

Title: **Assessment, Detailed Design for modernization of the Rotek Balancing Plant Control Room – Phase 1**

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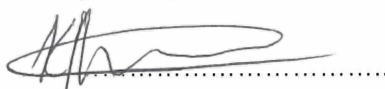
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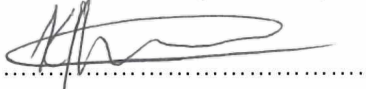


Khaya Sobuwa

Chief Engineer, Gx
Engineering

Date: 09-Mar-2022

Functional Responsibility



Khaya Sobuwa

Chief Engineer, Gx
Engineering

Date: 09-Mar-2022

Authorised by



Andiswa Minyi

Plant Manager (acting), TGS
– Works Balancing Plant

Date: 2022/03/10

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1 Objectives

This Scope of Work (SoW) seeks to describe the required investigative and design scope of work required to retrofit the existing hardwired control room / desk of the Rotek Balancing Plant (BP) to a modern fully computerised control room. This Phase 1 work will thus enable the sourcing of an Installation Contractor for the designs and plans submitted in Phase 1. The Installation work, both pre-shutdown and during shutdown will be executed under Phase 2 of the project.

Phase 2 Scope of Work will include supply, installation, and commissioning of the modernized control room up to handover. The Phase 1 design entity shall be hired to conduct Technical Quality Assurance during Phase 2 of the works.

2 Background

The Rotek BP located in Rosherville, being the only +300 ton balancing plant in the continent of Africa, is exposed to obsolescence of the control equipment employed in the operation of the plant. Almost all key control equipment, including the control room were installed with the initial commissioning of the plant in 1982. The BP services roughly about 20 to 70 rotor (turbine and generators mostly) machines per annum, and thus is very critical to the Generation Maintenance program of such machines.

2.1 High Level Description of Existing Balancing Plant

2.1.1 The Tunnel and related systems

The BP consists of pedestal tunnel where the serviced rotors are mounted before the balancing activities begin. The tunnel has pedestal bearings serviced by jacking and main lubricating oil systems. The tunnel has also a ventilating system as well as an evacuating (to form a vacuum) system which are used to simulate conditions in which the serviced rotors are subjected to in their respective plants. The source of ventilation air is a fan system, and the vacuum system uses vacuum pumps to establish the required vacuum.

The tunnel further has instrumentation which measures the vibration, eccentricity and other related shaft rotation parameters that are necessary for the balancing activities.

2.1.2 The Main Motors and DC Drives

There are two tandem motors (3200 kW each), both driven by DC electronic Variable Speed Drives (aka. DC Drives) that are coupled to the serviced rotors via a step-up gearbox and are used as the propellant for the rotors to achieve the required rotational speeds. The DC drives have the control electronics located in the Electrical room. The motors and the gearbox are serviced by a separate auxiliary lubricating oil system with its own tank and associated instrumentation. One of the motors was last rewound in 2017, and the other in 2005. The motors are not intended to be replaced.

2.1.3 The Electrical Power Supply Reticulation and Backup Power

The power supply for the motors comes via the 6.6kV transformer and related switching boards, also located in the Electrical Room. There is a backup 400kVA diesel gen for all the electrical systems (except the main motors). All Low voltage (LV) consumers like pumps have their switchgear boards and circuits also located in the Electrical Room. The switchgear circuits interface with the control

room panels to facilitate remote operation of the drives / pumps, as well as viewing of the plant parameters during the balancing activity.

There is currently battery back-up power supply for 220VDC for the control voltage on the drives.

110VAC is also used as control voltage on the switchgear LV drives.

There is also 48VDC signalling voltage. This has no battery supply and is supplied by the mains power which is backed-up by the diesel gen.

2.1.4 The central Cooling Water system

There is cooling water system with pumps that is used for cooling the pedestal bed, the main lubricating oil, as well as the auxiliary lubricating oil systems. The cooling water is also used for the HVAC chiller system for the building. The cooling water system also cools the main motors and vacuum system. The main heat exchanger for the cooling water is a cooling tower located in the premises.

