

Title: **Lethabo Condition Monitoring
System Replacement Technical
Specification**

Unique Identifier: **375-LET-BEEC-
D00035-25**

Alternative Reference Number: **N/A**

Area of Applicability: **Engineering**

Documentation Type: **Report**

Revision: **3**

Total Pages: **81**

Next Review Date: **N/A**

Disclosure Classification: **CONTROLLED
DISCLOSURE**

Compiled by



C.F. Barnard

**Lethabo Power Station
Engineer**

Date: 2021/06/10

Functional Responsibility

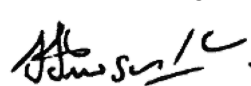


L.D. Nel

**Lethabo Power Station C&I
Engineering HOS**

Date: 2021-06-11

Authorised by



H. Sewsunker

**Lethabo Power Station
Engineering Manager**

Date: 2021/06/14

CONTENTS

	Page
1. INTRODUCTION.....	5
2. SUPPORTING CLAUSES	5
2.1 SCOPE.....	5
2.1.1 Purpose.....	5
2.1.2 Applicability	5
2.2 NORMATIVE / INFORMATIVE REFERENCES	5
2.2.1 Normative.....	5
2.2.2 Informative	6
2.2.3 Standards.....	6
2.3 DEFINITIONS	6
2.4 ABBREVIATIONS	7
2.5 ROLES AND RESPONSIBILITIES	10
2.6 PROCESS FOR MONITORING	10
2.7 RELATED / SUPPORTING DOCUMENTS	10
3. GENERAL.....	11
3.1 INTRODUCTION	11
3.2 OVERVIEW.....	11
4. EMPLOYER'S REQUIREMENTS	12
4.1 QUALITY & PERFORMANCE REQUIREMENTS	12
4.2 DESIGN STANDARDS, GUIDELINES AND CODES	13
4.3 REQUIREMENTS RELATED TO SAFETY	14
4.4 REQUIREMENTS RELATED TO AVAILABILITY.....	14
4.5 REQUIREMENTS RELATED TO RELIABILITY.....	14
4.6 REQUIREMENTS RELATED TO MAINTAINABILITY.....	15
4.7 REQUIREMENTS RELATED TO TECHNICAL DOCUMENTATION.....	15
4.7.1 Training Manuals	16
5. TECHNICAL SPECIFICATION SCOPE.....	17
5.1 WORK, EQUIPMENT AND SERVICES TO BE PROVIDED BY THE EMPLOYER	17
5.1.1 Process and Mechanical.....	17
5.1.2 Power Supply.....	17
5.2 WORK TO BE PERFORMED AND EQUIPMENT AND PLANT TO BE PROVIDED BY THE CONTRACTOR.....	19
5.2.1 General	19
5.2.2 Control and Instrumentation: Condition Monitoring System Design.....	19
5.2.3 Process and Mechanical.....	30
5.2.4 Electrical	31
5.2.5 Maintenance	34
5.2.6 Operating	34
5.2.7 Coding and Labelling	34
5.2.8 Documentation.....	35
5.2.9 Training	35
5.2.10 Removal of Existing Equipment.....	37
6. EXECUTION REQUIREMENTS	38
6.1 BASIC ENGINEERING	40
6.1.1 High Level Engineering Philosophies & Concepts	40
6.1.2 Plant Investigation Work	41
6.1.3 Scope definition	41
6.1.4 Interfaces to Other Systems	41
6.1.5 OEM Requirements in Basic Engineering	41
6.1.6 BASIC ENGINEERING DESIGN FREEZE.....	42

CONTROLLED DISCLOSURE

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

6.2 DETAILED ENGINEERING	42
6.2.1 OEM Requirements in Detailed Engineering	42
6.2.2 Detailed Engineering Design Freeze	42
6.3 MANUFACTURING	43
6.3.1 FAT	43
6.4 PROCUREMENT, ERECTION & INSTALLATION	45
6.4.1 Pre-Outage Installation Work.....	45
6.4.2 Site Integration Test (SIT).....	46
6.4.3 Cold Commissioning	47
6.4.4 Hot Commissioning.....	47
6.5 ACCEPTANCE CRITERIA.....	48
6.6 "AS BUILT" DOCUMENTATION PACKAGE AND FINAL HANDOVER.....	48
7. PROCUREMENT PROCESS TECHNICAL INPUT	50
7.1 TENDER RETURNABLES.....	50
8. AUTHORISATION	53
9. REVISIONS.....	53
10. DEVELOPMENT TEAM.....	53
11. ACKNOWLEDGEMENTS.....	53
APPENDIX A : VDSS	54
APPENDIX B : OPTION 1 TURBINE VIBRATION DIAGNOSTIC SYSTEM	55
APPENDIX C : OPTION 2 BOILER PLANT VIBRATION DATA ACQUISITION SYSTEM	56
APPENDIX D : EXISTING DESIGN DOCUMENTATION	59
APPENDIX E : DESIGN STANDARDS, GUIDELINES AND CODES.....	60
APPENDIX F : MAIN TURBINE OPERATING PHILOSOPHY.....	62
APPENDIX G : BFPT OPERATING PHILOSOPHY	67
APPENDIX H : SFP OPERATING PHILOSOPHY.....	69
APPENDIX I : EFP OPERATING PHILOSOPHY	70
APPENDIX J : INSTRUMENTATION SCHEDULE.....	72
APPENDIX K : LIMITS OF SUPPLY AND SERVICES	73
APPENDIX L : FUNCTION INPUT/OUTPUT BLOCK DIAGRAMS	74
APPENDIX M : TEMPLATES OF TECHNICAL DOCUMENTATION.....	75
APPENDIX N : COMPLIANCE SCHEDULE.....	76
APPENDIX O : EXISTING INTERFACE TO AUTOMATION AND PROTECTION SYSTEM TERMINATION	77

FIGURES

Figure 1: Unit Condition Monitoring System Concept.....	21
Figure 2: Concept Cable Block Diagram	26
Figure 3: Interface Example for Single Measurement	29
Figure 4: Single Line Diagram for 24V DC Power Supply	32
Figure 5: Proposed Execution Strategy for the first Unit.....	39
Figure 6: Proposed Execution Strategy for the consecutive Units.....	39

CONTROLLED DISCLOSURE

TABLES

Table 1: Minimum performance criteria 12

Table 2: Main Turbine CMS Measurement Parameters 62

Table 3: Main Turbine Parameter Ranges & Setpoints 62

Table 4: Main Turbine CMS Parameters Relating to Turbine Protection System 66

Table 5: BFPT CMS Measurement Parameters 67

Table 6: BFPT Parameter Ranges & Setpoints 67

Table 7: BFPT CMS Parameters Relating to Turbine Protection System 68

Table 8: EFP Alarm and Trip Values 71

CONTROLLED DISCLOSURE

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the database.

1. INTRODUCTION

This project aims to address the operational risk posed by the obsolescence of the existing condition monitoring system installed at Lethabo. This will be done by replacing the existing system on three units with the C&I replacement project replacing the system on the remaining three units. This supervisory system which is also known as the Turbovisory is used for the measurement, monitoring and analysis of various process parameters on large rotating equipment.

This technical specification will be the technical section of the works information and will be used in the commercial process to acquire a Contractor to supply the necessary services and equipment. This document defines the scope as well the minimum performance measures.

This technical specification is based on the Concept design baseline. An exemption from the basic design baseline was requested and approved based on the following motivation:

- The requirements definition was thoroughly conducted and documented in the authorised stakeholder requirements definition report (375-LET-BEEC-D00035-8).
- The concept design has been developed to a level of detail that enables an accurate definition of the project scope as well as the development of the technical specification.

Further development of the design will require details about the specific system and equipment to be installed.

Interface to the Eskom Centralised condition monitoring network is not explicitly defined. The interface will be realised through the buffered outputs included in the scope. This will ensure all tenders are developed on the same basis without benefitting a specific supplier.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document contains the technical portion of the works information for the Lethabo condition monitoring replacement project.

The following project aspects which need to be developed before the tender process is initiated are not defined in this document:

- Execution planning
- Quality assurance requirements

2.1.1 Purpose

The purpose of this document is to provide clear, comprehensive technical scope and define roles and responsibilities of the work to be performed for the Lethabo condition monitoring replacement project.

2.1.2 Applicability

This document applies to Lethabo Power Station.

2.2 NORMATIVE / INFORMATIVE REFERENCES

2.2.1 Normative

[1] 375-LET-BDDD-D00185-7: Lethabo Condition Monitoring System Replacement Concept Design Rev 1

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

2.2.2 Informative

- [2] 240-53114002: Engineering Change Management Procedure
- [3] 240-53113685: Design Review Procedure
- [4] 240-76394083 C&I Internal Design Review Work Instruction
- [5] 375-LET-MBBZ28-SP0008-5 Lethabo Condition Monitoring System Replacement Required Operational Capability Rev 1
- [6] 375-LET-BEEC-D00035-8 Stakeholder Requirements Definition for Lethabo Condition Monitoring System Replacement Rev 1
- [7] API STANDARD 670,4th Edition, December 2000

2.2.3 Standards

The reference list for all Design standards, guidelines and codes applicable to this document is provided as Appendix E.

2.3 DEFINITIONS

Term	Description
3rd Party Interface	Any network, system, computer or component that lies outside the Unit condition monitoring system.
Alarm	A notification of an undesirable event that requires operating, engineering or maintenance personnel's attention.
Basic Engineering	Also called System Engineering, is defined as being all activities necessary to clearly the Contractor's scope of works
Condition Monitoring System	System used to measure, monitor and analyse certain parameters in large rotating machinery to proactively identify unsafe conditions and developing faults. The system can affect automatic shutdown or trip of the machine. The CMS is divided into two subsystems namely, Diagnostic System and Data Acquisition System.
Control Room	A designated room from which control and operating of a plant or sub-plant occurs.
Control System	System used for process automation.
Controlled disclosure	Document classification: controlled disclosure to external parties (either enforced by law, or discretionary).
Cross Marshalling	The signal mapping between the trunk cables from the junction boxes, and the IO modules
Data Acquisition System	Aspect/Subsystem of the CMS used to measure and monitors certain parameters in large rotating machinery. This system initiates an alarm in the control room during abnormal conditions and initiates an automatic shutdown or trip of the machine in unsafe conditions.
Diagnostic System	Aspect/Subsystem of the CMS used to collect the data measured by the Data Acquisition System, analyse the data, display the results in various reports and graphs The system also store the data as well as the results.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Term	Description
Equipment Room	The room containing C&I equipment located within the Unit Control Suite.
Field Equipment	All field control and measurement equipment and associated installation equipment.
Human Machine Interface	The human interface used for the operation and monitoring of the Unit concerned.
Indication	Display of the state of a device or the degree or quantity represented on a measuring instrument or device.
Operability	Ability to control the function of equipment, a system or a whole industrial installation in a safe and reliable manner, according to pre-defined operational requirements.
Primary Racking	All main racking – including racking supports – for multiple cables from secondary racking to the automation system.
Process Automation System	The primary system via which process control is achieved.
Protection Automation System	The automation system in which the safety functions are executed.
Secondary Racking	All racking, conduit, trunking etc. – including the racking supports – for the following: <ul style="list-style-type: none"> From the field measurement or drive to the junction or splitter box From the junction or splitter box, 3rd party interfaces or LCS to the primary racking.
S_{MAX}	Maximum shaft relative displacement vibration amplitude; also defined as maximum shaft displacement from the time-integrated mean (DC) position. Calculated as the maximum of $\sqrt{x^2 + y^2}$ where x and y denote the dynamic (AC) waveform displacements measured by X and Y proximity probes respectively. Two perpendicular measurements are therefore required to calculate S _{MAX} . S _{MAX} represents the zero-to-peak vibration amplitude of a bearing.
System	An integrated set of constituent parts that are combined in an environment to accomplish a defined objective
Main Turbine	The turbo-generator set used to generate electricity consisting of a HP Turbine, IP Turbine, two LP turbines, a generator and an exciter and all associated equipment.
Turbovisory	System specifically used to monitor the turbine vibration, shaft position and differential expansion values and alarm/protect the turbine in abnormal conditions.
Unit	Steam driven Turbo-generator set powered by a coal fired boiler. Each Unit is capable of generating 618 MW MCR. (Lethabo has six Units)
User Management	Software that manages all users, user rights and user authentication on a particular system

2.4 ABBREVIATIONS

Abbreviation	Description
AKZ	Anlagenkennzeichnungssystem

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Abbreviation	Description
BFPT	Boiler Feed Pump Turbine
CoE	Centre of Excellence
CM	Configuration Management
CMS	Condition Monitoring System
C&I	Control and Instrumentation
DCS	Distributed Control System
DE	Drive End
EFP	Electric Feed Pump
EDWL	Engineering Design Work Lead
ERA	Execution Release Approval
FAT	Factory Acceptance Test
FRF	Fire Resistant Fluid
GO	General Overhaul
GTE	Group Technology Engineering
HP	High Pressure
HMI	Human Machine Interface
IN	Inspection
IO	Input Output
IP	Intermediate Pressure
IR	Interim Repair
LDE	Lead Discipline Engineer
LAN	Local Area Network
LP	Low Pressure
MCR	Maximum continuous rating
NDE	Non-Drive End
NTP	Network Time Protocol
OPC	Object Linking and Embedding for process control
OEM	Original Equipment Manufacturer
OT	Operational Technology
PBS	Plant Breakdown Structure
0-pk	Zero-to-peak (amplitude)
pk-pk	Peak-to-peak (amplitude)
RAM	Reliability Availability and Maintainability
ROC	Required Operational Capability
SIT	Site Integration Test
SNTP	Simple Network Time Protocol

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Abbreviation	Description
SRD	Stakeholder Requirements Definition
SFP	Steam Feed Pump
UCLF	Unplanned Capability Loss Factor

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

2.5 ROLES AND RESPONSIBILITIES

Relating to the document, roles and responsibilities will be as stipulated in the Engineering Change Management procedure [2] and Design Review procedure [3]. More specifically for this project phase:

- (1) The **EDWL** is responsible for the engineering effort during the design phases of the project. The EDWL performs the following functions:
 - i. Ensure compliance to procedure.
 - ii. Co-ordinate and lead the an engineering team, who is responsible for ensuring that classified Engineering Change Requests (ECRs) have been subjected to the appropriate review cycles and are acceptable for implementation. It may have, as its members, specialists and/or external consultant personnel on an ad hoc basis.
 - iii. Coordinate the development of the technical specification.
 - iv. Coordinate compilation of the technical specification report including all the necessary supporting documents.
- (2) The **LDEs** are responsible for the design related to his/her discipline. The LDE ensures the technical integrity of the design concerned with his/her respective discipline. The LDE performs the following functions:
 - i. Accountable for the management of the interfaces within their specific engineering domain.
 - ii. Accountable for the technical integrity for the design within their specific engineering domain.
 - iii. Member of the Design Review Committee (DRC).

The roles and responsibilities for the Works are as follows:

- (1) The **Contractor** will provide at tender document for the design, manufacture, deliver, test, install and commission the Condition monitoring system according to the specification defined in this document. The Contractor will also provide the documentation and training services as defined in this document
- (2) The **Employer** will provide the services and equipment specified in this document.
- (3) The **Project Manager** will incorporate this document as part of the tender package. The project manager must ensure that the technical evaluation criteria are developed based on this document.

2.6 PROCESS FOR MONITORING

The primary process that shall be used for monitoring the application of the Technical Specification is the Engineering Change Management Procedure [2] and the Design Review Procedure [3].

2.7 RELATED / SUPPORTING DOCUMENTS

All technical documentation to be developed/supplied as part of the works as well as existing documents identified to be maintained are listed in Appendix A.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

3. GENERAL

3.1 INTRODUCTION

- (1) The objective of this Works is to provide an integrated, available and reliable Condition Monitoring System that is used to measure, monitor and analyse various parameters on selected rotating machinery in order to operate, protect and maintain the said machinery.
- (2) The Condition Monitoring System shall be provided per Unit as standardised, standalone systems on three Units. The Condition Monitoring System shall consist of the following:
 - i. CMS Data Acquisition System
 - ii. CMS Diagnostic System (Takeout Option 1)
- (3) The following machinery or process plant is to be monitored by the Condition Monitoring System:
 - i. Main Turbine
 - ii. BFPT (including SFP)
 - iii. EFP A (Pump and motors)
 - iv. EFP B (Pump and motors)
- (4) The Milling plant as well as the Draught group Fans will also be monitored by the Condition Monitoring System but are excluded from the scope of supply for this project. The Condition Monitoring System will be designed with the functionality and capacity to be expanded at a later stage to make provision for the Milling plant as well as the Draught group Fans.

