8	DIESEL GENERATOR PROTECTION 3 PHASE UNDERVOLTAGE RELAY CIRCUIT DIAGRAM
0 64	19362	9	DIESEL GENERATOR PROTECTION OVERCURIENT PROTECTION CIRCUIT DIAGRAM
0 64	19362	10	DIESEL GENERATOR PROTECTION FREQUENCY RELAY CIRCUIT DIAGRAM
0 64	19362	11	DIESEL GENERATOR PROTECTION OVERVOLTAGE PROTECTION CIRCUIT DIAGRAM
0 64	19362	5	DIESEL GENERATOR PROTECTION ALARMS CIRCUIT DIAGRAM
0 64	19362	7	DIESEL GENERATOR PROTECTION EARTH FAULT RELAY
0 64	17040		3 3KV STATION DIESEL GENERATOR EQUIPMENT LAYOUT
0 64	20763		UNITS 2-6 DIESEL GENERATOR ELECTRICAL EQUIPMENT LAYOUT

APPENDIX B: VENDOR DOCUMENT SUBMITTAL SCHEDULE (VDSS)

Refer to attached VDSS

APPENDIX C: TECHNICAL TENDER RETURNABLES

Technical Tender Returnables	Y/N
One hard copy and one soft copy (electronic) of the Technical Schedules A&B	
A comprehensive list of customers (with contact details) detailing the equipment ratings supplied as well as the delivery dates	
A company overview detailing the company background, industry market share, available expertise and national technical support capabilities	
Where applicable, an OEM signed confirmation letter/s confirming that warrantees to the end user shall be honoured by the OEM	
Proof of registration as an Electrical Contractor with DoL	
Submission of Companies and Intellectual Property Commission certification	
Proof of years of experience on supply, installation & commissioning of diesel generator control systems, with supporting letters that includes the contract numbers / order numbers / list of customers / verifiable references, with equipment supplied	
High level method statement demonstrating understanding of full scope of work	
Detailed project plan with timelines based on the scope of work This should include a list of long lead items and timelines from order to delivery, installation & commissioning	

APPENDIX D: TECHNICAL SCHEDULE A&B

Refer to attached technical schedule A&B

APPENDIX E: CODES & STANDARDS

ISO 9001 Quality Management Systems

ISO 45001 Occupational health and safety (OH&S) management system

240-62772907 Specification for Stationary Diesel Generator Systems

240-56227589 List of Approved Electronic Devices to be used in Eskom

240-56227443 Requirements for Control and Power Cables for Power stations Standard

0 00/1310 Power and Control Cables Codes

240-56227516 Specification for LV switchgear and control assemblies and associates equipment for voltages up to and including 1 000 V AC and 1 500 V DC

240-56356396 Earthing and Lightning protection system Standard

240-56176729 Essential Power Supplies for Power Stations Standard

240-56357424 MV and LV Switchgear Protection Standard

240-75655504 Corrosion protection standards for new indoor and outdoor Eskom equipment, components, materials and structures manufactured from steel standard

32-333 Standards for Electronic Protection and Fault Monitoring Equipment for Power Stations

240-64685228 Generic Specification for Protective Intelligent Electronic Devices (IEDs)

SANS 1507, Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1900/3300 V)

SANS 8528, Reciprocating internal combustion engine driven alternating current generating sets (all parts)

SANS 10140, Identification colour marking

SANS 60034 Rotating electrical machines

SANS 60529 Degrees of protection provided by enclosures

SANS 60947 Low-voltage switchgear and control gear – Part 7-1 Ancillary equipment – Terminal blocks for copper conductor

SANS 10142 Wiring of Premises

*1036668 Kendal configuration management plan

*1017821 Kendal configuration management work instruction for projects

*1017822 Kendal functional location KKS coding and labelling works instruction

*1015695 Kendal document management work instruction

*10222174 Kendal process control and monitoring software work instruction