2.1.5 The Control Room

The BP control room consists of two main areas, the control desk and back panel, as well as the Balancing Panel with its own desk. This arrangement allows for parallel operating during the balancing activity, where the control desk is used for BP operation, and the Balancing Panel is used to monitor the rotor machine that is being serviced.

The control desk and its back panel allow for the operation of the electrical reticulation system, operation of the main motors and the DC drives, including varying the speed of the motors, monitoring of the motors and the gearbox, operation of the main and auxiliary lube oil systems, operation of the ventilation / vacuum system as well as operation of the cooling water system.

The Balancing Panel on the other hand allows for the monitoring of all the balancing instrument parameters of the serviced rotors. It also allows for the operation of the Excitation system in the case of generator rotors.

There is also a Fire Detection control panel for the whole balancing plant which is monitored in the control room. There is also an Air Conditioning panel located inside the control room.

The control desk also mounts an old CCTV system which is used to monitor the activities in the tunnel.

See drawings FBHO-117005 and FBHO-117201 in Annexure A for layout of existing control room. The cable entry to control room is located both at the bottom and at the top.

2.2 The Need / Problem

Due to increased difficulty of maintaining obsolete control room equipment, and a foreseen risk of not meeting the Generation Maintenance schedule, an upgrade of the existing hardwired control room is envisaged to modernize the control room and improve maintainability for sustainability of the critical operations of the BP. The control room must be retrofitted to a fully computerised control centre, almost similar to the Central Gx Fleet Vibration monitoring control room.

It is preferred that the Balancing Panel be integrated to the new Computerised control centre, where the new desk can sit at least 2 operators working in parallel. Fig 1 below illustrates the conceptual arrangement of the new desk.

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As can be seen in Fig.1 below, the control desk for the Balancing Plant operation can be managed in one of the Operator stations, while the Balancing Panel activities for the serviced rotor can be managed on another Operating station (if needs be), both in the same Operating desk.

The SCADA system must be configured such that any operation can happen in any of the 2 Operator Stations simultaneously. For example, the main drive speed control can also be commanded from any of the Operator Stations, even if it is responsible for the Balancing Panel activities.

The retrofit must be done within a 14 day downtime period, and for smooth continuation of the services after the implementation, the Operating Team must be trained before return to service of the new control room. Hence the Phase 1 Scope of Work to investigate, plan and complete designs (including selection of equipment and materials) to ensure success of the 14 days installation downtime is seen as crucial.

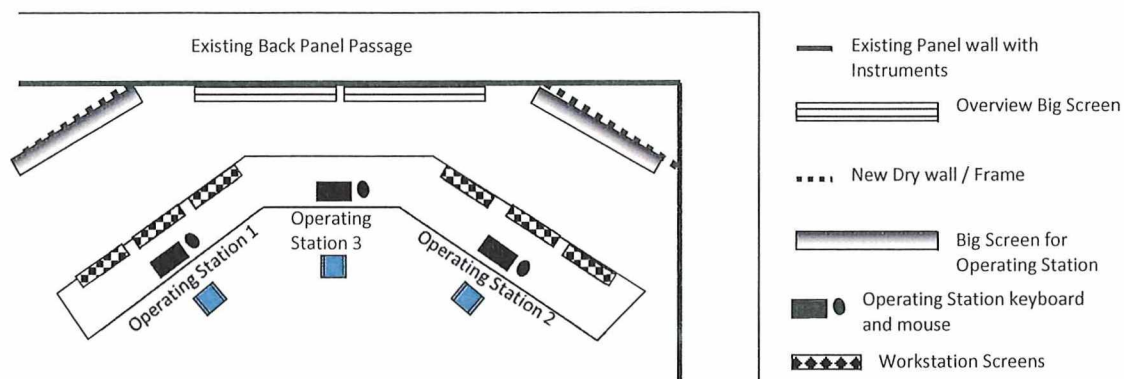


Figure 1: Concept Layout of envisaged Control Room

The envisaged project execution plan / methodology is shown figure 2 below. This informs the overall project plan for both Phase 1 and Phase 2. This SoW pertains the Phase 1 Activities.