3.2 OVERVIEW

- (1) The Contractor shall provide all design, engineering, installation and commissioning of the Works and equipment for the Works to be performed on three units at Lethabo Power Station. –The specific units depend on the outage plan and will be finalised during the negotiations. The Contractor shall provide the necessary resources to support the scope.
- (2) The scope of the work as described in this Works Information shall include:
 - i. Engineering, design, procurement, manufacturing, factory acceptance testing, packing, delivery to site, off-loading at site, storage, installation, site testing, commissioning, optimisation and as-built documentation for the Condition monitoring system.
 - ii. Fully installed Condition Monitoring Systems on three units for the operation, protection, interlocking and monitoring of parameters on the Unit concerned.
 - iii. Interfaces to 3rd party systems as specified in section 5.2.2.4.
 - iv. Field equipment as specified in section 5.2.2.1.6.
 - v. Plant codification and labelling for all equipment supplied as part of the Works.
 - vi. Provide power supply for the new Condition Monitoring System and server including power cabling and earthing of all equipment supplied as part of the Works as specified in section 5.2.4.
 - vii. All software, license and copyright agreements for the Works.
 - viii. Training of Operating, Engineering & Maintenance staff.
 - ix. Decommissioning and removal of existing equipment

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

4. EMPLOYER'S REQUIREMENTS

4.1 QUALITY & PERFORMANCE REQUIREMENTS

- (1) The Condition Monitoring systems shall be configured as fully operational systems and are workable in all respects and are implemented in a consistent and integrated manner.
- (2) The Condition Monitoring Systems shall be configured, designed, engineered, installed and commissioned using this Works Information, OEM best practices and industry best practices.
- (3) All hardwired interfaces (inputs/outputs) shall be designed to include galvanic isolation for binary as well as analogue interfaces.
- (4) The Condition Monitoring systems shall be designed to ensure that all measurements are free of radio-frequency interference.
- (5) The Condition Monitoring systems shall comply with the following minimum:

Table 1: Minimum performance criteria

Components	Testing Range	Operating Range	Within Testing Range	Outside Testing Range but Within Operating Range
Proximity probes	0°C to 45°C	-35°C to 120°C	Incremental Scale Factor ¹ : $\pm 5\%$ of 7.87 mV/mm	Incremental Scale Factor ¹ : An additional $\pm 5\%$ of the testing range accuracy
Extension cables	0°C to 45°C	-35°C to 65°C	Deviation from Straight Line ² : within ± 25.4 mm of the best fit straight line at a slope of 7.87 mV/mm	Deviation from Straight Line ² : within ± 76 mm of the best fit straight line at a slope of 7.87 mV/mm
Oscillator-demodulators	0°C to 45°C	-35°C to 65°C	Minimum linear range: 2 mm	Minimum linear range: same as for testing range

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Accelerometers and accelerometer extension cables ³	20°C to 30°C	-55°C to 120°C	Principal Axis Sensitivity: 100 mV/g $\pm 5\%$ Amplitude Linearity: 1% from 0.1 g pk to 50 g's pk ⁴ Frequency Response ⁵ : ± 3 dB from 10 Hz to 10 kHz, referenced to the actual measured principal axis sensitivity ⁶ .	Principal Axis Sensitivity: 100 mV/g $\pm 20\%$
Monitor system components for measuring:				
Radial Vibration, Axial Position, Piston Rod Drop, and Casing Vibration	0°C to 45°C	-20°C to 65°C	$\pm 1\%$ of full scale range for the channel	Same as for testing range

1. The incremental scale factor (ISF) error is the maximum amount the scale factor varies from 7.87 mV per micrometer when measured at specified increments throughout the linear range. Measurements are usually taken at 250 mm increments. ISF error is associated with errors in radial vibration readings.
2. The deviation from straight line (DSL) error is the maximum error in the probe gap reading at a given voltage compared to a 7.87 mV per micrometer best fit straight line. DSL errors are associated with errors in axial position or probe gap readings.
3. During the testing of the accelerometers, the parameter under test is the only parameter that is varied. All other parameters must remain constant.
4. Conditions of test: at any one temperature within the Testing Range, at any single frequency that is not specified but is within the specified frequency range of the transducer.
5. Frequency Response testing conditions: at any one temperature within the Testing Range, at an excitation amplitude that is not specified but is within the specified amplitude range of the transducer.
6. Principal Axis Sensitivity testing conditions: (Testing Range) at any one temperature within the Testing Range, at 100 Hz, at an excitation amplitude that is not specified but is within the specified amplitude range of the transducer. (Operating Range) at any one temperature within the Operating Range, at 100 Hz, at an excitation amplitude that is not specified but is within the specified amplitude range of the transducer.

4.2 DESIGN STANDARDS, GUIDELINES AND CODES

- (1) The Works shall be provided in compliance with:
 - i. This Works Information.
 - ii. Design standards, guidelines and codes listed in Appendix E.
- (2) The Contractor shall obtain his own copies of International and National standards.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

- (3) The Contractor shall report any conflict within this Works Information, with any referenced standards, specifications or technical guideline.
- (4) This Works Information shall take precedence over differences existing between this Works Information and any document in Appendix E, except for statutory requirements.
- (5) Substitutions of any standard in Appendix E shall be approved by the Engineer. Additional standards proposed by the Contractor shall be submitted to the Engineer for approval.
- (6) Only the most recent versions of the relevant standards, guidelines, or codes shall be used with this Works.

4.3 REQUIREMENTS RELATED TO SAFETY

- (1) The Contractor shall comply with the latest revision of the Eskom Generation Plant Safety Regulations (36-681).
- (2) No individual Condition Monitoring System fault shall endanger the safety of the people or plant or jeopardise the integrity of major plant.
- (3) All Condition Monitoring System equipment shall be earthed to the station earth point.

4.4 REQUIREMENTS RELATED TO AVAILABILITY

- (1) No individual Condition Monitoring System fault shall cause a forced outage or Unit trip.
- (2) Any changes made to the system databases shall be made in real-time and on-load.
- (3) All software changes shall be effective without restarting any part of the system.

4.5 REQUIREMENTS RELATED TO RELIABILITY

- (1) Each of the Unit Condition Monitoring Systems shall be completely independent in every aspect and shall not share any equipment with any other Unit.
- (2) The following redundancies shall be provided in the Condition Monitoring System:
 - i. All Condition Monitoring System internal power supply & distribution components, internal networks, media converters and communication modules shall be fully redundant such that:
 - a. Any single failure in the Condition Monitoring System internal power supply & distribution components, internal networks, media converters and communication modules shall not cause data to be lost.
 - b. Any single failure in the Condition Monitoring System internal power supply & distribution components, internal networks, media converters and communication modules and subsequent transfer to the redundant path shall not disrupt the C&I system and/or plant.
- (3) The redundancy scheme of all redundant equipment is self-monitoring such that the transfer to the back-up shall be bump-less, seamless and shall occur without human intervention and disruption to the Condition Monitoring System and/or plant.
- (4) The Contractor shall consider in his design the reliability of the CMS and provides measure such as redundant cable routes equipment to prevent common points of failure.
- (5) The Contractor shall consider in his design the impact of the Condition Monitoring System on the Unit's reliability and provides measure such as redundant field equipment and voting to prevent common points of failure that will cause the Unit to trip.

CONTROLLED DISCLOSURE

4.6 REQUIREMENTS RELATED TO MAINTAINABILITY

- (1) The components installed shall be protected from the harsh or hazardous power plant environment:
 - i. Components installed in the field shall be designed to withstand exposure to exposure to steam, dust, oil, water, high temperatures and vibration. Field equipment shall have a minimum ingress protection rating of IP65.
 - ii. Components installed in the Equipment rooms or Computer rooms shall be designed to withstand exposure to:
 - a. Temperatures of up to 30 °C
 - b. 50% humidity
 - c. Dust
- (2) The Contractor shall ensure that the installation of the field equipment:
 - i. Allow for safe and easy access for maintenance and calibration.
 - ii. Allow for the environmental conditions.
 - iii. Allow for the removal of equipment not related to the Condition Monitoring System for maintenance in the vicinity of the transducer.
- (3) The system provided by the Contractor must be fully supported for the next 15 years with the exemption of OT hardware (i.e. servers, switches).
- (4) The system provided by the Contractor must be fully supported locally. Procurement of maintenance services and spares must be available locally.

4.7 REQUIREMENTS RELATED TO TECHNICAL DOCUMENTATION

- (1) The basis for the completion of all engineering activities shall be documentation as defined in:
 - i. Appendix A – Vendor Document Submittal Schedule.
 - ii. This Works Information
- (2) Comprehensive document control of all documents shall be provided for the duration of the Works.
- (3) The document control system implemented, as a minimum shall contain the revision status of all documents in relation to the 'As Required' and 'As Built' plant status.
- (4) The master register of documentation shall be submitted monthly, in a Microsoft Excel format, to the Engineer.
- (5) All documentation submittals shall be accomplished with a documentation transmittal advice.
- (6) Appendix A – Vendor Document Submittal Schedule specifies the following:
 - i. The type of documentation which shall be provided.
 - ii. The native/original format in which the soft copy of the documentation shall be provided in addition to the PDF soft copy.
 - iii. The limits of supply of the documentation (clarifying the provider and maintainer of the documentation).
 - iv. The stage in the project execution during which the documentation shall be provided as a deliverable.
- (7) Appendix A – Vendor Document Submittal Schedule defines the type of technical documents that must be exchanged during the project execution only. It is not a document index that lists each and every technical document.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

- (8) Hardcopies, PDF soft copies and native/original soft copies of each document specified in Appendix A shall be provided at the stages defined in Appendix A – Vendor Document Submittal Schedule.
- (9) All documentation submitted by the Contractor shall be in an adequate state of completeness.
- (10) All documentation shall be in English.
- (11) All drawings shall be submitted in PDF format for review purposes. All drawings shall be submitted in Microstation (DGN) format as well as PDF at handover.
- (12) All documentation shall be reviewed and accepted by the Employer before installation commences.
- (13) All drawings are to be developed using the template provided in Appendix B.

4.7.1 Training Manuals

- (1) The Contractor provides all course material including manuals.
- (2) The course material is in English and includes all third party documentation.
- (3) Printed and electronic copies of the training documentation are supplied for each trainee plus an additional three hardcopy master sets and three electronic copies.
- (4) All training documentation provided by the Contractor is customised for Lethabo Power Station.
- (5) Purely generic training documentation is not acceptable. The training documentation contains the specific system architecture, configuration, layout, software, equipment, Data Acquisition HMI specific design capabilities provided by the Contractor as part of the works.
- (6) Training manuals are continuously updated by the Contractor up to the date of issue of the Defects Certificate for the whole of the works.
- (7) The Contractor provides all the Condition Monitoring System procedures and training material.

CONTROLLED DISCLOSURE

5. TECHNICAL SPECIFICATION SCOPE

5.1 Work, Equipment and Services to be provided by the Employer

- (1) The Employer provides all rooms relevant to the Works
- (1) The Employer provides HVAC to all rooms relevant to the Works
- (2) The station earth point provided by the Employer.
- (3) Earthing integrity and continuity tests and earthing reports to confirm the status of the earth point can be provided upon request to the Project Manager.
- (4) The Employer makes the following available to the Contractor prior to breaker open for pre-outage activities, installation and commissioning:
 - i. Non-redundant 220V power supply from the 220V main distribution board in the existing Unit Equipment room.
- (5) The Employer shall include for the design, supply and installation of the hardware and furniture for the HMI as below.
 - i. desks
 - ii. chairs
 - iii. Workstation
- (6) All existing equipment will remain the property of the Employer. The Employer will store existing equipment removed as part of this Works Information.
- (7) The Employer shall store all existing equipment removed from the plant as part of the Works.
- (8) The Employer shall terminate all cabling in the existing process automation system and protection automation system.

5.1.1 Process and Mechanical

- (1) Existing sensor mounting structures (brackets) must be utilised as far as reasonably possible. Where required brackets do not exist, adequate brackets (similar to existing brackets) shall be designed by the Contractor, in consultation with the Employer, for installation by the Contractor (refer to section 5.2.3).
- (2) The existing plant does not provide for shaft eccentricity measurement on the Main Turbine (refer to Appendix F) – the design pertaining to the inclusion of this measurement parameter is to be conducted by the Employer in consultation with the Turbine/BFPT/EFPT OEM of the Main Turbine to determine adequate/appropriate physical location(s) and mounting method and/or structure (bracket) of the probe(s), in accordance with Turbine/BFPT/EFPT OEM requirements and ISO 10817-1.
- (3) The employer shall provide access to areas inside the Turbine required for installation of instrumentation (i.e. opening and closing of bearing pedestal covers).

5.1.2 Power Supply

- (1) 24V DC \pm 20% power supply shall be provided by the Employer to all condition monitoring equipment for three units consisting of main and backup supply. The 24 V DC supplies will be fed from 24V DC Unit Board A and B (0*DM19 and 0*DN19) respectively that supply the existing condition monitoring system. The main and backup supplies have a maximum capacity of 60 Amp rated combined fuse switch.

CONTROLLED DISCLOSURE

- (1) The Employer shall provide an approximate 60 Amps (24VDC) capacity for all condition monitoring equipment's per Unit.
- (2) Additional, 220V AC UPS supply shall be provided by the Employer to supply any new network equipment. An approximate spare capacity of 6 Amps (x2 per unit) has been identified for this purpose. The termination details are from a Unit * 20KVA UPS, Q13, terminal 42 and Q12, terminal 41.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

5.2 Work to be Performed and Equipment and Plant to be Provided by the Contractor

5.2.1 General

- (1) The Contractor shall co-ordinate a clarification process between the Contractor's process experts, the Contractor's condition monitoring system experts, the Employer and the Turbine/BFPT/EFP OEMs to determine the process variables to be measured (in addition to the minimum requirements defined in this Works Information) that create the best correlation to equipment health and accurate condition monitoring.

5.2.1.1 Rooms Related to Works

- (1) C&I rooms shall be defined as being any room in which Condition monitoring system equipment is located. The list of C&I rooms is as follows:
 - i. Unit 1 Control room
 - ii. Unit 1 Equipment room
 - iii. Unit 1 & 2 Computer/Server room
 - iv. Unit 2 Control room
 - v. Unit 2 Equipment room
 - vi. Unit 3 Control room
 - vii. Unit 3 Equipment room
 - viii. Unit 3 & 4 Computer/Server room
 - ix. Station Server Room
 - x. IT Server Room
- (2) The Contractor's work related to the equipment rooms shall include the following:
 - i. Sealing of all related cable entries into and out of the room with an approved fire seal in accordance with section 5.3.1 of 240-54937450 Fire Protection and Life Safety Design Standard.
 - ii. Design, supply, installation and commissioning of all cabling including power cabling and associated infrastructure for the Power Station's Condition Monitoring System equipment in the room.
 - iii. Specification of the Power Station's Condition Monitoring System equipment heat loads including heat load calculation for each item of equipment supplied.
 - iv. Floor loads for all rooms (i.e. weights of cabinets, etc.)
 - v. Core drilling where required

5.2.2 Control and Instrumentation: Condition Monitoring System Design

- (1) The Contractor designs and installs a Condition Monitoring System per Unit for three units in accordance with:
 - i. As found and installed operating plant, equipment and systems
 - ii. This Works Information.
 - iii. Design standards, guidelines and codes listed in Appendix E.
- (2) The Condition Monitoring System (for each Unit) provided by the Contractor shall consist of a Data Acquisition System as well as an optional Diagnostic System as further defined below.

CONTROLLED DISCLOSURE

- (3) The Data Acquisition System shall be capable of performing the following functions:
- i. The acquisition, conditioning and validation of signals (measuring plant parameters)
 - ii. Supervisory functions and alarm management to prevent and communicate unsafe condition in the process plant and the Unit condition monitoring system.
 - iii. Calculation of S_{MAX} relative vibration amplitudes in units μm (in addition to the signal processing functions listed under section 4.9 of standard 36-618) for alarm management (communication of unsafe relative shaft vibration) and protection. Where the existing Condition Monitoring System utilizes peak-to-peak based alarm and trip boundary limits (setpoints), these boundary limits must be set to half of their peak-to-peak values since S_{MAX} amplitudes are equivalent to zero-to-peak amplitudes. Alarming functionality is required to conform to section 4.8 of standard 36-618.
 - iv. Engineering functions to modify the system configuration and the management of configuration changes
 - v. Internal and external data communication.
- (4) The Contractor design, provides and installs the Unit Condition Monitoring System to monitor the following process plants:
- i. Main Turbine
 - ii. Boiler Feed Pump Turbine Including the Steam Feed Pump
 - iii. Electric Feed Pump including the Electric Feed Pump Motor
- (5) The Contractor provides as a takeout option, the Unit Condition Monitoring System with Diagnostic system and associated network infrastructure (Appendix B).
- (6) The Contractor provides as a takeout option, the Unit Condition Monitoring System with the expandability to include the Milling plant and Draught Group plant (Appendix C).
- (7) The concept drawing below (Figure 1) shows an example of a single Unit to clarify the scope of points (4), (5) and (6) above:

CONTROLLED DISCLOSURE

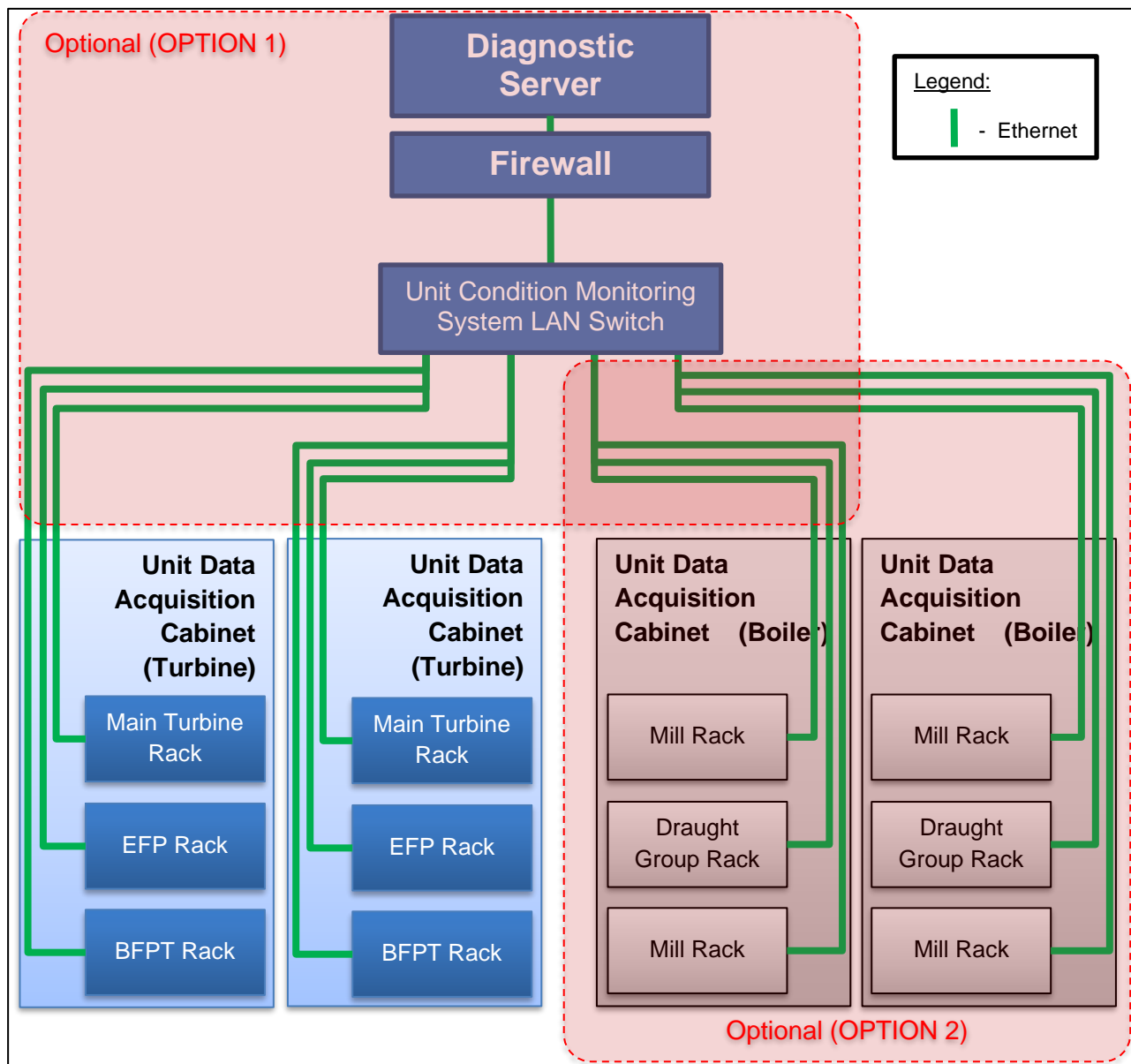


Figure 1: Unit Condition Monitoring System Concept

- (8) The Contractor suggests changes to existing operating, control and protection philosophies based on the changes made to existing plant as well as the Contractor's experience and best practices.
- (9) The Contractor designs the Condition Monitoring Systems to measure the following parameter types (per process plant) as a minimum:

	Main Turbine	BFPT incl. SFP	EFP incl. Motor	Milling Plant	Draught Group Fans
Relative shaft vibration	✓	✓	✓		
Bearing/Pedestal vibration	✓	✓	✓	✓	✓
Phase	✓	✓	✓		

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

	Main Turbine	BFPT incl. SFP	EFP incl. Motor	Milling Plant	Draught Group Fans
Shaft position	✓	✓			
End thrust	✓				
Differential expansion	✓				
Absolute expansion	✓				
Shaft eccentricity	✓				

- (10) Time stamping shall be done via the process LAN using the existing GPS on all measurements. The existing GPS is a Hopf 6036 and uses NTP for synchronisation.