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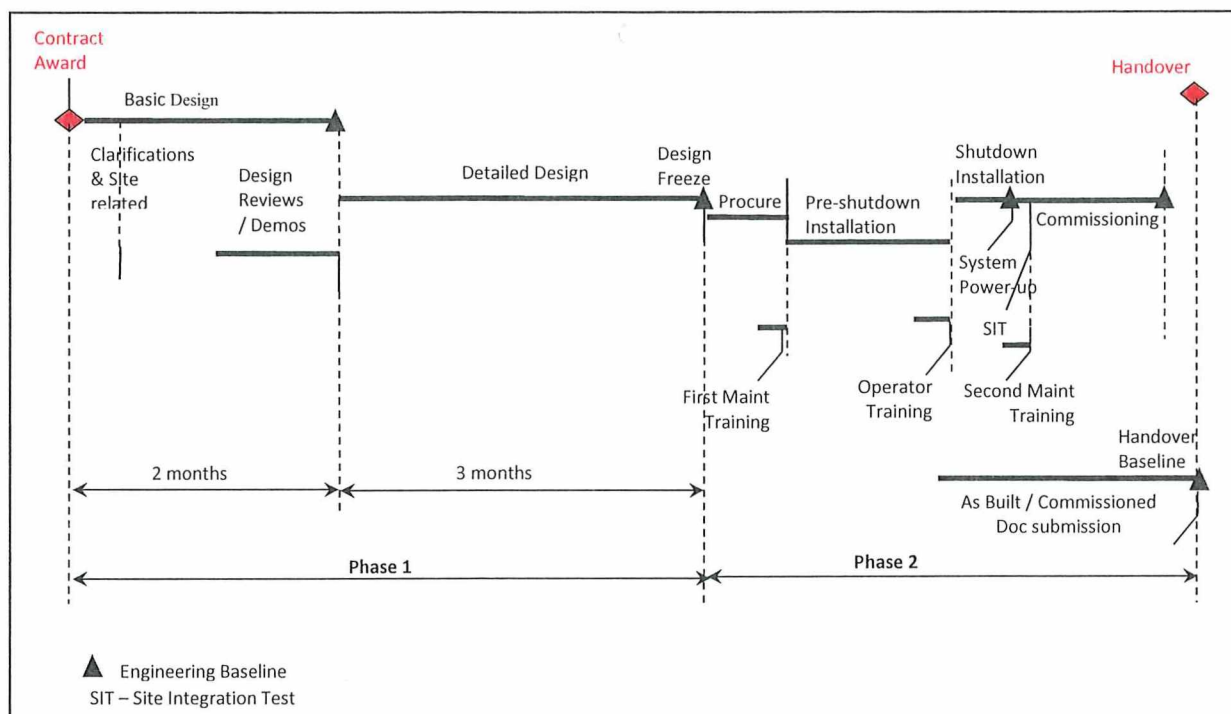


Figure 2: Project Execution Methodology

The Engineering Baselines represented in figure 2 are, Basic Design Baseline, Design Freeze Baseline (after Detailed Design), As-Built Baseline, As-Commissioned Baseline, and the Handover Baseline. The first 2 Baselines are in Phase 1, while the other 3 Baselines are achieved during Phase 2 of the project.

2.3 Related Projects

There are two related projects which may happen before the control room retrofit, the DC drive upgrade.

- Upgrade of the DC Drives by the OEM1 of the original drives. Only a portion of the hardwired control desk will be upgraded by the OEM1 of the DC drives. This project is intended to solve the obsolescence of the controls of the DC drives, which cause poor synchronisation of machine speed control and thus mechanical stresses on the gearbox (increasing the maintenance costs of the gearbox).
- Upgrade of the tunnel machine monitoring (vibration, eccentricities, etc.) instruments and certain portions of the Balancing Panel by another OEM2.

The integration of these 2 projects into the new control room solution is envisaged, and thought should be given to the timing and integration efforts in the Phase 1 Activities.