5.2.2.1 Data Acquisition System

- (1) All equipment supplied by the Contractor that require 24V DC supply shall be capable of normal operating between input voltages of 20.4 V DC – 27 V DC
- (2) Equipment supplied by the Contractor to be installed around the generator shall comply with Hazardous location classification (LBT00014WN) requirements. Specifically, all equipment at and around the Generator shall be rated Flameproof (Exd IIC T4).
- (3) The Contractor shall design and submit voting logic for redundant measurements to the Employer for acceptance.

5.2.2.1.1 Signal and Logic Processing

- (1) The Data Acquisition System shall have the functionality to configure the failure status of each measurement that is fail high or low.
- (2) The system shall provide configurable trip multipliers for use during turbine run-ups if required.
- (3) The failure in one transducer/probe shall not affect any other channel.
- (4) The radial shaft vibration shutdown system shall be field changeable so that one (single logic) or both transducer signals must reach or violate the setpoint to activate a trip relay. Dual voting (two-out-of-two) logic shall be standard.
- (5) Fixed time delays for trip relay activation that are field changeable (via controlled access) to require from 1 to 3 seconds sustained violation. A delay of 1 second shall be standard.
- (6) In an axial position dual voting logic system, although each channel may have reached or violated its respective preset trip setpoints at different times, both channels must jointly and continuously be at or above the trip setpoints for the specified time delay before the trip relay activates. In the event of the failure of a single transducer or circuit, only the circuit-fault alarm and the alarm will activate (that is, the trip relay will not activate).
- (7) The trip relay in a dual voting logic system will activate when any of the following conditions occur:
 - i. Both transducers or circuits fail.
 - ii. Either channel has failed, and the other channel has violated the shutdown (danger) setpoint.
 - iii. Both channels jointly violate the shutdown (danger) setpoint.

CONTROLLED DISCLOSURE

- (8) Internal circuit faults, including transducer system failure, shall be indicated with externally visible circuit fault indication for each individual channel. A no-fault condition shall be positively indicated (for example, lighted).
- (9) A common circuit fault relay shall be provided for data acquisition system. A circuit fault shall not initiate a shutdown or affect the shutdown logic except as part of the dual voting logic. The common circuit fault is to be alarmed on the operator desk via the existing interface.
- (10) The Data Acquisition System shall be provided with the following outputs per measurement as a minimum:
 - i. A buffered output.
 - ii. A 4-20 milliamp DC analog output shall be provided for each measured variable.
 - iii. A 0-10 Volt DC analog output shall be provided for each measured variable.
 - iv. 24V binary alarm output
 - v. 24V binary trip output
- (11) Each channel shall have alarm and trip setpoints that are individually adjustable over the entire monitored range.
- (12) Each channel or channel pair shall have an alarm indication on the front of the module as well as an alarm output from to a corresponding alarm relay. Nonvoting (OR) logic is required.
- (13) Each channel or channel pair shall have a trip indication on the front of the module as well as a trip output to a corresponding trip relay. Trip indication shall be positive indication (for example, illuminated when channel violates its trip setpoint)
- (14) The time required to detect and initiate an alarm or a trip shall not exceed 100 milliseconds.
- (15) A tamperproof means for disarming the trip function and shall be provided for each channel.

5.2.2.1.2 Functional Distribution

- (1) The design of the Data Acquisition System structure shall take into account the plant configuration and process plant redundancy (i.e. One BFPT and two EFPs that perform the same function).
- (2) The integrity of the mechanical plant's redundancy shall be maintained when optimising the allocation of plant and equipment to cards/racks.
- (3) The failure of any card/rack/controller shall not cause failure of more than one set in a redundantly configured mechanical sub-system, e.g. the failure of one rack does not cause the failure of more than one mill or of both EFPs.
- (4) Redundant measurements shall not be installed on the same rack.
- (5) The original functional distribution of the Data Acquisition System measurements shall be provided as a minimum. The Contractor shall submit any suggested improvement of the functional distribution to the Employer for review and acceptance. The existing functional distribution is defined in the following cabinet layout drawings provided in Appendix B:
 - i. 0.63/19729 Sheet 15
 - ii. 0.63/19733 Sheet 16
- (6) The Contractor shall not terminate more than one process plant on the same terminal strip in order to improve maintainability.

CONTROLLED DISCLOSURE

5.2.2.1.3 Data Acquisition System HMI

- (1) The Contractor shall use the existing workstation in the Control room to provide the operator with real-time indication of all measurements. The necessary software shall be provided by the Contractor. The workstation provided by the Employer shall have the following specification as a minimum:
 - i. Intel Core i7-9700, 8 Core, 12MB Cache, 3.0GHz, 4.7 GHz Turbo w/UHD Graphics 630
 - ii. 16GB (2x8GB) 2666MHz DDR4 UDIMM Non-ECC
 - iii. M.2 512GB PCIe NVMe Class 40 Solid State Drive
 - iv. Integrated Intel SATA Controller
 - v. NVIDIA(R) Quadro(R) P620, 2GB, 4 mDP to DP adapter
 - vi. Windows 10 Pro (64 Bit), English,
 - vii. Windows 10 Pro OS Recovery 64bit - USB
- (2) The workstation shall display the relevant process alarms as well as the data acquisition diagnostic alarms (i.e. module failure, power supply or field failure)

5.2.2.1.4 Data Acquisition System Engineering

- (1) The Contractor shall provide the necessary hardware and software tools through which the Data Acquisition System is engineered, configured and maintained.
- (2) The functionality to engineer, configure and maintain the Data Acquisition System shall be provided through standalone computers in the form of laptops.
- (3) The contractor supplies two laptops to engineer, configure and maintain the Data Acquisition System as part of the Works.
- (4) The laptops supplied by the Contractor shall be loaded with the configuration software and contain all the system design documentation in PDF format as well as the necessary software to view the documentation. The operating system shall be the latest version of Windows (compatible with the configuration software). The laptop hardware specification shall be in line with the minimum requirements of the software.
- (5) Any special tools used for testing and fault-finding shall be provided by the Contractor as a take-out option (i.e. wobbelator and test rig for eddy current probes).

5.2.2.1.5 Data Acquisition System Cabinets

- (1) The Contractor shall provide all new cabinets for Data Acquisition System equipment.
- (2) The Contractor shall install the Data Acquisition System cabinets within the space constraints of the existing Unit equipment rooms.
- (3) The Contractor shall remove the following existing Data Acquisition System cabinets for each Unit and use the same space to install the new cabinets:
 - i. JT02
 - ii. JT03
 - iii. JP04
- (4) The existing Data Acquisition System cabinets location is shown for each of the three Units in the following drawings included in Appendix B:
 - i. 0.63/2624 Units 1 & 2 Auxiliary Bay Equipment Room Electrical Equipment Layout

CONTROLLED DISCLOSURE

- ii. 0.63/2625 Units 3 & 4 Auxiliary Bay Equipment Room Electrical Equipment Layout
 - iii. 0.63/2626 Units 5 & 6 Auxiliary Bay Equipment Room Electrical Equipment Layout
- (5) The Data Acquisition System cabinets shall be installed in the equipment room.
- (6) All Data Acquisition System cabinet dimensions shall not exceed:
- i. Width: 890 mm
 - ii. Height: 2200 mm
 - iii. Depth: 400 mm
- (7) All Data Acquisition System cabinets shall be IP21 or better.
- (8) The Contractor shall provide dust ingress protection on all cabinets supplied as part of the Works
- (9) All cabinet fans where used shall be robust, silent and of industrial type.
- (10) All Data Acquisition System cabinets shall be provided with top and bottom cable entry.

5.2.2.1.6 Field Equipment

- (1) The Contractor designs and installs field equipment for the following process plants:
- i. Main Turbine
 - ii. Boiler Feed Pump Turbine Including the Steam Feed Pump
 - iii. Electric Feed Pump including the Electric Feed Pump Motor
- (2) All the existing field measuring (Including primary devices), Junction Boxes and cabling as specified in the below document are replaced or installed by the Contractor in accordance with:
- i. Appendix J - Instrumentation Schedule
 - ii. Appendix K - Limits of Supply and Services
 - iii. Appendix L - Function Input/output Block Diagrams
- (3) The measurements listed in Appendix J - Instrumentation Schedule shall be provided by the Contractor as a minimum.
- (4) Radial shaft vibration shall be monitored in paired channels from the two transducers mounted at each bearing.

5.2.2.1.7 Instrumentation

- (1) The Contractor shall replace all existing probes and install new probes which form part of the works.
- (2) Each probe supplied by The Contractor shall be able to measure the entire range of the relevant measurement. A single range shall not be measured by multiple probes.
- (3) Installations shall comply with sections 3.2.1.13.2.4 and 3.7 the Eskom Field Instrument Installation Standard (240-56355754)
- (4) The Contractor shall use the instrumentation schedule provided in Appendix J as a basis for his design. The Contractor shall update and maintain the instrumentation schedule throughout the project to reflect the design.
- (5) The signal conditioning module or Oscillator-Demodulator for each measurement shall be installed inside a junction box

CONTROLLED DISCLOSURE

5.2.2.1.8 Cabling

- (1) The Contractor shall design and replace/install the following cables as illustrated in Figure 2 below:
 - i. Field Cabling: Cable between the Instrument and the junction box termination.
 - ii. Trunk Cabling: Cable between the junction box termination or 3rd party interface and the cross marshalling termination in the equipment room.
 - iii. Cross marshalling cabling: Cabling between cross marshalling termination and the module termination in the equipment room
 - iv. Network Cabling: Communication cable between condition monitoring systems and certain external interfaces.
 - v. Power Cabling: Electrical Design. All cabling providing power to condition monitoring system equipment.

Figure 2Figure 2: Concept Cable Block Diagram

- (2) All existing cabling that is replaced as part of the works shall be removed by the Contractor
- (3) All cables provided as part of the Works shall be installed with mechanical support and protection such as cable armour, conduit, racking system, or combination thereof.
- (4) The contractor shall take measures in his cabling design to prevent any radio-frequency interference in measurements by making use of metallic conduit, armoured cable and/or radio-frequency interference (conductive) gasketing where necessary.
- (5) All cabling provided by the Contractor shall be fire retardant and low halogen.
- (6) All Field cabling shall be armoured.
- (7) All Field cabling inside the machines (Turbine, BFPT) shall be routed along the existing channel to ensure the cables are protected.
- (8) All Field cabling shall be securely tied down to prevent cable whipping or chafing or oil ingress.
- (9) All Field cabling shall be shielded, twisted pair, or shielded triad to minimize susceptibility to electromagnetic or radio frequency interference.
- (10) All Trunk cabling shall be twisted triples provided with individual screens as well as an overall screen.
- (11) All Trunk cabling shall not exceed a physical length of 150 meters.
- (12) The Contractor's design shall include a cross marshalling design of all signal wires connected to the condition monitoring system to increase maintainability. No trunk cabling shall be terminated directly onto modules.
- (13) The Contractor shall develop and install Cable routing design in the form of primary and secondary racking for all cables included the project scope. Existing primary racking shall be used where spare capacity is available. All racking required that does not already exist shall be supplied by the Contractor. The existing drawings that define cable routing can be found in Appendix B
- (14) The cabling design shall be developed in accordance with 240-56227443 - Requirements for control and power cables for power stations. (sections 3.1.2 and 3.7)
- (15) The Contractor installs fire barriers where cabling related to the works enters or exists cable tunnels. This is done in accordance with. 240-54937450 Fire Protection and Life Safety Design (section 5.3.1).
- (16) Trunk cabling supplied by the Contractor shall be in accordance with the following specification:

CONTROLLED DISCLOSURE

- i. Signal wiring shall be shielded, twisted pair, or shielded triad to minimize susceptibility to electromagnetic or radio frequency interference.
 - ii. Not exceed a physical length of 150 meters.
 - iii. Use continuous runs only.
 - iv. Cables shall be shielded single-circuit cable for vibration, axial position, and speed sensing transducers shall contain three twisted conductors.
 - v. The conductors shall be 0.336 to 1.374 square millimetres, seven strand (minimum), Class B, concentric-lay, tinned copper. The lay of the conductor's twist shall be from 38 to 64 millimetres. The conductors shall be colour coded black, white, and red. The drain wire attached to the cable shield shall have the same specification as the three twisted conductors. Prior to installation of the cable, a green or green and yellow stripe sleeving shall be installed over the drain wire.
 - vi. The conductors' primary insulation shall be rated for 300 volts, 100°C . The standard primary insulation shall be polyvinyl-chloride (PVC) a thickness of 0.38 millimeter.
 - vii. The cable shield shall be polyester/aluminium film tape with 100% coverage and drain wire, or tinned copper wire braid with 90% coverage. The tape shall be helically applied with a minimum of a 25% overlap. The aluminium-coated side of the film shall be at least 0.9 micrometer thick and shall be in continuous contact with the drain wire, which shall be of the same specification as the inner conductors of the cable. A braided shield shall have a single conductor attached to it. The single conductor shall be of the same specification as in the inner conductors of the cable.
 - viii. The cable's standard jacket shall be PVC with a nominal thickness of 0.75 millimeter and meet the other requirements of D.2.2.
 - ix. Where Trunk cabling is routed through an area of potential exposure to FRF the cable provided by the Contractor shall be suitable for use with Anvol PE 46 XC Fire-resistant hydraulic fluid.
- (17) Field cabling (Instrument cabling) supplied by the contractor shall be in accordance with the following specification:
- i. No cable connections shall be made inside the machine. To facilitate maintenance while the machine is running, all cable connections shall be made in junction boxes located outside the machine.
 - ii. Instrument cable shall be suitable for use in an environment with Anvol PE 46 XC Fire-resistant hydraulic fluid.
 - iii. All cables inside the turbine pedestal shall be installed with nitrile butadiene rubber tubing for protection.
 - iv. The sensor lead shall be properly secured to prevent damage as a result of whipping, chafing, windage, and oil
 - v. Glands shall be supplied for every cable inside the pedestal. Cable glands shall be suitable for use in an environment with Anvol PE 46 XC Fire-resistant hydraulic fluid.
- (18) The cable shield for each measurement loop is only grounded at the monitor system.
- (19) The Contractor provides and manages a cable schedule for all the cables that form part of this works according to Appendix M.

5.2.2.1.9 Junction Boxes

- (1) The Contractor shall design and install junction boxes in accordance with Eskom standard 240-56355815

CONTROLLED DISCLOSURE

- (2) The Contractor shall replace all existing junction boxes. The existing pedestal junction boxes shall not be reused
- (3) The Contractor shall not install any junction boxes under floor panels.

5.2.2.2 Diagnostic System

- (1) A diagnostic system is specified in Appendix B as a takeout option. If this option is included in the Works the tenderer shall supply a diagnostic system in accordance with the specification set out in Appendix B.

5.2.2.3 Power Distribution

- (1) The Contractor performs Power distribution to all the designs which form part of this works.
- (2) The Contractor designs of Power distribution shouldn't have any single point of failure. Each CMS and network provided by the Contractor must follow plant and electrical redundancy approach.
- (3) The Contractor provides its power supplies requirements to the Employer for the works.
- (4) The Contractor performs all the modification's required on the existing power distribution infrastructure for all the works.
- (5) The Contractor provides load calculation, termination schedules for all the loads which form part of this works.
- (6) The Contractor provides and manages a cable schedule for all the power distribution cables that form part of this works according to the template provided in Appendix M.

5.2.2.4 Condition Monitoring System Interface to 3rd party systems

- (1) The Contractor provides develops and manages the panel interface list (as per template in Appendix M) that defines the interface of the CMS to 3rd party systems.

5.2.2.4.1 Existing Control Automation and Protection Automation Systems

- (1) The Contractor provides an Interface to the existing Control Automation and Protection Automation Systems which are obsolete and consist of the following systems:
 - i. Siemens Teleperm C
 - ii. Siemens Iskamatic B
- (2) The Contractor provides an Interface between the Unitised Condition Monitoring System and the Existing Control Automation and Protection Automation Systems capable of the following:
 - i. Prevent start-up of plant under certain process conditions (interlocking)¹.
 - ii. Protect/trip plant under certain process conditions².
 - iii. Indication of certain plant/parameter states on the operator panel in the control room.
- (3) The termination of the existing interface for point (2) above is detailed in Appendix O.
- (4) The interface shall be hardwired.

¹ Signal processing, parameter evaluation and logic functions relating to existing interlocks should not be altered.

² S_{MAX}-based relative shaft vibration protection to be incorporated (instead of peak-to-peak-based protection).

CONTROLLED DISCLOSURE

- (5) All limit values (alarms, interlocks and protections) shall be determined in the Unit Condition Monitoring System and relayed to the control and protection systems via the interface.
- (6) The interface will require hardwired 24V DC binary outputs for each measurement as defined in the Function Input/Output diagrams (Appendix L). The concept interface to the existing control system is shown in Figure 3 below.
- (7) For the following shaft vibrations there will be an addition binary output required during turbine run-up program. These outputs are high when vibration is less than 60 μm .
 - i. SB11Z043 HP Front Shaft Vibration
 - ii. SB12Z043 IP Rear Shaft Vibration
 - iii. SB14Z043 LP1 Front Shaft Vibration
 - iv. SB16Z043 LP2 Front Shaft Vibration
 - v. SQ11Z043 Gen Front Shaft Vibration
 - vi. SQ12Z043 Gen Rear Shaft Vibration

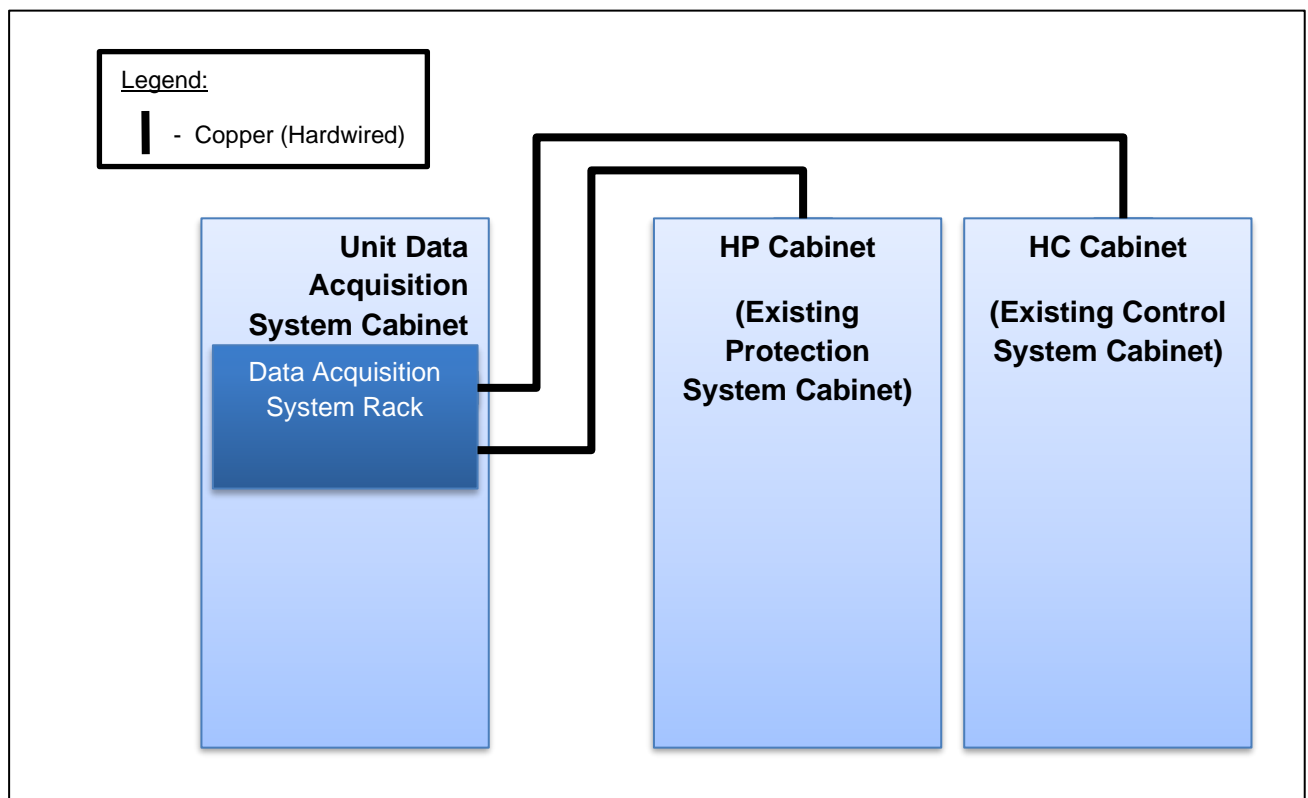


Figure 3: Interface Example for Single Measurement

- (8) Relay operation shall have a local LED to indicate operation.
- (9) The trip signal relays shall be double contact (NO/NC) relays with 24 V supplied from the HP cabinet.
- (10) All relays shall be DIN rail mounted inside the same cabinet as the related measurement.
- (11) Real-time indications of all measurement shall be made available to the operator with a workstation as described in section 5.2.2.1.3.
- (12) The Contractor shall install the cable up to the existing automation system cabinet in accordance with the AKZ and termination details for each existing measurement is defined in Appendix O.

CONTROLLED DISCLOSURE

5.2.2.4.2 Process LAN

- (1) The Unit Condition Monitoring System supplied by the Contractor shall include an interface to the Unit's process LAN to provide the following functionality:
 - i. Access to condition monitoring system information and diagnostic functionality from Process LAN.
 - ii. Archiving of data on the historian.
 - iii. Time synchronisation using the GPS time server
- (2) The Contractor shall interface the Unit Condition Monitoring System with the existing historian provided by the employer to ensure archiving of process measurements recorded by the data acquisition system. The interface shall be accomplished via OPC.

5.2.3 Process and Mechanical

5.2.3.1 General Mechanical Scope

- (1) For all probes/sensors, except the Main Turbine Centreline eccentricity probes, the Contractor shall utilise existing brackets to mount required probes/sensors as far as reasonably possible. Existing brackets may be modified to accommodate new probes/sensors.
- (2) Where brackets cannot be modified or do not exist, adequate brackets (similar to existing brackets) shall be designed by the Employer (refer to section 5.1.1) and installed by the Contractor for mounting required probes/sensors.
- (3) All welding (if required) shall be done in accordance to the following standards: 240-56246601, 240-56241933, 240-83540088 and 240-83539994 (incl. in Appendix E). The Contractor shall supply material certificates and welding records (if applicable) for the installation of the brackets.
- (4) Brackets supplied by the Contractor shall be constructed from material which is compatible with that of the surrounding equipment (bearing, casing, shaft, etc.).
- (5) The contractor shall provide any requirements regarding access to the Employer during detailed engineering. Any additional access requirements during the outage must be submitted to the employer at least 7 days in advance.

5.2.3.2 Mechanical Scope Related to the Main Turbine and BFPT

- (1) The Contractor shall determine adequate positions/locations for the new eccentricity probes in consultation with the Turbine/BFPT/EFPT OEM (via the Employer) and in accordance with Turbine/BFPT/EFPT OEM requirements and shall design brackets for these probes in consultation with the Turbine/BFPT/EFPT OEM, in accordance with Turbine/BFPT/EFPT OEM requirements and in accordance with ISO 10817-1.

5.2.3.3 Mechanical Scope Related to the SFPs and EFPs

- (1) The Contractor is to supply and install vibration probes to align to the operational philosophy described in Annex F and G. This includes the probes, the cabling, layout and mounting brackets.
- (2) The Contractor is to ensure that the tracks used for the measurements are adequate for measurements.
- (3) The Contractor is to make provision for the inclusion of bearing measurements for the SFP's to be used in the online monitoring and diagnosis for vibrations in these pumps.
- (4) The Contractor shall ensure that the probes conform to ISO 10817-1: section 5.2.1 a) non contacting shaft measuring probes including seismic measurement for relative shaft vibration.

CONTROLLED DISCLOSURE

- (5) The Contractor identifies the location for the four case vibration monitoring probes on the EFP's, in accordance with the API 670 standard for machinery protection systems, and for the acceptance of the Employer.
- (6) The design of the trip shall include a 3 second delay to initiate the trip when it is triggered, and this trip is related to the S_{max} value as indicated in ISO 10816-7.
- (7) The trip for the EFP's during start-up shall include a delay of 12 seconds (with the range of 30 seconds for adjustment) during start-up. The vibration values during this time should be able to only trip at 0.9 x bearing clearance (to avoid machine failure). The trip values according to ISO 10816-7 should be implemented when this delay time is passed.
- (8) The information for the mounting and machining of the NDE and DE covers to accommodate the probes shall be supplied and carried out by *others*.

5.2.4 Electrical

5.2.4.1 General

- (1) Below in Figure 4 is the general overview of the 24V DC reticulation to supply the new Condition Monitoring System. . Figure 4 should be read in conjunction with the Unit & Station Network Single Line Electric Diagram (0.63/210) in Appendix B.
- (2) Presently 24V DC Unit Board A and Board B are used to supply the CMS cabinets. The same feeder circuits that are supplying the existing condition monitoring shall be reused by the Contractor.
- (3) An alternative supply from the 24V DC Auxiliary Panel (0*DH02) will be available through a miniature circuit breaker (MCB). The alternative supply capacities are rated 6A and 4A respectively, which is much lower than the existing supplies for the CMS cabinets (60A).
- (4) A spare capacity of 2 x 230V AC, 6A shall be made available by the Employer to supply any power requirement for new network equipment.
- (5) The Contractor is responsible for the entire work starting from the existing feeder circuit (identified by the Employer); high level scope not limited to, will consist of supply, install and commission of cabling, termination on the condition monitoring system. Further electrical scope is detailed below.

CONTROLLED DISCLOSURE

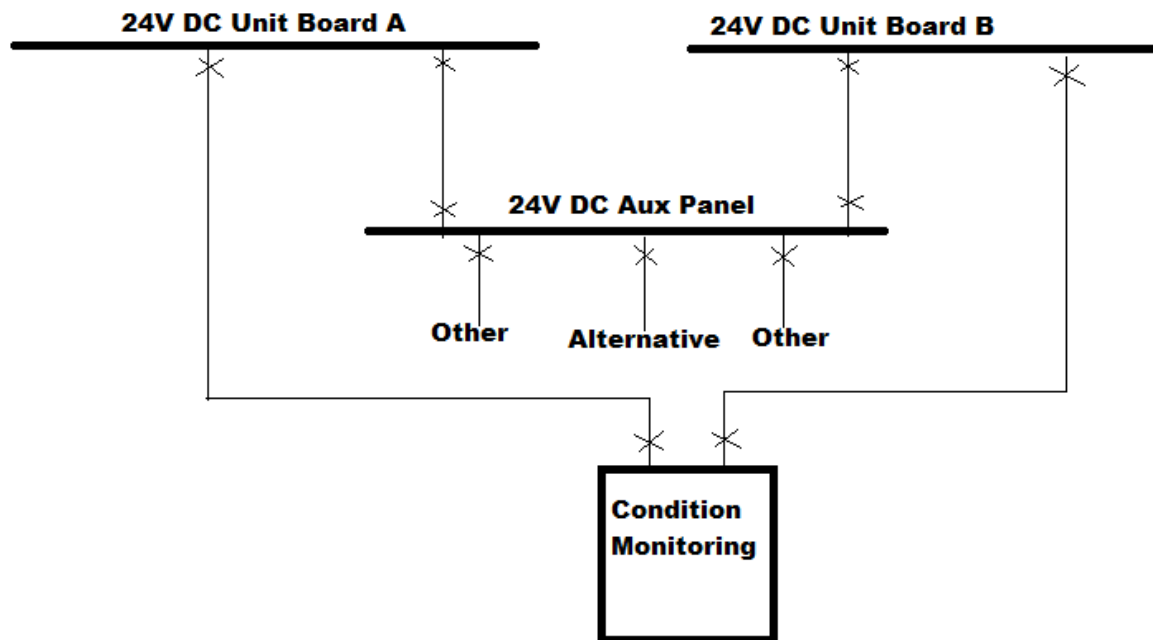


Figure 4: Single Line Diagram for 24V DC Power Supply

5.2.4.2 Power Supply

- (1) 24V DC \pm 20% power supply shall be provided by the Employer to all condition monitoring equipment's for three Units consists of main and backup supply. The 24 V DC supplies will be from 24V DC Unit Board A and B (0*DM19 and 0*DN19) respectively. The main and backup supplies have a maximum capacity of 60 Amp rated combined fuse switch.
- (2) Alternative spare circuits allocated on the 24V DC Aux panel rated 6A and 4A are also available, however these supply points are not redundant.
- (3) Additional, 2 x 220V AC UPS supply shall be provided by the Employer to supply any new servers. An approximate spare capacity of 6 Amps has been identified. The termination details are from a Unit * 20KVA UPS, Q13, terminal 42 and Q12, terminal 41.
- (4) The electrical source termination points are from the unit DC Switchgear room located on the 6.6m level and the destination termination point is on the equipment room 11.9 m level as well as on the computer room on the 16m level.
- (5) The Contractor shall assess and test the conditions and adequacy (capacity) of the existing cable and the feeder circuit to supply the new loads prior to connecting the new loads. The Contractor shall assess the adequacy of the protection (fuses) for the cable and the load from the feeder circuit

5.2.4.3 Cabling

- (1) The Contractor shall provide the distribution boxes if required and supply cables to and from the boards for all the Contractors electrical power supply requirements to execute the Works.
- (2) The Contractor shall decommission the existing power cable and manufactures/procures, transports, supplies, installs, tests and commissions new power cables to be terminated between the sources (24V DC boards and 220V AC UPS distribution panels) and the new equipment that will form part of the works.

CONTROLLED DISCLOSURE

- (3) The Contractor shall reuse the existing cable racking as far as possible. New cable racks shall only be considered where the existing cable racks cannot be utilised. The Contractor shall inform the Employer where new racks are required for approval before implementation.
- (4) The Contractor shall develop, finalise and implement the optimised cable routing. Produce exact cable routing designs of all the cables. Cater for cable servitudes and cable racking. Implement all cable routing designs as approved. Implement all cable terminations. Conduct an earth continuity tests and provide certification for quality controls.
- (5) Produce all documentation and drawings (manuals, load list, schedules (switchgear and cable schedules) updated termination schedules, wiring diagrams and general arrangement drawings) for approval by the Employer.
- (6) The Contractor shall where applicable design, supply and install cable racks as per 240-56227443 Requirements for Control and Power Cables for Power stations.
- (7) All cables shall be adequately clamped to the support structures to ensure that there is no damage due to forces created by the through faults.
- (8) All cables are of the PVC type with, low smoke and flame retardant outer sheath in accordance with SANS 1507 and SANS 1411, Parts 1 to 6.
- (9) All cable ratings are in accordance with SANS 10142-1: The wiring of premises, Part 1: Low-voltage installations and the cable manufacturers' rating tables.
- (10) No low voltage cables are installed in areas where there is a possibility of chemical, heat or mechanical damage to the cable insulation unless provisions have been made to overcome such dangers.
- (11) No low voltage cables are installed within 600mm from telecommunication lines or within 300mm from a water line. Where low voltage cables cross other services, the minimum vertical distance allowed between such services and the low voltage cable should be 300mm.
- (12) Colour coding of low voltage cable cores is accordance with 240-56227443, Requirements for Control and Power Cables for Power Stations.
- (13) AC and DC voltages should not be allowed in the same trunking or cable. Trunking for AC and DC wiring must be separate.

5.2.4.4 Condition Monitoring Panel Termination

- (1) Panels supplied by the Contractor, It is the responsibility of the Contractor to do all power cable terminations.

5.2.4.5 Earthing and Lighting Protection

- (1) The earthing and lightning protection requirements will be as per Eskom Earthing and Lightning protection Standard. The standard requires that all non-current carrying metals be grounded through the earth strap to the earth mat. The objective is to limit the touch and step potentials on the structures and equipment to provide low impedance return path to limit damage to equipment by fault current and to protect the installations from lightning strikes.
- (2) Earthing and lightning protection for the new condition monitoring system will be done in accordance to 240-56356396 Earthing and Lighting Protection Standard.
- (3) All earthing with the purpose of eliminating signal interference shall be provided by the Contractor. All metal instrument casings shall be properly earthed (grounded) by the Contractor to the earth mat to avoid any electromagnetic interference which may arise from portable RF transmitters, cell phones and other equipment used on the plant.

CONTROLLED DISCLOSURE

5.2.5 Maintenance

- (1) The Contractor shall provide a maintenance philosophy and maintenance manuals for all equipment supplied as part of the works.
- (2) After implementation, the Contractor provides a comprehensive recommended spare's lists, containing a list of all spares, a classification of critical spares and of recommended stock level for each item on the list.
- (3) All special tools required to maintain the works shall be provided as part of the works.
- (4) The Contractor shall ensure that necessary spares are available prior to commission of a Unit to prevent delays.

5.2.6 Operating

- (1) The Contractor develops the operating philosophies for all new process parameters monitored by the Condition Monitoring System for acceptance by the Employer.

5.2.7 Coding and Labelling

- (1) The AKZ coding system is used for coding of all equipment at Lethabo Power Station. The Lethabo Plant Codification Manual (LIM 103) defines the use of the AKZ system at Lethabo. A unique AKZ code will be assigned to all equipment as per LIM103.
- (2) AKZ codes for any new equipment are assigned by the Lethabo power station codification officer. The Contractor shall request AKZ for all new equipment from the codification officer with the relevant form (LMF 026).
- (3) All equipment will be physically labelled to improve maintainability of the plant. The Contractor shall supply and install all labelling related to the works. All equipment labelling shall be supplied according to Lethabo requirements as follows:
 - i. The list of labels required will be finalised during the Detail design
 - ii. Labelling material will be blended aluminium/stainless steel.
 - iii. Label fixing devices (e.g. rivets, self-tappers, adhesives, ties) will be fit for purpose. Label fixing devices will not penetrate the equipment housing or constitute a potential source of corrosion.
 - iv. All labels will be secure, i.e. not move under reasonable pressure.
 - v. Labels or back plates/brackets will not have sharp edges or protrude in such a way as to pose a safety risk.
 - vi. Labels will not cover equipment specification plates
 - vii. The following three labelling types will be used:

Description	Dimensions	Font Type	Information
Large	95mm x 70mm	SL 513 INT	AKZ code and description
Small	80mm x 20mm	SL 513 INT	AKZ code only
Panel label	160mm x 33mm	SL 513 INT	AKZ code and description

CONTROLLED DISCLOSURE

5.2.8 Documentation

- (1) As a minimum, the documentation specified in Appendix A the Contractor is provided as part of the works
- (2) Appendix A specifies the following:
 - i. The type of documentation provided.
 - ii. The software format (where applicable) in which the documentation is provided.
 - iii. The limits of supply of the documentation (clarifying the provider and maintainer of the documentation).
 - iv. The stage in the project execution during which the documentation is provided as a deliverable.
- (3) The existing design documentation provided in Appendix B shall be updated by the Contractor throughout the project.
- (4) The Contractor provides full sets of drawings and schedules per Unit related to Electrical work as prescribed in the VDSS (Appendix A).

5.2.9 Training

- (1) The following training shall be provided by the Contractor:

5.2.9.1 General Requirements

- (1) The Contractor shall provide training on the equipment and systems included as part of the Works to the various categories of the Employer's technical staff for the duration of the Works.
- (2) Training shall be focused on the specific systems' architecture, configuration, layout, equipment, software and design that the Contractor provides for the Works.
- (3) Training facilities shall be on site and shall be provided by the Employer.
- (4) Training material and tools shall be provided by the Contractor in English.
- (5) Training material and tools shall not be shared by trainees during the training.
- (6) The training shall be provided as per the detailed training programme and prospectus accepted by the Employer.
- (7) The training schedule shall be incorporated in the approved programme.
- (8) After a training course each trainee shall be assessed and declared competent by the Contractor.
- (9) The Contractor shall include enough detail in the training manuals for each manual to remain completely functional without guidance from an instructor.