3 Scope of Work for the Client / Employer

To complete the required works, and over and above the services mentioned in Section 5 below, the Client further provides the following outputs / materials to complete the works. **Anything not mentioned in this chapter is to be provided by the Consultant / Subcontractor.**

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- 1) The Client provides existing Plant Codification Manual together with the plant colour coding manual during Phase 1 as design input information.
- 2) The Client provides the Balancing Panel signal list for integrating into the control room SCADA system, 2 weeks before the submission of the Basic Design Report by the Consultant. Any specialised monitoring system which requires dedicated software and cannot be viewed on the SCADA is mentioned by the Client.
- 3) The controlled Environment conditions at the control room and Electrical room (temperature and humidity) are provided by the Client during Phase 1 as design input information.
- 4) A location for the Operator Training room must be identified by the Client 2 weeks before the end of the Basic Design.
 - a) The Client must decide before the end of Phase 1 whether they will take the option of acquiring additional Operator Training Equipment for the SCADA HMI activities. This will be housed in the Operator Training Room mentioned above.
- 5) The Client provides the existing Power Supply specification sheets (48VDC, 110VAC, and 220VAC) as design input information 2 weeks after Contract Award for Phase 1.
- 6) The Client provides existing drawings of the electrical drive switchgear, including power supplies and interfaces to the control room as design input information 2 weeks after Contract Award for Phase 1.
- 7) The Client provides a list of tags / signals that will form part of the balancing activity report, as well as the weblink page for the Manager at the end of the Basic design.
- 8) The Client provides the hot commissioning sequence 2 weeks before the end of Phase 1 to be effected into the level 3 schedule for Phase 2.
- 9) The Client is responsible for fixing any plant defects that affect progress of hot commissioning.

4 Scope of Work for the Consultant / Contractor

With the aim to fulfil the Need and solve the Problem mentioned in Section 2.2 above, i.e. to retrofit the control room (and control desk and its back panel, as well as integrating the Balancing Panel) from its hardwired state to a fully computerised control room / desk with big screens in the back panel, ***investigative work and design work is required before planning the downtime period for implementation.*** For these reasons the project is broken into two Phases, namely:

- a) Phase 1 – Technical Investigative, Detailed Design and Enabling Works plans; and
- b) Phase 2 – Procure, Supply, Install and Commission the new Control Room

Note 1: The fundamental engineering principle of achieving the retrofit of the hardwired control room to a computerised one is to convert all the hardwired signals / measurements / indications from the plant as well as the switchgear panels and commands from the control room into digital format (data) that can be used by the computer(s) in the control room.

Some ideas are presented below to guide the Investigative and Design work.

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4.1 Phase 1 – Technical Investigation, Detailed Design and Enabling Plans

To achieve the transformation to digital data format, the following concept design plus sequence of activities is proposed:

- 1) A PLC or group of PLC's with I/O per switchgear cabinet or group of cabinets must be installed. Time stamping is required as part of the digital data.
- 2) Install network equipment to collate the data into a redundant SCADA Server.
- 3) Install a redundant SCADA Server and related Operator Workstation Clients as per fig. 1.
- 4) Consider backed up Power Supply for both PLC system and the SCADA system.
 - a) The SCADA system power supply must cater for a 72 hour back up power.
 - b) The PLC system power supply must cater for a 4 hour back up power supply.
 - c) The 2 systems (PLC and SCADA) can share the power supply as well.
- 5) The SCADA Application software must have the functionality:
 - a) To view live mimics of the controlled plant and the changing state of plant / parameters.
 - b) To present a Sequence of Events report, that can be filtered based on Plant Code (plus colour coding) and Time.
 - c) To present a special report on the balancing activity of the serviced rotor. This will require information from the integrated Balancing Panel system.
- 6) The redundant SCADA Servers and Operator Workstation machines can be located behind the back panel in a properly ventilated and dust proof enclosure. The Environmental conditions of the enclosure location must be considered.
- 7) A KVM system can be used to link the mouse, screens and keyboards of the Operator Workstations. Not less than 3 Operator stations should be implemented in the new computerised control centre, with one Operator Station dedicated to the big screens mounted in front of the back panel. A minimum of 2 big screens (min 65 inch) is considered in the design.
- 8) Update times on the SCADA Operator Stations should be less than 2 seconds for status changes and operator commands.
- 9) **Training of Operators/Electricians to navigate the new SCADA:** this is to be planned during the Phase 2 period prior to the downtime period, so as to enable smooth plant operation after the downtime period. A location for training room will be identified by the Client.
- 10) The Training platform must be quoted as a separate delivery as an option for the client to purchase at the end of the project to train future operators.
- 11) For cabling and field design work, the following activities are proposed:
 - a) Investigate cable routes that will be used.
 - b) Investigate the existing switchgear panel interfaces to the control room, as well as those from the field junction boxes to the control room.
 - c) Investigate the existing Power Supplies and their adequacy to meet the required back up times.