5.2.9.2 Training Categories and Numbers

- (3) Practical hands-on training for each individual trainee shall form an integral part of each of the courses in these categories:
 - i. Training of Operating Staff. The Contractor shall provide training for five (5) people.
 - ii. Training of C&I Maintenance Staff. The Contractor shall provide training for twenty-two (22) people.
 - iii. Training of Engineering Staff. The Contractor shall provide training for four (4) people.
- (4) The elements of the training are described in the subsections below.

CONTROLLED DISCLOSURE

(5) Diagnostic system training requirements are specified in Appendix B

5.2.9.3 Training of Operating Staff

(1) Operator training shall include, as a minimum:

- i. Familiarisation with the documentation provided as part of the Works, including drawing configuration logic.
- ii. Familiarisation with the Diagnostic software and functionality.
- iii. Operation during various types of plant modes.

5.2.9.4 Training of C&I Maintenance Staff

(1) Maintenance training shall include, as a minimum:

- i. Usage of the Condition monitoring system configuration software.
- ii. Familiarisation with the documentation forming part of the Works, including drawing configuration logic.
- iii. Hardware familiarisation.
- iv. Hardware configuration which includes the computers, processing modules, communication modules, IO modules, power supply monitoring modules, and all other peripheral equipment supplied as part of the Works.
- v. Hardware installation.
- vi. Condition Monitoring System software reloading.
- vii. System hardware maintenance through use and interpretation of diagnostic routines and error codes of online and off-line diagnostic software for the detection of faulty modules.
- viii. Module problem report retrieval.
- ix. Condition Monitoring System hardware maintenance training including the computers, modules, and all other peripheral equipment supplied as part of the Works.
- x. Maintenance Procedures including maintenance of field instrumentation.
- xi. Usage of engineering tools.
- xii. Installation, configuration and maintenance of all software packages forming part of the Works.
- xiii. Programme storage and reloading.
- xiv. System backup and restore.
- xv. Maintenance procedures

5.2.9.5 Training of Engineering Staff

(1) C&I Engineering training shall include the maintenance training as well as the following, as a minimum:

- i. Familiarisation with the documentation forming part of the Works, including drawing configuration logic.
- ii. Usage of the Condition monitoring system hardware and configuration software.
- iii. System hardware configuration.
- iv. Usage of the Condition monitoring system configuration software.

CONTROLLED DISCLOSURE

- v. Usage of engineering tools.
- vi. Usage of the Condition monitoring system analysis software.
- vii. Installation, configuration and maintenance of all software packages forming part of the Works.
- viii. Administration of the Condition monitoring system software.
- ix. Implementation of modifications to the hardware and software configuration/design (i.e. Adding an additional measurement or modification of voting logic)

5.2.10 Removal of Existing Equipment

- (1) The Contractor is responsible for the decommissioning and removal of all existing equipment and associated infrastructure (including the cabinets) that forms part of the Works.
- (2) The Contractor shall package all existing modules and probes after removal in order to avoid any damage from handling before handing the modules over to the Employer.
- (3) All removed equipment is transported to the areas specified by the Employer. All such areas are located within the boundaries of the Power Station.
- (4) All equipment and material that is removed is deemed re-usable and remains the property of the Employer.
- (5) Where field equipment and/or cabling have been removed, the area needs to be made good.
- (6) The term “making good” refers to the following:
 - i. Trunk cabling from the old junction boxes to the Unit equipment room is removed. Cables which cannot be removed shall be agreed with the Employer. Cables identified not to be removed shall be cut back to the area where access is restricted, cut off on both ends, sealed or capped, labelled and secured.
 - ii. 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.
 - iii. 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.
 - iv. The removal of equipment is co-ordinated with the Project manager to protect 3rd Party Systems from damage.
- (7) 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.
- (8) The Contractor’s removal, decommissioning or demolition activities do not impact the operation of the running plant.
- (9) 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.

CONTROLLED DISCLOSURE

6. EXECUTION REQUIREMENTS

- (1) During the execution of the first Unit the following activities are required to be conducted by the Contractor (as shown in Figure 5 below):
- i. Basic Engineering.
 - ii. Detail Engineering.
 - iii. Manufacturing & FAT.
 - iv. Training.
 - v. Procurement & Installation.
 - vi. SIT, Cold & Hot Commissioning.
 - vii. Optimisation.
 - viii. As Built Documentation Compilation.
- (2) During the execution of the consecutive Units the following activities are required to be conducted by the Contractor (as shown in Figure 6 below):
- i. Detail Engineering.
 - ii. Manufacturing.
 - iii. Procurement & Installation.
 - iv. SIT, Cold & Hot Commissioning.
 - v. Optimisation.
 - vi. As Built Documentation Compilation.
 - vii. Training (only when required as defined in the contract)

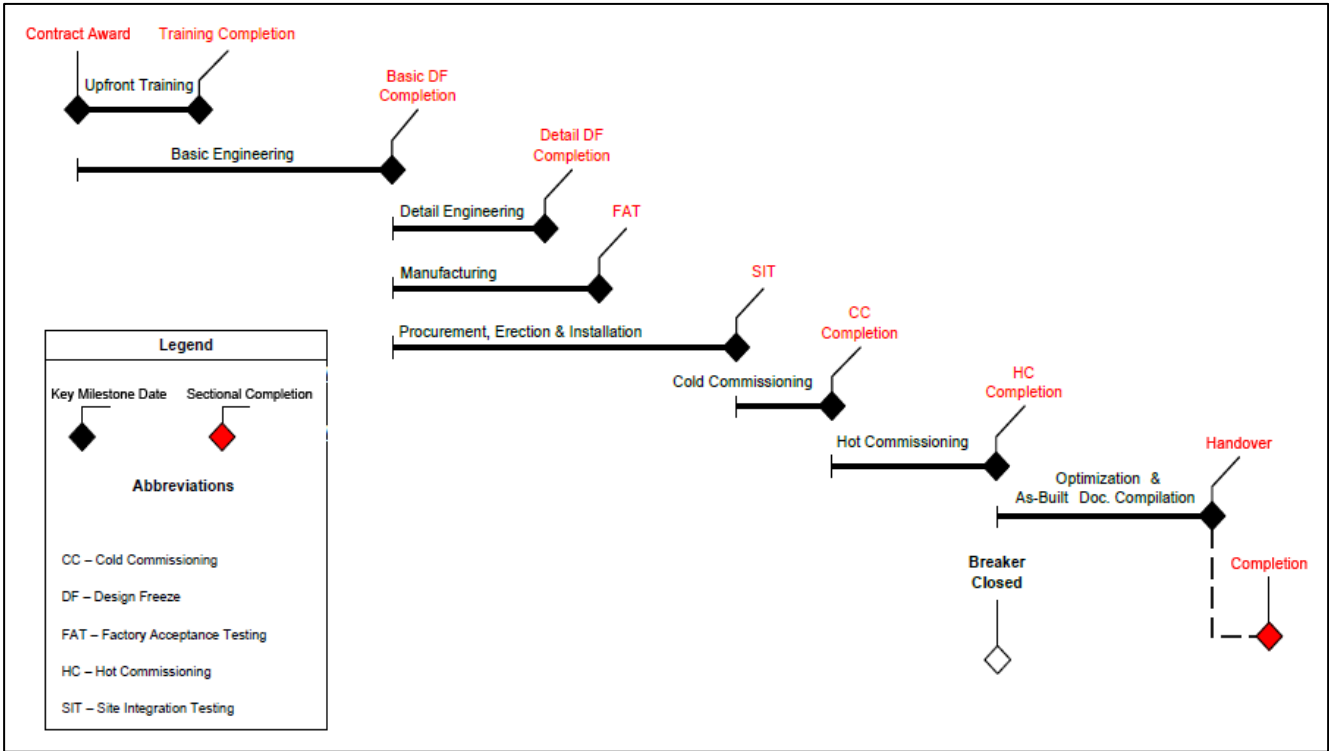


Figure 5: Proposed Execution Strategy for the first Unit

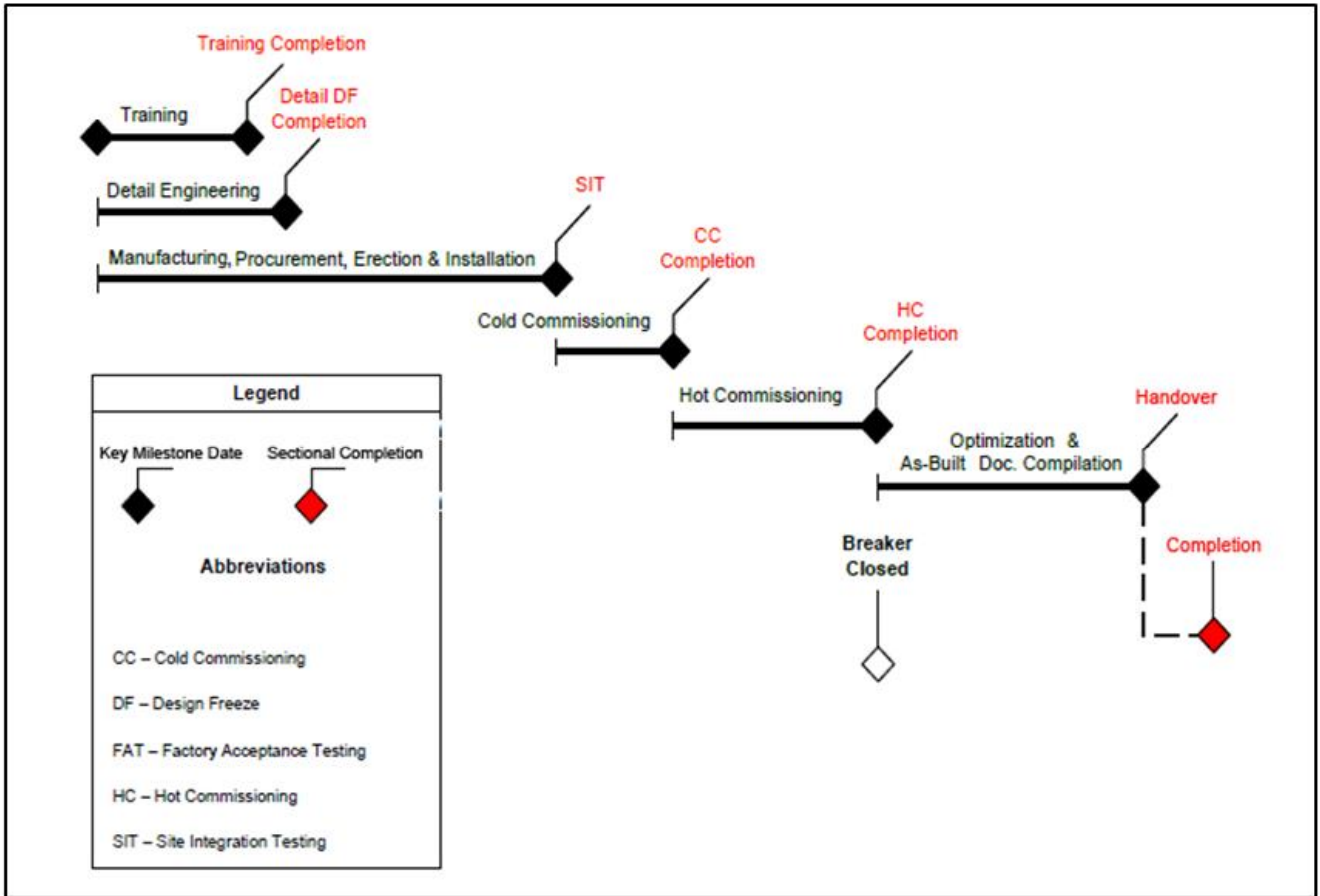


Figure 6: Proposed Execution Strategy for the consecutive Units

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

6.1 Basic Engineering

- (1) Basic Engineering is defined as being all activities necessary to clarify the *Contractor's* scope of works.
- (2) As a minimum, Basic Engineering consists of the following activities:
 - i. High Level Engineering Philosophies & Concepts – during which the rules, philosophies and concepts followed in the various engineering and design activities, are clearly defined, clarified and accepted.
 - ii. Plant investigation work – during which the Contractor conducts his plant investigation work.
 - iii. Scope definition – during which detailed scope definition and clarifications is performed.
- (3) All Basic Engineering activities are executed by the *Contractor* in active co-operation with the *Project Manager*.
- (4) The *Contractor* and the OEM identifies any discrepancies that would lead to shortcomings in the design and makes the *Employer* aware of such discrepancies and provides recommendations, where applicable. The *Contractor* takes action on such discrepancies. (Here the reference to OEM refers to mechanical original equipment manufacturers, such as the turbine OEM, and where applicable, refers to the OEM of the C&I equipment, and where the Contractor identifies specific OEM interaction).
- (5) Any discrepancies found in the design after Basic Engineering design freeze is the responsibility of the *Contractor*.

6.1.1 High Level Engineering Philosophies & Concepts

- (1) *During the high level engineering philosophies & concept activity The Contractor shall develop the following:*
 - i. Engineering program (Program showing all activities and durations related to the works).
 - ii. Index and Master register of documents (List of all documents developed and/or maintained as part of the works).
 - iii. Documentation synopsis (List and description of each type of document that forms part of the works).
 - iv. Change management procedures (Define standardised procedure to capture, track and manage all design changes).
 - v. OEM best practices.
 - vi. Plant coding philosophy (Define standardised coding convention according to LIM103).
 - vii. Signal description philosophy (Define standardised naming convention).
 - viii. Signal acquisition concepts (Define how signals from field mounted transmitters and other field or interfacing devices are acquired).
 - ix. Functional logic design philosophies (Define standardised naming convention).
 - x. Field installation philosophy (Define standardised installation philosophy for each equipment type).
 - xi. Network installation philosophy (Define standardised installation philosophy for network equipment and cabling).
 - xii. CMS system architecture and concept.
 - xiii. Power distribution philosophy (Define proposed power distribution design).

CONTROLLED DISCLOSURE

- xiv. Alarm philosophy (Definition of alarm management within the CMS).
- xv. Alarm rationalisation methodology (definition of alarm prioritisation).
- xvi. Functional separation and failure response methodology.
- xvii. Revised Protection philosophies

6.1.2 Plant Investigation Work

(1) *The scope of the plant investigation work includes, but is not limited to:*

- i. Verification of the location and suitability of all instruments
- ii. Verification of the scope of work as defined by the LOSS diagrams, IO Blocks, schedules, P&IDs and the Works Information
- iii. Existing/proposed Cable routing

(2) *During the plant investigation work, the Contractor takes responsibility for collecting all necessary plant data and information to enable the Contractor's design to be completed.*

6.1.3 Scope definition

(1) As a minimum, during the scope definition activities the following are developed, clarified and accepted:

- i. I/O scope
- ii. Hook Up Diagrams.
- iii. Junction box allocation and positions.
- iv. Selection of all field devices.
- v. Selection of materials for field equipment.
- vi. Main cable routes and racking.
- vii. Vibration Monitoring System's architecture.
- viii. The functional design specifications of each component in vibration monitoring system.
- ix. Installation & implementation standards.
- x. Procurement plan.

(2) The Contractor revises the existing operating, control and protection philosophies for all CMS plant areas, in consultation with the plant's OEM via the Employer. It is envisaged that operating and control philosophies are based upon existing philosophies but where there are differences contrary to these that these be carefully documented and aligned to as built criteria.

6.1.4 Interfaces to Other Systems

- (1) Where the Contractor's system interfaces to Employer's provided systems, the Contractor co-ordinates and designs the interface to ensure an overall complete design.
- (2) The Contractor takes full responsibility for all technical interfaces between the CMS systems and other systems

6.1.5 OEM Requirements in Basic Engineering

- (1) The CMS OEM confirms, prior to Basic Engineering design freeze, that all configurations are standard according to the CMS OEM best practices, and that no individual Eskom Power Station

CONTROLLED DISCLOSURE

specific configurations or customisations have been implemented without proper technical clarification. Consideration is given during Basic Engineering of future version upgrades, and the impact of the non-standard applications.

- (2) The CMS OEM provides a detailed lifecycle management strategy to the Employer, highlighting the high risk aspects, as well as identifying any risk mitigating strategies possible. This lifecycle strategy includes aspects to consider during the implementation phase, for the period of the project, and identifies lifecycle issues for every system that is part of the Contract including those not part of the Contractor's own internal supply.
- (3) The CMS OEM reviews in depth and approves Basic Engineering design freeze documentation.

6.1.6 BASIC ENGINEERING DESIGN FREEZE

- (1) Basic Engineering design freeze is achieved when all Basic Engineering design freeze documents defined in Appendix A are accepted by the *Project Manager*.

6.2 DETAILED ENGINEERING

- (1) Detailed engineering is defined as being all activities necessary to translate the Contractor's scope of works, as defined at Basic Engineering design freeze, into fully functional system.
- (2) As a minimum, detailed engineering consists of the development, clarification and acceptance of the following:
 - i. Detailed IO and channel assignment lists.
 - ii. Hook Up diagrams.
 - iii. Alarm List(s) and alarm response procedures.
 - iv. Equipment configuration diagrams.
 - v. Logical network drawings.
 - vi. General Arrangement & internal layout drawings.
 - vii. Acceptance test procedures.
 - viii. Engineering and maintenance procedures.
- (3) Detailed engineering of the interfaces within the works and the interfaces to other systems, forms part of the works.

6.2.1 OEM Requirements in Detailed Engineering

- (1) The CMS OEM confirms, prior to detail engineering design freeze, that all configurations are standard according to the CMS OEM best practices, and that no individual Eskom Power Station specific configurations or customisations have been implemented without proper technical clarification.
- (2) The CMS OEM reviews in depth and approves detailed engineering design freeze documentation as indicated in Appendix A.

6.2.2 Detailed Engineering Design Freeze

- (1) Detailed engineering design freeze is achieved when all Detailed Engineering design freeze documents defined in Appendix A are accepted by the Project Manager.

CONTROLLED DISCLOSURE

6.3 MANUFACTURING

- (1) The CMS System excluding field equipment will undergo Factory Acceptance Testing for the first Unit.
- (2) The remaining units will only undergo Site Integration Testing.
- (3) The Employer has the right to appoint a representative or representatives to inspect all parts during manufacture and to be present at any of the tests specified.
- (4) The Project Manager is free to specify 'hold and witness points' during the fabrication and factory testing of the condition monitoring system.
- (5) The Contractor issues preliminary notification of hold and witness points by fifteen day advance notice to the Project Manager.
- (6) The Contractor confirms hold and witness points at least seven days prior to the activity, as shown in the Accepted Programme.
- (7) Arrangements for witnessing inspections are made through the Project Manager.
- (8) A minimum of ten working days' notice is given by the Contractor for inspections and is shown in the Accepted Programme.

6.3.1 FAT

- (1) During FAT, the Contractor demonstrates that the CMS meets the requirements of this Works Information and the detailed engineering design freeze documentation.
- (2) The FAT is done at the Contractors manufacturing factory.
- (3) The Contractor provides all necessary facilities and simulation systems at the FAT venue such that full testing of the control system's functional logic can be done.
- (4) The Contractor ensures that all CMS hardware and software is available and operational in time for the individual tests.
- (5) The Project Manager determines if any further testing is required, such as that of any new technologies being used.
- (6) The Contractor, OEM, the Engineer, Site owner, and Other Project Contractors shall attend the FAT.
- (7) The scope of the equipment tested at the FAT shall be as follows
 - i. All of the first Unit's CMS equipment. This includes any cross marshalling in the CMS cabinets.
 - ii. All of the CMS system's equipment.
- (8) As a minimum, the following tests and inspection shall be performed during the FAT, for the approval by the Engineer:
 - i. Full testing of the CMS's functional logic.
 - ii. Full testing of the philosophy.
 - iii. Mechanical and visual inspection and tests of all equipment.
 - iv. Wiring and visual inspection of all CMS cabinet's internal wiring and cross marshalling.
 - v. CMS integrity and application tests.
 - vi. CMS testing of all bus interfaces to 3rd party system.
 - vii. CMS testing of hardwired interfaces to 3rd party system.
 - viii. All tests and inspections defined in IEC 62381.

CONTROLLED DISCLOSURE

- ix. In addition to the FAT requirements specified in IEC 62381, the following tests and inspections as defined in this subsection are conducted during the FAT as a minimum:
- (a) Documentation checks
 - (b) Inventory Checks
 - H/W Inventory (versions, serial numbers)
 - S/W & Firmware Inventory (licenses, versions)
 - (c) Mechanical Checks
 - Mechanical Inspection (cable entry, labelling, mounting, connections, earthing, maintainability of fans, cabinet construction)
 - Wiring and termination inspection (internal wiring, circuit breakers, labelling, segregation of wiring, wire crimp pull test, connector labelling)
 - (d) Application of Functional Logic checks (protections activated, limits)
 - (e) Design Philosophy Tests
 - Implementation of the AKZ Tagging philosophy
 - Implementation of the Signal description philosophy
 - Implementation of the design codes
 - (f) Verification of all quality and performance requirements defined in section 4.1
 - (g) Verification of the plant coding philosophy
 - (h) Verification of the signal description philosophy
 - (i) Verification of the functional distribution
 - (j) Verification of the expandability and spare capacity requirements
 - (k) Verification of scan cycles

6.3.1.1 FAT Procedure

- (1) The Contractor prepares a detailed test procedure in preparation for FAT.
- (2) As a minimum, the proposed FAT procedure identifies the following:
 - i. Functional Design.
 - ii. Operation of input processing modules.
 - iii. Operation of output modules.
 - iv. Operation of input and output by simulating the field instrumentation inputs.
 - v. Hardware compatibility.
 - vi. Termination layout.
 - vii. Interfaces.
 - viii. Labelling.
 - ix. Test calibration of inputs.
 - x. Designed philosophies.

CONTROLLED DISCLOSURE

- xi. Confirm the failure response of the CMS, its IO modules and processing units. This is to ensure the overall reliability of the CMS, its resilience and ability to operate and protect correctly throughout all modes of failure are confirmed through dedicated FAT testing.

6.3.1.2 FAT Report & FAT Completion

- (1) A final FAT report is prepared by the Contractor that includes the following as a minimum:
 - i. Test procedures used during FAT.
 - ii. Detailed Test results.
 - iii. Discrepancies identified during the tests.
 - iv. Resolution of the discrepancies.
 - v. Retests conducted and results thereof.
 - vi. FAT certificate.
- (2) The Contractor submits the Final FAT Report to the Project Manager for acceptance.
- (3) FAT Completion is achieved upon acceptance of the Final FAT Report by the Project Manager.

6.4 PROCUREMENT, ERECTION & INSTALLATION

- (1) This stage consists of the procurement, installation, and on-site inspection and testing of all equipment forming part of the works as well as other items that the Employer has specified such as free issued items.
- (2) This stage consists of both pre-outage and outage work.
- (3) The Contractor provides all test equipment required for any inspections and tests.
- (4) The Employer nominates representatives who will work alongside (and be trained by) the Contractor during installation and commissioning.

6.4.1 Pre-Outage Installation Work

- (1) The following work is completed by the Contractor prior to breaker open:
 - i. Installation of trunk cabling.
 - ii. Installation of network cabling.
 - iii. Installation of Network switches.
 - iv. Installation of network cabling infrastructure.
 - v. Installation of junction boxes.
 - vi. Installation of field cables.
 - vii. Installation of network cabinets (and associated equipment).
 - viii. Installation of labelling
 - ix. Termination of the trunk cabling at the junction boxes.
 - x. Termination of the field cabling at the junction boxes and at the instrumentation.
 - xi. Approval for Remote access Connection.

CONTROLLED DISCLOSURE

6.4.2 Site Integration Test (SIT)

- (1) The SIT only begins once the following has occurred:
 - i. The first Unit's Condition Monitoring System has been installed in their final locations and connected to permanent power supplies.
 - ii. All interfaces to Employer 3rd party systems have been implemented.
- (2) The SIT is carried out before plant commissioning commences to ensure:
 - i. Correct performance of the CMS.
 - ii. Safety of plant and personnel.
 - iii. Compliance with the Works Information and the detailed engineering design freeze documentation.
- (3) In addition to the SIT requirements specified in IEC 62381, the following tests and inspections as defined in this subsection are conducted during the SIT as a minimum:
 - i. Verification that all enclosures are suitable for the applicable environmental conditions.
 - ii. Verification of all 3rd party interfaces not tested during the FAT
 - iii. Verification of any tests from the FAT procedure not performed during the FAT
 - iv. Verification of the Unit Condition Monitoring System and Condition Monitoring System Network with final power connected
 - v. Mechanical and visual inspection of the Unit Condition Monitoring System and Condition Monitoring System Network after installation has been completed
 - vi. Re-verification of any FAT tests at the discretion of the Engineer

6.4.2.1 SIT Procedure

- (1) The Contractor prepares a detailed test procedure for the SIT.
- (2) As a minimum, the proposed SIT procedure identifies the following:
 - i. Major test activities.
 - ii. Comprehensive list and description of the individual tests to be performed.
 - iii. How the tests are to be prepared and conducted.
 - iv. Test dates and durations.
 - v. Checklists - how the test results will be documented.
 - vi. Acceptance Criteria.
 - vii. How the identified discrepancies will be processed.
 - viii. Retesting requirements.

6.4.2.2 SIT Report & SIT Completion

- (1) A Final SIT Report is prepared by the Contractor that includes the following as a minimum:
 - i. Detailed Test results.
 - ii. Discrepancies identified during the tests.
 - iii. Resolution of the discrepancies.
 - iv. Retests conducted and results thereof.

CONTROLLED DISCLOSURE

- v. SIT certificate.
- (2) The Contractor submits the Final SIT Report to the Project Manager for acceptance.
- (3) When all tests are successful and the final SIT Report is accepted by the Project Manager, the system is classified as 'ready for use'. The system is then deemed ready for cold commissioning

6.4.3 Cold Commissioning

- (1) As a minimum, the cold commissioning activities conducted by the Contractor consists of:
 - i. Functional Tests.
 - ii. Electrical and instrumentation loop checks.
 - iii. All field equipment checks.
 - iv. Loop checks.
 - v. Interface checks.
 - vi. Testing of system functionality.
 - vii. Integrity Checks.
- (2) Linearization (where applicable) of all instrumentation forms part of the works and linearization sheets must be provided and signed by both parties and included as part of the documentation package for the works.
- (3) The Integrity checks are function checked by simulation at the field equipment device. The Contractor provides a printed log to confirm signals and integrity.
- (4) Physical checks (quality/conformance of installation, labelling)
- (5) Zero adjustment of all expansion, shaft position and end thrust instrumentation. This is conducted after the shaft has been pushed to a mechanical zero by the Employer.

6.4.4 Hot Commissioning

- (1) The Contractor submits the Cold Commissioning test results to the Project Manager.
- (2) The Contractor requests the commencement of hot commissioning upon acceptance of cold commissioning results.
- (3) Hot commissioning commences on turbines as soon as the turbine is ready to be put on barring.
- (4) Hot commissioning is where the plant processes are placed into operation and the Data Acquisition System functionality will be verified.
- (5) The Contractor is responsible for the commissioning of the CMS system for all three Units forming part of the Works.
- (6) The Contractor shall ensure availability of his resources to perform the following activities during hot commissioning:
 - i. The Contractor shall validate the performance of the Condition Monitoring System when the Turbine is on barring.
 - ii. The Contractor shall validate the performance of the Condition Monitoring System when the BFPT is on barring.
 - iii. The Contractor shall validate the performance of the Condition Monitoring System on the EFPs when in starting up as well as in running condition.
 - iv. The Contractor shall validate the performance of the Condition Monitoring System while the Turbine is being run up.

CONTROLLED DISCLOSURE

- v. The Contractor shall validate the performance of the Condition Monitoring System while the Turbine is on load.
 - vi. The Contractor shall validate the performance of the Condition Monitoring System while the BFPT is being run up.
 - vii. The Contractor shall validate the performance of the Condition Monitoring System while the BFPT is on load.
- (7) The commissioning activities are carried out in conjunction with the Project Manager.
- (8) The Employer is responsible for the preparation of the plant for hot commissioning.
- (9) If a defect is identified in the equipment interfacing to, or external to the Contractor's scope the Contractor informs the Project Manager or Representatives immediately.

6.5 ACCEPTANCE CRITERIA

- (1) The Completion will be divided into sectional completion per unit. The following criteria must be met for sectional completion.
- i. The installation must be complete.
 - ii. All equipment removed by the Contractor must be adequately packaged and provided to the employer.
 - iii. All defects and NCRs related to the Unit must be corrected by the Contractor.
 - iv. The relevant tests (FAT, SIT, Cold Commissioning, Hot Commissioning,) completed and results accepted by the Employer.
 - v. Documentation related to the Unit, handed over to the Employer and accepted by the Employer.
 - vi. All documentation relevant to the applicable Unit (i.e. Operating and maintenance procedures) updated and handed over to the Employer and accepted by the employer.
 - vii. Acceptance of the 'As Built' documentation is a pre-requisite for the Sectional Completion of the Plant Area concerned.
 - viii. Training completed as per contract.
 - ix. All software backups and licences provided to the Employer.
 - x. All Spares and special tools stipulated in the contract provided to the Employer.
 - xi. A successful running time review of equipment performance. The running time review shall last a minimum of 72 hours.
- (2) At sectional completion of a Unit the contractor shall supply soft copies of all documentation
- (3) All non-unitised documentation shall be updated as necessary before sectional completion and submitted as part of the sectional completion package
- (4) All unitised documentation supplied by the Contractor at sectional completion shall be provided specific to the related Unit. Generic unitised documentation is not acceptable.
- (5) After acceptance of sectional completion, the Contractor shall supply hard copies of all unitised documentation.

6.6 "AS BUILT" DOCUMENTATION PACKAGE AND FINAL HANDOVER

- (1) Final handover will occur when sectional completions have been finalised on all related Units.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

- (2) 'As Built' documentation, as listed in Appendix A is supplied by the Contractor to the Project Manager upon completions of works.
- (3) The format of all documentation is specified in Appendix A.
- (4) The documents are reviewed by the Project Manager for correctness and conformance to the accepted design.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

7. PROCUREMENT PROCESS TECHNICAL INPUT

7.1 TENDER RETURNABLES

- (1) The tender returnables must be aligned to the documentation listed under “ENQUIRY/TENDER” in the VDSS (Appendix A)
- (2) The following should be requested from the Contractor during the tender process as a minimum:

	Focus	Relevant Section	Description
1.	Letter from system OEM	5.2.2	Provide an official letter from system OEM which confirms the acknowledgement of the system OEM of the tenderers capability to provide the system and the OEMs support for the tenderer during the execution of the project.
2.	Table of compliance	Appendix L	Provide a table of compliance acknowledging compliance to each section technical specification in the works information. List all deviations per section.
3.	Condition Monitoring System Design	5.2.2	Provide a proposed CMS solution that defines equipment and functionality. Include the following design documentation as a minimum: <ul style="list-style-type: none"> • CMS Functional Specification • Concept network architecture (Showing proposed solution for single Unit) • List of measurement types • Functional distribution concept • Installation concept for new measurements
4.	Condition Monitoring System HMI Design	5.2.2.1.3	Provide the following to define the proposed CMS HMI solution: <ul style="list-style-type: none"> • Description of the HMI solution and functions provided for the Works. • Operator interface concept (including architecture drawing) • Technical specifications related to HMI solution. • Colour examples of typical HMI views, trends and graphics
5.	Condition Monitoring System Cabinets	(2)	Provide a proposed Cabinets design for CMS Include the following design documentation as a minimum: <ul style="list-style-type: none"> • CMS Cabinet Specification • Typical cabinet layout drawing showing rack layout as well as cable management system • Proposed cabinet location shown on existing layout drawings 0.63/2624, 0.63/2625, and 0.63/2626 • Network cabinet specification
6.	Cyber Security	5.2.2.1.6	Provide a proposed Cyber threat management solution.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

	Focus	Relevant Section	Description
7.	Power Distribution	5.2.2.3	<p>Provide a proposed power reticulation design that includes a cable block diagram for the 220V AC Distribution Board as well as 24 V DC distribution boards (diagram must show redundancy), to supply the new loads</p> <p>Provide Power load list for all equipment that form part of the Works.</p>
8.	Condition Monitoring System Interface to 3 rd party systems	5.2.2.4	<p>Provide design solution for each of the following external interfaces:</p> <ul style="list-style-type: none"> Existing Control Automation and Protection Automation Systems Process LAN Business LAN (including cyber threat management)
9.	Field Design	5.2.2.1.6	<p>Provide a proposed field design solution with its physical location assessment report and mounting designs.</p> <p>Provide the field equipment design manuals, data sheets and technical design information of the proposed solution for the Field Instrumentation and of its respective such as mounting requirements</p> <p>Provide an instrumentation schedule that includes all the new instrumentation (Appendix J).</p> <p>Provide example of material certificate for brackets.</p> <p>Provide a proposed concept designs for the new installations.</p> <ul style="list-style-type: none"> New Equipment codification Specification for each type of Cable Cable Routing <p>Provide proposed junction box design specification and drawings</p>
10.	Earthing Design Concept	5.2.4.5	<p>Provide a proposed Earthing design for all the equipment forming part of the works.</p> <ul style="list-style-type: none"> Cabinets, Cables Instrumentation Junction Box
11.	Training	5.2.9	<p>Provide proposed training programme (content list and durations).</p> <p>Provide proposed example training manual</p>
12.	Project Resource	N/A	<p>Provide a comprehensive project engineering organogram with a CV of each project member.</p>
13.	Online Condition Monitoring Solution for the EFP's	Appendix I	<p>Provide a comprehensive solution for the CMS of the EFP's which have not had a previous online monitoring system in place.</p> <p>This provision to include the mounting brackets, the probes, the layouts, as well as the operational philosophy as described in Appendix I.</p>

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

	Focus	Relevant Section	Description
14.	Experience	N/A	The Contractor to provide at least three detailed reference to a project which the Contractor executed with similar scope. The references include information regarding project scope and contact details
15.	Subcontractor Verification	N/A	The Contractor to provide detailed information of all subcontractors.
16.	Quality Control	N/A	The Contractor to provide quality control plan
17.	Local Support	4.6	The Contractor to provide details of local support for system and equipment.
18.	Lifecycle Status	4.6	The Contractor to provide/define lifecycle status for all equipment/systems provided as part of the works.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

8. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Cornelius Visagie	Chief Technologist C&I (Gx Eng)
Blackie Swart	Lethabo C&I Engineering Senior Advisor
Fanie Clarence	Lethabo Condition Monitoring
Marcel van Eden	Lethabo C&I Senior Engineer
Prudence Lekota	Lethabo IM Operations Manager
Isaac Gama	Snr Information Systems (IS) Architect

9. REVISIONS

Date	Rev.	Compiler	Remarks
December 2016	1	C.F. Barnard	Draft IDR and MDR comments incorporated
November 2017	2	C.F. Barnard	Report revised to include comments from PEIC specialist and CCCC
June 2021	3	C.F. Barnard	Document revised after scope for project reduced to three units. Specification updated accordingly.

10. DEVELOPMENT TEAM

The following people were involved in the development of revision 2 this document:

- Armand Kruger (Turbine LDE)
- Franco Barnard (EDWL and C&I LDE):
- Mxolisi Nhlengethwa (Electrical LDE)
- Yusuf Khan (Pumps LDE)

The following people were involved in the development of revision 3 this document:

- Cornelius Visagie (SME)
- David Kunene (Electrical LDE)
- Ferdinand Coertze (Turbine LDE)
- Franco Barnard (EDWL and C&I LDE)

11. ACKNOWLEDGEMENTS

- Priyanka Thakur (C&I CoE Engineer)– Compiler of the “Kriel Main Turbine and Boiler Feed Pump Turbine and EFP’s Vibration Monitoring Replacement” works information.
- Cornelius Visagie (C&I PEIC) - Providing Turbovisory knowledge and expertise and sharing experience from other Eskom powers stations

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX A: VDSS



Appendix A - VDSS.xlsx

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX B: OPTION 1 TURBINE VIBRATION DIAGNOSTIC SYSTEM

The tenderer provides for the scope as described in the annexure which provides for the provision of the works for the delivery of a turbine vibration diagnostic system. The option will form part of the tender evaluation. All costing associated with the provision of the option is provided as separate lines specific to the turbine vibration diagnostic system which allows the Employer to identify the specific cost associated with the option to allow financial evaluation.

The Employer however reserves the right to include or exclude the turbine vibration diagnostic system provided in the option.

Employer responsibilities, sub-contractor requirements, services provided by the Employer project execution requirements are as per the requirements provided in the main technical specification.



Diagnostic system
option.docx

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX C: OPTION 2 BOILER PLANT VIBRATION DATA ACQUISITION SYSTEM

The tenderer provides for the scope as described below which provides for the provision of the Works for the delivery of a boiler vibration data acquisition system. The option will form part of the tender evaluation. All costing associated with the provision of the option is provided as separate lines specific to the Boiler vibration data acquisition system which allows the Employer to identify the specific cost associated with the option to allow financial evaluation.

The Employer however reserves the right to include or exclude the Boiler vibration data acquisition system provided in the option.