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- d) **From activities a) to c) above produce cable block diagrams (or mark existing diagrams) for the new solution.**
 - e) Investigate Panel Layout and terminal allocations in the panels and **produce new panel layouts which include the PLC solution.**
 - f) Investigate the feasibility of converting all 48VDC / 110VAC signalling components interposing relays for commands in the switchgear into 24VDC for use by the PLC systems. Switchgear drives will remain with local hardwired start/stop buttons to allow local operation when in Test Mode. When in remote mode, the drives are commanded from the control room or by logic via the PLC. Existing drawings must be marked up and be updated during Phase 1 of the project.
 - g) Investigate any field devices that will keep its power supply and signal cable, as well as those that need to be replaced to interface to the new PLC.
 - h) For drives like main motors and pumps, **develop a drive interface (with I/O) that will be used in the new PLC solution.**
 - i) For other Electrical Reticulation panels and DC drives, identify the interface required as well as alarms that need to be included in the I/O list.
 - j) **Develop a new panel list, instrument and drive list to complete the I/O list** to be accommodated by the PLC system for the new control centre.
 - k) Also investigate the replacement of the existing CCTV system mounted on the control desk, currently monitoring the balancing tunnel. The monitoring can be integrated on any of the Operator stations, preferably the big screens of Operating station 3 (fig. 1).
 - l) Investigate both switchgear room and control room space to house any new panels / enclosures as well as new control desks to house the new Operator Workstations.
 - m) At the end of the Detailed Design, propose all hardware and related software products and systems, including instruments and cabling to be purchased during Phase 2 of the project. Locally available commercial Off-the-Shelf products are preferred.
 - n) A Bill of Quantities is produced to represent the products and materials mentioned above in m).
- 12) **Develop a new Control Layout and 3D perspective for the upgraded control centre using fig 1 as the input concept layout.**
- a) The layout drawing must be submitted in pdf format for review purposes, but the final file at the end of Basic Design must be in CAD format (dgn or dwg).
 - b) The 3D perspective drawings can be submitted as pdf or image files.
- 13) A System network architecture diagram (hidden IP addresses) showing all IP components, plus the router / firewall and cyber security equipment to the Eskom LAN (to allow for manager access to BP field data and balancing plant performance reports per rotor service which is hosted in the SCADA).
- a) A weblink is created for the BP Manager to access from the Eskom LAN, view BP field data on the SCADA and download balancing plant performance reports per rotor service from the SCADA.

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- 14) Develop a Basic Design (Functional Design) report for the new solution, describing the investigative methods, the solutions decided upon and including items noted above in 1) to 13), and submit within 2 months after Contract Award.
- 15) A 1 week period of Client Basic Design Review and commenting on any proposed solutions (functions and related equipment at high level). However, the design development process allows for incremental submission and approval of proposed solutions by the Client as early as possible after Contract Award. After approval of the Basic Design, the Detailed design can commence.
- 16) For the related projects mentioned in section 2.3 above:
 - a) For the DC Drive signal interface, investigate the feasibility of integrating the DC drive controller into the SCADA servers, without introducing / employing a different PLC. Information about the DC drive controller will be provided by the Client 2 weeks before the end of Phase 1.
- 17) **For Enabling Works Plans, the Client expects the following outputs and deliverables:**
 - a) Assessment of the Balancing Plant adjacent staff offices and take stock of the upgrading of the furniture based on the staff and needs analysis.
 - b) Identification (by the client) and assessment of the Operator Training room in terms of space and furniture requirements. The desk for the training centre does not need to be same specification as the BP control room, but the chairs need to be of similar ergonomics and comfort.
 - c) Specifying of all furniture for the Operator Training room as well as the BP supporting staff offices.
- 18) Draft a level 3 schedule / program for the Phase 1 work activities. Include site visits and a 1 week Client Review period up to **the end for acceptance of the submitted Detailed Design Package**. A level 2 schedule is submitted with the Tender for evaluation purposes, and the required level 3 schedule is submitted 2 weeks after contract award for Phase 1.
- 19) The Detailed Design package is submitted 3 months after approval of the Basic Design.
- 20) The Detailed Design package is the precursor for procurement and installation of the new control room, and as a minimum should have:
 - a) The Bill of Quantities of materials and components (including data sheets) required for the construction and commissioning of the upgraded BP Control Room.
 - b) Construction drawings for cabinets (room layouts and individual cabinet layouts), cables (new rack layouts if needed, cable block diagrams, cable schedules as well as termination drawings), and computerised equipment (network and layout drawings).
 - c) PLC hardware list (incl. data sheets) and list of software licenses required as well PLC Application software logic diagrams. The Engineering Tool is included in the list.
 - d) The SCADA server and HMI computer hardware list (incl. data sheets), list of software licenses and HMI Application (mimic diagrams) software files. Alarm lists and alarm monitoring are included in this submission.
 - e) Backup methods for the SCADA Server system.

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- f) Installation Quality check sheets, as well as test procedures for Site Integration Tests, Loop checks, and functional tests for any logic pre cold commissioning. The sequence of hot commissioning the BP subsystems will be advised by the Client.
 - g) A Maintenance and Support Plan for the new system with a proposed 10% spares list and a logistical support plan for sourcing the spares. In this plan the Troubleshooting Guide for the PLC and SCADA systems is included.
- 21) Allow a 1 week period of Detailed design review and acceptance. However, the design development process allows for incremental submission as early as possible after approval of the Basic Design for approval of final designs by the Client.
- 22) Draft a level 3 schedule / program for Phase 2 work activities which will guide the Procurement of Equipment, software development and integration, pre-shutdown installation (including panel assemblies), Operator Training, downtime installation, test and commissioning up to handover **for submission at the end of Phase 1.**
- 23) **The reference projects and CV's of the lead design engineer(s) are submitted with the bid.**

4.2 Related Eskom and Local Standards to observe

The following Eskom standards and Guidelines are to be observed in the development of the specifications and the design and selection of solutions and materials. **Normalisation of the referenced standard and any exclusions / deviations should be done during Phase 1 of work activities**, so as to minimise the clarification in Phase 2 of the work activities. A session can be arranged to discuss where the Client sees the validity of the listed standards and guidelines:

No.	Standard / Guideline Description	Applicability
1)	240-56355731 Environmental Conditions for Process Control Electronic Equipment used at Power Stations standard	For selection of Environment enclosures for SCADA servers and computer Equipment.
2)	240-56356396 Earthing and Lightning Protection Standard	For design of PLC power supply and signal wiring with reference to existing interfaces
3)	240-56227443 Requirements for Control and Power cables for Power stations standard	For ensuring that design & installation of power cables and control (incl. network) cables are adequate.
4)	240-56355808 Ergonomic Design of Power Station Control Suites Guideline	To ensure that use of space and finishes meets the ergonomic design for human performance.
5)	240-56355728 Human Machine Interface (HMI) Design Requirements Standard	To ensure that Eskom's preferences to modern computerised HMI design are considered.
6)	240-57859210 Alarm System Performance of Digital Control Systems for Fossil Plant Standard	To ensure that alarm system design considers the researched human performance capabilities – to minimise flooding of alarms.
7)	240-56355466 Eskom Alarm management system guideline	To communicate the preferred alarm management methods in computerised HMI systems.