Employer responsibilities, sub-contractor requirements, services provided by the Employer project execution requirements are as per the requirements provided in the main technical specification.

The following measurements are provided by the contractor per unit as part of the option:

#	Existing Long Description	LOSS	IO Function Block
1	LEFT HAND FORCED DRAUGHT FAN BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
2	LEFT HAND FORCED DRAUGHT FAN BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
3	LEFT HAND FORCED DRAUGHT FAN BEARING VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG
4	LEFT HAND FORCED DRAUGHT FAN BEARING VIBRATION 4	LOSS_BLRVIB	IO_VIB_BRG
5	LEFT HAND FORCED DRAUGHT FAN BEARING VIBRATION 5	LOSS_BLRVIB	IO_VIB_BRG
6	LEFT HAND FORCED DRAUGHT FAN BEARING VIBRATION 6	LOSS_BLRVIB	IO_VIB_BRG
7	LEFT HAND FORCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
8	LEFT HAND FORCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
9	LEFT HAND FORCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
10	LEFT HAND FORCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
11	LEFT HAND INDUCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
12	LEFT HAND INDUCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
13	LEFT HAND INDUCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
14	LEFT HAND INDUCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
15	LEFT HAND INDUCED DRAUGHT FAN VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
16	LEFT HAND INDUCED DRAUGHT FAN VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
17	LEFT HAND INDUCED DRAUGHT FAN VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG
18	LEFT HAND PRIMARY AIR FAN FAN DRIVE END BEARING VIBRATION 4	LOSS_BLRVIB	IO_VIB_BRG
19	LEFT HAND PRIMARY AIR FAN FAN DRIVE END BEARING VIBRATION 5	LOSS_BLRVIB	IO_VIB_BRG
20	LEFT HAND PRIMARY AIR FAN FAN DRIVE END BEARING VIBRATION 6	LOSS_BLRVIB	IO_VIB_BRG
21	LEFT HAND PRIMARY AIR FAN FAN NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

22	LEFT HAND PRIMARY AIR FAN FAN NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
23	LEFT HAND PRIMARY AIR FAN FAN NON DRIVE END BEARING VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG
24	LEFT HAND PRIMARY AIR FAN MOTOR DRIVE END BEARING VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG
25	LEFT HAND PRIMARY AIR FAN MOTOR DRIVE END BEARING VIBRATION 4	LOSS_BLRVIB	IO_VIB_BRG
26	LEFT HAND PRIMARY AIR FAN MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
27	LEFT HAND PRIMARY AIR FAN MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
28	RIGHT HAND FORCED DRAUGHT FAN BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
29	RIGHT HAND FORCED DRAUGHT FAN BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
30	RIGHT HAND FORCED DRAUGHT FAN BEARING VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG
31	RIGHT HAND FORCED DRAUGHT FAN BEARING VIBRATION 4	LOSS_BLRVIB	IO_VIB_BRG
32	RIGHT HAND FORCED DRAUGHT FAN BEARING VIBRATION 5	LOSS_BLRVIB	IO_VIB_BRG
33	RIGHT HAND FORCED DRAUGHT FAN BEARING VIBRATION 6	LOSS_BLRVIB	IO_VIB_BRG
34	RIGHT HAND FORCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
35	RIGHT HAND FORCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
36	RIGHT HAND FORCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
37	RIGHT HAND FORCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
38	RIGHT HAND INDUCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
39	RIGHT HAND INDUCED DRAUGHT FAN MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
40	RIGHT HAND INDUCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
41	RIGHT HAND INDUCED DRAUGHT FAN MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
42	RIGHT HAND INDUCED DRAUGHT FAN VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
43	RIGHT HAND INDUCED DRAUGHT FAN VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
44	RIGHT HAND INDUCED DRAUGHT FAN VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG
45	RIGHT HAND PRIMARY AIR FAN FAN DRIVE END BEARING VIBRATION 4	LOSS_BLRVIB	IO_VIB_BRG
46	RIGHT HAND PRIMARY AIR FAN FAN DRIVE END BEARING VIBRATION 5	LOSS_BLRVIB	IO_VIB_BRG
47	RIGHT HAND PRIMARY AIR FAN FAN DRIVE END BEARING VIBRATION 6	LOSS_BLRVIB	IO_VIB_BRG
48	RIGHT HAND PRIMARY AIR FAN FAN NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
49	RIGHT HAND PRIMARY AIR FAN FAN NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
50	RIGHT HAND PRIMARY AIR FAN FAN NON DRIVE END BEARING VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG
51	RIGHT HAND PRIMARY AIR FAN MOTOR DRIVE END BEARING VIBRATION 3	LOSS_BLRVIB	IO_VIB_BRG

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

52	RIGHT HAND PRIMARY AIR FAN MOTOR DRIVE END BEARING VIBRATION 4	LOSS_BLRVIB	IO_VIB_BRG
53	RIGHT HAND PRIMARY AIR FAN MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
54	RIGHT HAND PRIMARY AIR FAN MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
55	MILL A LUBRICATION OIL SYSTEM GEARBOX VIBRATION	LOSS_BLRVIB	IO_VIB_BRG
56	MILL A MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
57	MILL A MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
58	MILL A MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
59	MILL A MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
60	MILL B LUBRICATION OIL SYSTEM GEARBOX VIBRATION	LOSS_BLRVIB	IO_VIB_BRG
61	MILL B MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
62	MILL B MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
63	MILL B MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
64	MILL B MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
65	MILL C LUBRICATION OIL SYSTEM GEARBOX VIBRATION	LOSS_BLRVIB	IO_VIB_BRG
66	MILL C MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
67	MILL C MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
68	MILL C MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
69	MILL C MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
70	MILL D LUBRICATION OIL SYSTEM GEARBOX VIBRATION	LOSS_BLRVIB	IO_VIB_BRG
71	MILL D MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
72	MILL D MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
73	MILL D MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
74	MILL D MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
75	MILL E LUBRICATION OIL SYSTEM GEARBOX VIBRATION	LOSS_BLRVIB	IO_VIB_BRG
76	MILL E MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
77	MILL E MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
78	MILL E MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
79	MILL E MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
80	MILL F LUBRICATION OIL SYSTEM GEARBOX VIBRATION	LOSS_BLRVIB	IO_VIB_BRG
81	MILL F MOTOR DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
82	MILL F MOTOR DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG
83	MILL F MOTOR NON DRIVE END BEARING VIBRATION 1	LOSS_BLRVIB	IO_VIB_BRG
84	MILL F MOTOR NON DRIVE END BEARING VIBRATION 2	LOSS_BLRVIB	IO_VIB_BRG

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX D: EXISTING DESIGN DOCUMENTATION

This Appendix consists of two folders:

D1 - Existing Design documentation for information only

Documents provided in this folder is for information purposes only and shall be managed by the Employer

D2 - Existing design documentation to be updated as part of the Works Information

Documents provided in this folder shall be managed and updated by the Contractor throughout the project

D3 – Drawing Templates

Documents provided in this folder shall be used by the Contractor to develop technical drawings

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX E: DESIGN STANDARDS, GUIDELINES AND CODES

E1 – Standards that have to be complied with:

- (1) 36-681: Plant Safety Regulations, Rev 1
- (2) ISO 10817-1: Rotating Shaft Vibration Measuring Systems – Part 1: Relative and absolute sensing of radial vibration
- (3) ISO 7919-1: Mechanical Vibration of Non-Reciprocating Machines - Measurements on Rotating Shafts and Evaluation Criteria – Part 1: General guidelines
- (4) ISO 7919-2: Mechanical Vibration of Non-Reciprocating Machines - Measurements on Rotating Shafts and Evaluation Criteria – Part 2: large land-based steam turbine generator sets
- (5) ISO 10816-2: Mechanical Vibration - Evaluation of Machine Vibration by Measurements on Non-Rotating Parts - Part 2: Land-based steam turbines and generators in excess of 50 MW with normal operating speeds of 1500 rpm, 1800 rpm, 3000 rpm and 3600 rpm
- (6) ISO 10816-7: Mechanical vibration. Evaluation of machine vibration by measurements on non-rotating parts. Part 7: Rotodynamic pumps for industrial applications, including measurements on rotating shafts
- (7) ISO 7919-3: Mechanical Vibration of non-reciprocating machines – Measurements on rotating shafts and evaluation criteria – Part 3: Coupled industrial machines
- (8) 240-56355815 Field Instrument Installation Standard for Junction Boxes and Cable Termination
- (9) 240-56356396 Earthing and Lighting Protection
- (10) 240-56227516: LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard.
- (11) SANS 10142-Part 1 - The Wiring of Premises Part 1: Low-voltage installations.
- (12) IEC 62381 - Automation Systems in the process industry, FAT, SAT and SIT
- (13) LIM103 Lethabo Power Station Notes on Alpha Numeric Plant Codification AKZ Coding Manual
- (14) 240-55410927 Cyber Security Standard For Operational Technology Rev 1
- (15) SANS 10198-12, Edition 1, the selection, handling and installation of electric power cables of rating not exceeding 33kV Part 12: Installation of earthing system, South African National Standards, Pretoria.
- (16) 240-56176852: Essential Power Supply for Power Station Standard
- (17) SANS 1507-Part 1: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 1: General.
- (18) SANS 1411-Part 1: Materials of insulated electric cables and flexible cords Part 1: Conductors
- (19) 240-56246601 Qualification, Certification and Accreditation Requirements for Personnel and Entities Performing Welding Related Work on Eskom Plant Standard
- (20) 240-56241933 Control of Welding during Construction, Repair and Maintenance Activities Standard
- (21) 240-83540088: Requirements for Non-Destructive Testing (NDT) on Eskom Plant Standard
- (22) 240-83539994 Eskom NDT Personnel Approval (NPA) for Quality Related Special Processes on Eskom Plant Standard

CONTROLLED DISCLOSURE

- (23) LBT00014WN Classification of Hazardous Locations rev3
- (24) 32-373 Information Security – IT/OT And Third Party Remote Access Standard (related to Option 2)

E2 – Standards used to compile the Works (only sections specified and/or content referenced in the Works to be complied with):

- (25) 36-618: Definition of Vibration Monitoring & Diagnostic System for Large Steam Turbine Centreline & Boiler Feed Pump Turbines on Eskom Power Stations Rev 1
- (26) 240-56355754 Field Instrument Installation Standard
- (27) 240-56227443 Requirements for Control and Power Cables for Power stations Standard
- (28) 240-54937450 Fire Protection and Life Safety Design Standard
- (29) API 670 fourth edition - Machine Protection Systems

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX F: MAIN TURBINE OPERATING PHILOSOPHY

CMS Measurement Parameters (Primary):

Parameters measured by the CMS:

Table 2: Main Turbine CMS Measurement Parameters

Parameter	Location(s)	Existing	Probes per location	Total no. of probes
Relative shaft vibration	12 bearings	Yes	2 (X & Y)	24
Pedestal vibration	12 bearings	Yes	1/2 (horiz. & vert.)	12/24
Shaft position	At thrust bearing	Yes	2	2
End thrust	At thrust bearing	Yes	2	2
Absolute expansion	HP front	Yes	1	1
Differential expansion	HP front; IP rear; LP2 rear	Yes	1	3
Phase reference/speed	Exciter	Yes	1	1
Shaft eccentricity	To be determined	No	1	To be determined

Parameter Ranges and Alarm/Trip Boundary Limits (Setpoints):

Table 3: Main Turbine Parameter Ranges & Setpoints

AKZ	Description	Original / Existing Spec.	Value / Range	Duration / Delay	Status
SB11Z011	Diff expansion alarm / trip HP turb front differential expansion	Original specifications (AEG-Kanis)	Range: -8mm to 12 mm at -2.5 mm at +8.5 mm at -3 mm at +9 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip
		Existing specification (EPRO)	Range: -8mm to 12 mm at -2.5 mm at +8.5 mm at -3 mm at +9 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip
SB13Z011	Diff expansion alarm / trip LP turb rear differential expansion	Original specifications (AEG-Kanis)	Range: -8mm to 12 mm at -5 mm at +7 mm at -5.5 mm at +7.5 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip
		Existing specification (EPRO)	Range: -8mm to 12 mm at -5 mm at +7 mm at -5.5 mm at +7.5 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip

CONTROLLED DISCLOSURE

AKZ	Description	Original / Existing Spec.	Value / Range	Duration / Delay	Status
SB17Z011	Diff expansion alarm / trip LP turb 2 rear differential expansion	Original specifications (AEG-Kanis)	Range: -10mm to 30 mm at -4 mm at +17 mm at -4.5 mm at +18 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip
		Existing specification (EPRO)	Range: -10mm to 30 mm at -4 mm at +17 mm at -4.5 mm at +18 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip (not in operation currently)
SB11Z043	Shaft vibration HP front	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SB11Z045	Shaft vibration HP rear	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SB12Z043	Shaft vibration IP front	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SB12Z045	Shaft vibration IP rear	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SB14Z043	Shaft vibration LP1 front	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

AKZ	Description	Original / Existing Spec.	Value / Range	Duration / Delay	Status
SB14Z045	Shaft vibration LP1 rear	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SB16Z043	Shaft vibration LP2 front	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SB16Z045	Shaft vibration LP2 rear	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 50 µm (0-pk) 80 µm (0-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm (pk-pk) 180 µm (pk-pk) X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SB11Z001	Turbine Absolute expansion	Original specifications (AEG-Kanis)	Range: 0 to 50mm	-	-
		Existing specification (AEG-Kanis)	Range: 0 to 50mm	-	-
SB12Z040	Turbine Shaft position	Original specifications (AEG-Kanis)	Range: -2 to 1mm Have spare (SB12Z041) probe	-	-
		Existing specification (EPRO)	Range: -2 to 1mm Have spare (SB12Z041) probe	-	-
SB12Z038	Turbine End thrust	Original specifications (AEG-Kanis)	Range: ±200kN (0-10V) Have spare (SB12Z039) probe	-	-
		Existing specification (AEG-Kanis)	Range: ±200kN (0-10V) Have spare (SB12Z039) probe	-	-
SB11Z021	Brg vibration HP turb front	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (AEG-Kanis)	Range: 0 to 50µm	-	-
SB12Z021	Brg vibration HP turb rear/IP turb front	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

AKZ	Description	Original / Existing Spec.	Value / Range	Duration / Delay	Status
		Existing specification (AEG-Kanis)	Range: 0 to 50µm	-	-
SB13Z021	Brg vibration IP turb rear	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (AEG-Kanis)	Range: 0 to 50µm	-	-
SB14Z021	Brg vibration LP 1 turb front	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (AEG-Kanis)	Range: 0 to 50µm	-	-
SB15Z021	Brg vibration LP 1 turb rear	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (AEG-Kanis)	Range: 0 to 50µm	-	-
SB16Z021	Brg vibration LP 2 turb front	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (AEG-Kanis)	Range: 0 to 50µm	-	-
SB17Z021	Brg vibration LP 2 turb rear	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (AEG-Kanis)	Range: 0 to 50µm	-	-
SQ11Z043	SHAFT VIBRATION GENERATOR FRONT	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 120 µm 180 µm X-Y feedback	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm 180 µm X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SQ11Z021	BRG VIBRATION GENERATOR FRONT	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 120 µm 180 µm X-Y feedback	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 µm 120 µm 180 µm X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SQ12Z043	SHAFT VIBRATION GENERATOR REAR	Original specifications (AEG-Kanis)	Range: 0 to 200 µm 120 µm 180 µm X-Y feedback	Instantaneous Instantaneous	Alarm Trip

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

AKZ	Description	Original / Existing Spec.	Value / Range	Duration / Delay	Status
		Existing specification (Bentley)	Range: 0 to 200 μ m 120 μ m 180 μ m X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SQ12Z021	BRG VIBRATION GENERATOR REAR	Original specifications (AEG-Kanis)	Range: 0 to 200 μ m 120 μ m 180 μ m X-Y feedback	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 μ m 120 μ m 180 μ m X-Y feedback	Instantaneous Instantaneous	Alarm Trip
SQ13Z021	VIBRATION EXCITER FRONT	Original specifications (AEG-Kanis)	Range: 0 to 200 μ m 120 μ m 180 μ m	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 μ m 120 μ m 180 μ m	Instantaneous Instantaneous	Alarm Trip
SQ14Z021	VIBRATION EXCITER REAR	Original specifications (AEG-Kanis)	Range: 0 to 200 μ m 120 μ m 180 μ m	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200 μ m 120 μ m 180 μ m	Instantaneous Instantaneous	Alarm Trip

CMS Interface to Turbine Protection System:

Parameters provided to the Turbine Protection System by the CMS:

Table 4: Main Turbine CMS Parameters Relating to Turbine Protection System

Parameter	Existing Interface
Relative shaft vibration	Yes
Pedestal vibration	No*
Axial shaft position	Yes
Rotor-casing differential expansion	Yes

*The existing Condition Monitoring System does not provide for alarming and tripping based on pedestal vibration.

Monitoring Modes:

The existing Condition Monitoring System does not possess the functionality to detect and switch between different monitoring modes depending on the operation of the monitored rotors.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX G: BFPT OPERATING PHILOSOPHY

CMS Measurement Parameters (Primary):

Parameters measured by the CMS:

Table 5: BFPT CMS Measurement Parameters

Parameter	Location(s)	Existing	Probes per location	Total no. of probes
Relative shaft vibration	2 bearings	Yes	2 (X & Y)	4
Pedestal vibration	2 bearings	Yes	1/2 (horiz. & vert.)	2/4
Shaft position	At booster pump end	Yes	2	2

Parameter Ranges and Alarm/Trip Boundary Limits (Setpoints):

Table 6: BFPT Parameter Ranges & Setpoints

AKZ	Description	Original / Existing Spec.	Value / Range	Duration / Delay	Status
SB51Z043	BFPT Shaft vibration Front	Original specifications (AEG-Kanis)	Range: 0 to 200µm 35µm (0-pk) 45 µm (pk-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200µm 120 µm (pk-pk) 180 µm (pk-pk)	Instantaneous Instantaneous	Alarm Trip
SB52Z043	BFPT Shaft vibration Rear	Original specifications (AEG-Kanis)	Range: 0 to 200µm 35µm (0-pk) 45 µm (pk-pk)	Instantaneous Instantaneous	Alarm Trip
		Existing specification (Bentley)	Range: 0 to 200µm 120 µm (pk-pk) 180 µm (pk-pk)	Instantaneous Instantaneous	Alarm Trip
SB51Z021	BFPT Front bearing vibration	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (Bentley)	Range: 0 to 50µm	-	-
SB52Z021	BFPT Rear bearing vibration	Original specifications (AEG-Kanis)	Range: 0 to 50µm	-	-
		Existing specification (Bentley)	Range: 0 to 50µm	-	-
SB51Z040	BFPT Shaft position	Original specifications (AEG-Kanis)	Range: -2 to 1mm at -1.0mm at +0.6 mm at -1.2 mm at +0.8 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

		Existing specification (AEG-Kanis)	Range: -2 to 1mm at -1.0mm at +0.6 mm at -1.2 mm at +0.8 mm	Instantaneous Instantaneous Instantaneous Instantaneous	Alarm Alarm Trip Trip
--	--	------------------------------------	---	--	--------------------------------

CMS Interface to Turbine Protection System:

Parameters provided to the Turbine Protection System by the CMS:

Table 7: BFPT CMS Parameters Relating to Turbine Protection System

Parameter	Existing Interface
Relative shaft vibration	Yes
Pedestal vibration	No*
Axial shaft position	Yes

*The existing Condition Monitoring System does not provide for alarming and tripping based on pedestal vibration.