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8)	240-129014618 Generation Cyber Security Compliance Guideline	To assist with compliance to Eskom's minimum Cyber Security requirements.
9)	240-131313815 - Critical Cyber Assets List	To identify the key Cyber Assets / components that need to be considered in the Cyber Security strategy, as well as during operations & maintenance.
10)	SANS 10400 Building regulations	To ensure that any civil or structural design is within the national regulations, and is safe for use.
11)	SANS 10142 The wiring of premises Part 1: Low voltage installations	To ensure that any general electrical design and wiring meets the national standard, and is safe for use.

5 Other Services to be provided by the Client / Employer

- 1) Office / Working space for the consultant / subcontractor – 2 desks and a telephone line.
- 2) Ablution facilities
- 3) Tap water or piped water for office consumption.

6 PROCEDURE ADHERENCE REQUIREMENTS

The ERI TGS Quality Management System consists of various procedures and processes that are utilized to manage and control the level of quality of maintenance activities during an outage to an acceptable standard. These procedures and processes are employed during the planning and execution of maintenance activities with a focus of meeting the customer's requirements and enhancing their satisfaction. These procedures shall be adhered to by the service provider and will be made available on request by the service provider.

- Execution and Control of All Site Work (240-137025973)
- Quality Control
- Control of Blanks and Foreign Material Exclusion Covers (T-03)
- Compilation of Reports and Data Books (F-737)
- Lifting Machines and Lifting Tackle Safe Working Practices (E-19)
- Management and Control of Tools in a Tool Store or a Container (240-125904456)
- Correcting of Check sheets Engineering Instruction (X-1384391-033)
- Project Management Product/Process Quality Plan (240-130329202)
- Control of Non-Conforming Product/Service, Corrective and Preventive Action (240-103649507)

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- Business Management System Audit (240-94027195)
- Coding of Business Management System Documentation (240-94027233)
- Development and Management of the Product/Process Quality Plan for Outages (240-142892057)
- Turbo Gen Services – scope Quality Control Cabin240-142894278)
- Turbo Gen Services Rework Work Instruction (240-147200671)
- Safe operation of electrical equipment (TT-A-01)
- Plant Safety Regulations

7 Key Performance Indicators

The performance of the contractor will be evaluated on the KPIs in the table below:

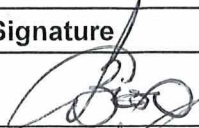

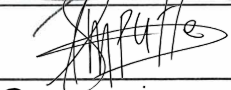
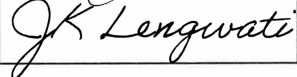
Objective	Key Performance Indicator	Measure	Unit of Measure	Source of Evidence
Zero harm	Project to be completed without any health and safety incidents	Loss Time Incident Rate	Rate	LTIR and incident records
	Compliance COVID-19 management and guidelines through the project	Number of reported COVID - 19 cases	Number	COVID-19 Baseline HIRA and Plan
Zero Legal and Environmental Contraventions	Project to be completed without any Legal and Environmental Contraventions	Number of legal and environmental contraventions	Number	Records of environmental contraventions-To be provided by supplier

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8 Baseline Approval

The Scope of Work (Technical Specification) baseline is accepted by:

Name and Surname	Designation	Signature
Carlos Gonzalez	Balancing Plant Specialist	
Duncan Scott	Balancing plant Electrician	
Lerato Mputle	Chief Electrical Engineer	
Joshua Lengwati	Electrical Senior Engineer	

9 Revisions

Date	Rev.	Compiler	Remarks
Jul 2021	0a	Khaya Sobuwa	Initial compilation

10 Annexures

- 1) Balancing Plant Control room Layout / Arrangement drawing – FBH0-117005;
- 2) Balancing Plant Desk and Panels Location of Instrumentation drawing – FBH0-117201;
- 3) Vendor (and Employer) Documentation Submittal Schedule

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