Monitoring Modes:

The existing Condition Monitoring System does not possess the functionality to detect and switch between different monitoring modes depending on the operation of the monitored rotors.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX H: SFP OPERATING PHILOSOPHY

Process Description:

Each boiler uses a SFP to deliver water into the boiler at 100% MCR. The BFPT uses steam tapped off from the turbine in order to operate and drive the SFP.

The SFP can be put in service when: the Main Turbine load is 30% MCR, all start up preparations have been carried out and the auxiliary aggregates are ready for operation. The SFP will be the main duty pump and will only be taken out of service for planned maintenance work or break downs.

The philosophy of this extensive pump arrangement is to operate mainly with the SFP (1X100%) and the EFP (2X50%) units on standby. The SFP is driven by a BFPT, directly coupled and speed regulated with this turbine speed. (As described in LBT00153 Operating Technical Specification Turbine Plant Rev 00)

Operating Modes:

- Pre-commissioning and commissioning

Here the electrical run out of the measurement is carried out to allow for 'noise' in the vibration response to be filtered out of the final readings. This is described in ISO 10817-1: Rotating Shaft Vibration Measuring Systems – Part 1: Relative and absolute sensing of radial vibration, under section 5.1.1.

- Start-up

The start-up of the SFP's are carried out after the unit is on load and the EFP's are in service. The EFP's are then brought out of service gradually and the SFP's are introduced in the process. This is done when there is adequate steam to supply the BFPT which is then used to drive the SFP. First the SFP is in leak-off mode to allow the pump to start up as the EFP's are brought out of service. The discharge from the SFP is open and the leak-off is closed to allow the pump to feed forwards. During this operation, the expected vibrations are higher than during running conditions, though are still within the trip and alarm values as described in ISO 10816-7 section 5.2 a) category 1 pumps and Zone B.

- Leak-off

Leak-off mode of the pumps is during start-up of the pumps and shut down of the pumps. This is to allow the transition from feeding into the process to stopping and from starting up to feeding forward. As described above, the vibrations expected during this mode is higher than usual, though should be within the limits as described in ISO 10816-7: section 5.2 a) Category 1 pumps and Zone B.

- Normal Operation

During normal operation, the pump vibrations are expected to stay consistent and have alarms and trips for high vibration according to ISO 10816-7: section 5.2 a) Category 1 pumps and Zone B. The leak-off valves are closed, and the discharge valve is open.

- Shutdown

During shut down of the pumps, the discharge valve closes and simultaneously the leak-off valve opens to allow the pump to stop feeding into the process and after the discharge is fully closed, the pump then proceeds to safe shut down. During shut down, as described above, the vibrations expected are higher than usual though also fall within the trip and alarm limits as described in ISO 10816-7: section 5.2 a) Category 1 Pumps and Zone B.

CONTROLLED DISCLOSURE

APPENDIX I: EFP OPERATING PHILOSOPHY

Process Description:

The two EFPs, each capable of delivering 50% MCR, are used to deliver water into the boiler during start-up and shut down, as well as for operational redundancy when for when the main SFP is not in operation or fails. The 50% pump units are also called start up units and are used as such. The 2 x 50% pump units are driven by electric motors. (As described in LBT00153 Operating Technical Specification Turbine Plant Rev 00)

Currently the EFP's trips for high vibrations are disabled due to the multiple trips reducing the availability of these pumps. The effect of the high vibrations for during start-up was considered by the EFP OEM and was found to be negligible, and hence the requirement for a trip was removed since the current system couldn't cater for the higher vibration limits during start-up.

Operating Modes:

- Pre-commissioning and commissioning

Here the electrical run out of the measurement is carried out to allow for 'noise' in the vibration response to be filtered out of the final readings. This is described in ISO 10817-1: Rotating Shaft Vibration Measuring Systems – Part 1: Relative and absolute sensing of radial vibration, under section 5.1.1.

- Start-up

The start-up of the EFP's are carried out after the unit is off load. The EFP's are brought into service and operate in leak-off mode with the discharge valve closed, and the leak off valve open. During this operation, the expected vibrations are higher than during running conditions. This has in the past gone to trip values and reduced the availability of the pumps. The EFP OEM subsequently inspected the pumps after the high vibrations and found negligible damage due to the higher vibrations on start-up and then recommended a start-up delay on the high vibration trip to allow the pumps. This limit is to be set to 0.9 X the bearing clearance of the pump preferably, or the capability to ignore the initial high vibrations at start-up for 12 seconds with a range of 0-30 seconds to allow for flexibility to adjust for optimum operation.

- Leak-off

Leak-off mode of the pumps is during start-up of the pumps and shut down of the pumps. This is to allow the transition from feeding into the process to stopping and from starting up to feeding forward. As described above, the vibrations expected during this mode is higher than usual, though should be within the limits as described in ISO 10816-7: section 5.2 a) Category 1 pumps and Zone B.

- Normal Operation

During normal operation, the pump vibrations are expected to stay consistent and have alarms and trips for high vibration according to ISO 10816-7: section 5.2 a) Category 1 pumps and Zone B. The leak-off valves are closed, and the discharge valve is open.

- Shutdown

During shut down of the pumps, the discharge valve closes and simultaneously the leak-off valve opens to allow the pump to stop feeding into the process and after the discharge is fully closed, the pump then proceeds to safe shut down. During shut down, as described above, the vibrations expected are higher than usual though also fall within the trip and alarm limits as described in ISO 10816-7: section 5.2 a) Category 1 Pumps and Zone B.

CONTROLLED DISCLOSURE

Table 8: EFP Alarm and Trip Values

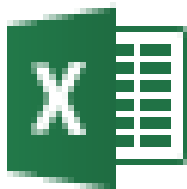
DESCRIPTION	INITIATING DEVICE	ORIGINAL SETPOINT (half peak)	CURRENT SETPOINT (half peak)	REQUIRED SETPOINT (peak to peak)	CURRENT SETUP
EFP A MOTOR VIBRATION NDE	RL01Z042	Alarm > 35 µm	Alarm > 35 µm	Alarm > 140 µm	Vertical Probe
		Trip > 75 µm (3s)		Trip > 170 µm	
EFP A SHAFT VIBRATIONS DE	RL01Z043	Alarm > 35 µm	Alarm > 35 µm	Alarm > 140 µm	Vertical Probe
		Trip > 75 µm (3s)		Trip > 170 µm	
EFP A SHAFT VIBRATIONS NDE	RL01Z044	Alarm > 35 µm	Alarm > 35 µm	Alarm > 140 µm	Vertical Probe
		Trip > 75 µm (3s)		Trip > 170 µm	
EFP B MOTOR VIBRATIONS NDE	RL02Z042	Alarm > 35 µm	Alarm > 35 µm	Alarm > 140 µm	Vertical Probe
		Trip > 75 µm (3s)		Trip > 170 µm	
EFP A SHAFT VIBRATIONS DE	RL02Z043	Alarm > 35 µm	Alarm > 35 µm	Alarm > 140 µm	Vertical Probe
		Trip > 75 µm (3s)		Trip > 170 µm	
EFP A SHAFT VIBRATIONS NDE	RL02Z044	Alarm > 35 µm	Alarm > 35 µm	Alarm > 140 µm	Vertical Probe
		Trip > 75 µm (3s)		Trip > 170 µm	

NOTE: This applies to **all** the modes with the exception of the start-up mode, when the limit is dependent of the clearance of that bearing and the delay is captured in the operating modes section under start-up.

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX J: INSTRUMENTATION SCHEDULE



Instrumentation Schedule.xlsx

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX K: LIMITS OF SUPPLY AND SERVICES



LOSS
DIAGRAMS.xlsm

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX L: FUNCTION INPUT/OUTPUT BLOCK DIAGRAMS



IO BLOCK DIAGRAMS.xlsm

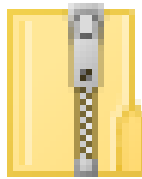
CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX M: TEMPLATES OF TECHNICAL DOCUMENTATION

The project documentation related to the following templates shall contain all relevant information required by the templates:

- (1) 240-56176097 Electrical Cable Schedule Template
- (2) 240-72346360 C&I 220 VAC Load Schedule Consumer per UPS Template
- (3) 240-72350241 C&I Panel Interface List Template
- (4) 240-72345357 24 VDC Load Schedule Consumer Per Battery Charger Template
- (5) 240-72351455 C&I Typical Loop Wiring Diagram Template



TEMPLATES OF TECH DOC.zip

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX N: COMPLIANCE SCHEDULE



COMPLIANCE
SCHEDULE.xlsx

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

APPENDIX H: COMPLIANCE SCHEDULE

Notes:	1. Indicate in Column C with "Yes" or "No" whether the proposed solution is compliant to the corresponding section in the Works		
	2. Any answer besides a Yes is a No		
	3. Where the answer is not Yes, list all and explain/clarify all non-compliances under the corresponding section		
Clause	Item	Compliant (Yes/No)	Comments
4.1	Quality & Performance Requirements		
4.2	Design Standards, Guidelines And Codes		
4.3	Requirements Related To Safety		
4.4	Requirements Related To Availability		
4.5	Requirements Related To Reliability		
4.6	Requirements Related To Maintainability		
4.7	Requirements Related To Technical Documentation		
4.7.1	Training Manuals		
5.2	Work to be Performed and Equipment and Plant to be Provided by the Contractor		
5.2.1	General		
5.2.2	Control and Instrumentation: Condition Monitoring System Design		
5.2.2.1	Data Acquisition System		

Clause	Item	Compliant (Yes/No)	Comments
5.2.2.2	Diagnostic System		
5.2.2.3	Power Distribution		
5.2.2.4	Condition Monitoring System Interface to 3rd party systems		
5.2.3	Process and Mechanical		
5.2.4	Electrical		
5.2.5	Maintenance		
5.2.6	Operating		
5.2.7	Coding and Labelling		
5.2.8	Documentation		
5.2.9	Training		
5.2.10	Removal of Existing Equipment		
6	Execution Requirements		

Clause	Item	Compliant (Yes/No)	Comments
6.1	Basic Engineering		
6.1.1	High Level Engineering Philosophies & Concepts		
6.1.2	Plant Investigation Work		
6.1.3	Scope definition		
6.1.4	Interfaces to Other Systems		
6.1.5	OEM Requirements in Basic Engineering		
6.1.6	Basic Engineering Design Freeze		
6.2	DETAILED ENGINEERING		
6.2.1	OEM Requirements in Detailed Engineering		
6.2.2	Detailed Engineering Design Freeze		
6.3	MANUFACTURING		
6.3.1	FAT		

Clause	Item	Compliant (Yes/No)	Comments
6.4	PROCUREMENT, ERECTION & INSTALLATION		
6.4.1	Pre-Outage Installation Work		
6.4.2	Site Integration Test (SIT)		
6.4.3	Cold Commissioning		
6.4.4	Hot Commissioning		
6.5	Acceptance Criteria		
6.6	“AS BUILT” DOCUMENTATION PACKAGE		

APPENDIX O: EXISTING INTERFACE TO AUTOMATION AND PROTECTION SYSTEM TERMINATION

Present AKZ	Existing Long Description	Original AKZ (Where different)	Siemens Interface					
			Alarm		Protection		Interlock	
			Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal
SB11Z001	TURBINE ABSOLUTE EXPANSION POSITION		N/A	N/A	N/A	N/A	N/A	N/A
SB11Z021	HP TURBINE FRONT BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SB11Z011	HP TURBINE FRONT DIFF. EXPANSION		HA05A	C967 B08	HP02	B99 CH3	HB06A	E975 Z2
SX10Z001	HP TURBINE FRONT SHAFT VIBRATION X PROBE	SB11Z043	HA05A	C967 B24	HP02	B107 CH1	JT04	X11:A7
SY10Z001	HP TURBINE FRONT SHAFT VIBRATION Y PROBE							
SB12Z038	TURBINE END THRUST		N/A	N/A	N/A	N/A	N/A	N/A
SB12Z039	TURBINE END THRUST		N/A	N/A	N/A	N/A	N/A	N/A
SB12Z040	TURBINE SHAFT POSITION		HA05A	TBA	HP02	B115 CH3	HB06A	D983 D8
SB12Z041	TURBINE SHAFT POSITION		N/A	N/A	N/A	N/A	N/A	N/A
SB12Z021	BEARING VIBRATION HP TURBINE REAR/IP TURBINE FRONT		N/A	N/A	N/A	N/A	N/A	N/A
SX20Z001	IP TURBINE FRONT SHAFT VIBRATION X PROBE	SB12Z043	HA05A	C967 B26	HP02	B123 CH1	JT04	X11:B17
SY20Z001	IP TURBINE FRONT SHAFT VIBRATION Y PROBE							
SB13Z021	IP TURBINE REAR BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Present AKZ	Existing Long Description	Original AKZ (Where different)	Siemens Interface					
			Alarm		Protection		Interlock	
			Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal
SB13Z011	IP TURBINE REAR DIFF. EXPANSION		HA05A	C967 B10	HP02	B123 CH3	HB06A	E975 Z4
SB16Z021	LP TURBINE 2 FRONT BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SX40Z001	LP TURBINE 2 FRONT SHAFT VIBRATION X PROBE	SB16Z043	HA05A	C967 D30	HP02	B139 CH2	JT04	X11:D17
SY40Z001	LP TURBINE 2 FRONT SHAFT VIBRATION Y PROBE							
SB17Z021	LP TURBINE 2 REAR BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SB14Z021	LP TURBINE FRONT BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SX30Z001	LP TURBINE FRONT SHAFT VIBRATION X PROBE	SB14Z043	HA05A	C967 D28	HP02	B131 CH2	JT04	X11:C17
SY30Z001	LP TURBINE FRONT SHAFT VIBRATION Y PROBE							
SB15Z021	LP TURBINE REAR BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SB17Z011	LP TURBINE REAR DIFF. EXPANSION		HA05A	C967 B12	HP02	B147 CH1	HB06A	E975 Z6
SO10Y014	TURBINE CENTRELINE KEY PHASOR		N/A	N/A	N/A	N/A	N/A	N/A
SQ13Z021	EXCITER FRONT BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SQ14Z021	EXCITER REAR BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SQ11Z021	GEN FRONT BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Present AKZ	Existing Long Description	Original AKZ (Where different)	Siemens Interface					
			Alarm		Protection		Interlock	
			Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal
SX50Z001	GEN FRONT SHAFT VIBRATION X PROBE	SQ11Z043	HA05A	C967 B32	HP02	TBA	JT04	X11:E17
SY50Z001	GEN FRONT SHAFT VIBRATION Y PROBE							
SQ12Z021	GEN REAR BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SX50Z002	GEN REAR SHAFT VIBRATION X PROBE	SQ12Z043	HA05A	C967 D18	HP02	TBA	JT04	X11:F17
SY50Z002	GEN REAR SHAFT VIBRATION Y PROBE							
TBA	EFP A MOTOR DE RELATIVE SHAFT VIBRATION X PROBE	RL01Z043	HA04B	B967 Z30	TBA	TBA	N/A	N/A
TBA	EFP A MOTOR DE RELATIVE SHAFT VIBRATION Y PROBE							
RL01Z042	EFP A MOTOR NDE BEARING VIBRATION		HA04B	B967 Z28	N/A	N/A	N/A	N/A
TBA	EFP A MOTOR NDE RELATIVE SHAFT VIBRATION X PROBE	RL01Z044	HA04B	B967 Z32	TBA	TBA	N/A	N/A
TBA	EFP A MOTOR NDE RELATIVE SHAFT VIBRATION Y PROBE							
TBA	EFP B MOTOR DE RELATIVE SHAFT VIBRATION X PROBE	RL02Z043	HA04C	B967 Z30	TBA	TBA	N/A	N/A

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Present AKZ	Existing Long Description	Original AKZ (Where different)	Siemens Interface					
			Alarm		Protection		Interlock	
			Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal
TBA	EFP B MOTOR DE RELATIVE SHAFT VIBRATION Y PROBE							
RL02Z042	EFP B MOTOR NDE BEARING VIBRATION		HA04C	B967 Z28	N/A	N/A	N/A	N/A
TBA	EFP B MOTOR NDE RELATIVE SHAFT VIBRATION X PROBE	RL02Z044	HA04C	B967 Z32	TBA	TBA	N/A	N/A
TBA	EFP B MOTOR NDE RELATIVE SHAFT VIBRATION Y PROBE							
SX03Z022	BFPT DE RELATIVE SHAFT VIBRATION X PROBE	SB51Z043	HB05	B975 B18	HP03	C027 CH3	N/A	N/A
SY03Z022	BFPT DE RELATIVE SHAFT VIBRATION Y PROBE							
SB51Z021	BFPT FRONT BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SX03Z021	BFPT NDE RELATIVE SHAFT VIBRATION X PROBE	SB52Z043	HB05	B975 B20	HP03	C035 CH3	N/A	N/A
SY03Z021	BFPT NDE RELATIVE SHAFT VIBRATION Y PROBE							
SB52Z021	BFPT REAR BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
SB51Z040	BFPT SHAFT POSITION		HP05B	TBA	HP03	C027 CH2	N/A	N/A

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.

Present AKZ	Existing Long Description	Original AKZ (Where different)	Siemens Interface					
			Alarm		Protection		Interlock	
			Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal	Existing Cabinet AKZ	Terminal
SX03Z012	SFP DE RELATIVE SHAFT VIBRATION X PROBE	RL03Z043	HB05	B975 Z30	N/A	N/A	N/A	N/A
SY03Z012	SFP DE RELATIVE SHAFT VIBRATION Y PROBE							
TBA	SFP FRONT BEARING VIBRATION		N/A	N/A	N/A	N/A	N/A	N/A
RL03Y001	SFP KEY PHASOR		N/A	N/A	N/A	N/A	N/A	N/A

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the database.