Eskom	Scope of Works	Engineering

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PART 3: SCOPE OF WORK

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1 Description of the *works*

1.1 Executive overview

a) Arnot Power Station is a coal fired power station located in the Mpumalanga Province, and it comprises of six Turbine-Generator sets, each capable of generating 400MW to the Eskom National grid. The control system used for all operation, control and protection functions is the ABB Distributed Control System (DCS), P14/P13 versions.

b) The Data Acquisition System (DAS) performs all the online vibration monitoring functions on the Main Turbine (MT), Electrical Feed Pumps (EFP) A&B and the Steam Feed Pump Turbine (SFPT) at Arnot Power Station.

c) The DAS monitors desired vibration parameters on a continuous basis, with pre-set alarm and trip conditions configured within the ABB DCS system.

d) The DCS interface to the Protection System, where protection trip commands are activated accordingly and trips the rotating machinery (MT, EFP's and SFPT).

e) In the case of the MT, EFP's and SFPT, the tripping functions of the rotating machine are performed within the ABB DCS system.

f) The DAS consists of the SKF M800 (Units 1, 2 & 6) and VM600 (Units 3, 4 & 5) systems, while the SKF M800 have reached its end of life and have been declared obsolete by the Original Equipment Manufacturer (OEM).

g) This *Scope of Works* covers an installation of a fully functional DAS and replacement of a full set of a unit field instruments, junction boxes, cables, and drives.

h) The *Contractor* designs, procures, supplies and delivers complete Parker Meggitt VM600 Data Acquisition Systems for Units 1, 2 and 6, including the required racks, I/O modules, power supply modules, communication interfaces, spare capacity, software licences and associated accessories.

The equipment shall be procured through the Original Equipment Manufacturer (OEM) or an OEM-authorised supply channel. The *Contractor* provides all remaining equipment, materials, services and *works* required to deliver a fully functional Vibration Monitoring System.

i) The *Contractor* carries out the full design, engineering, installation, integration, configuration, and commissioning of the VM600 Data Acquisition System (DAS) and decommissions the existing obsolete M800 system on Unit 1, 2 and 6, which forms part of the main scope of the *works* under this contract.

j) The *Contractor* performs commissioning of all functions relating to the Vibration Monitoring System, testing all required functionality between the VMS to DCS interface and from the DCS to the protection system interface. This involves the full integration of the VM600 to the existing ABB DCS, Bently System 1 Orbit 60 series and SKF field instrumentation (Vibrations, thrust, eccentricity and differential expansion).

k) There exists an interface between Information Technology (IT) and Operational Technology (OT). This takes the form of the VMS interfacing to the Eskom LAN for remote diagnostic capability and for connection to Rotek Engineering for remote monitoring. The *Contractor* is responsible for this scope of work and provides all necessary infrastructures to meet the functional requirements of the interface. The Vibration Monitoring System is used for the monitoring, engineering and diagnostic functions and is installed for each of the following plant areas by the *Contractor*:

- Units 1, 2 and 6 – The existing SKF M800 Vibration Monitoring Systems are replaced with Parker Meggitt VM600 systems. The *Contractor* procures, supplies, installs, configures, integrates, tests and commissions the complete VM600 DAS, including all racks, I/O modules, field instrumentation, accessories, cabling, power distribution equipment, network

infrastructure, software and associated *works* required to deliver a fully functional Vibration Monitoring System.

- Main Turbine (MT) – The obsolete VMS is replaced completely by the *Contractor*, including all MT field instrumentation; that is for differential expansion, eccentricity, vibrations and thrust)
- Electrical Feed Pump 1 (EFP1) – The *Contractor* provides, installs and integrates all new field equipment for the Vibration Monitoring System and bears full responsibility for system performance and compliance with the Works Information.
- Electrical Feed Pump 2 (EFP2) – The *Contractor* provides, installs and integrates all new field equipment for the Vibration Monitoring System and bears full responsibility for system performance and compliance with the Works Information..
- Steam Feed Pump Turbine (SFPT) – The *Contractor* provides, installs and integrates all new field equipment for the Vibration Monitoring System and bears full responsibility for system performance and compliance with the Works Information..

The diagram below indicates the signal interfaces for the MT, SFPT, EFP1 and EFP2 with the VMS.

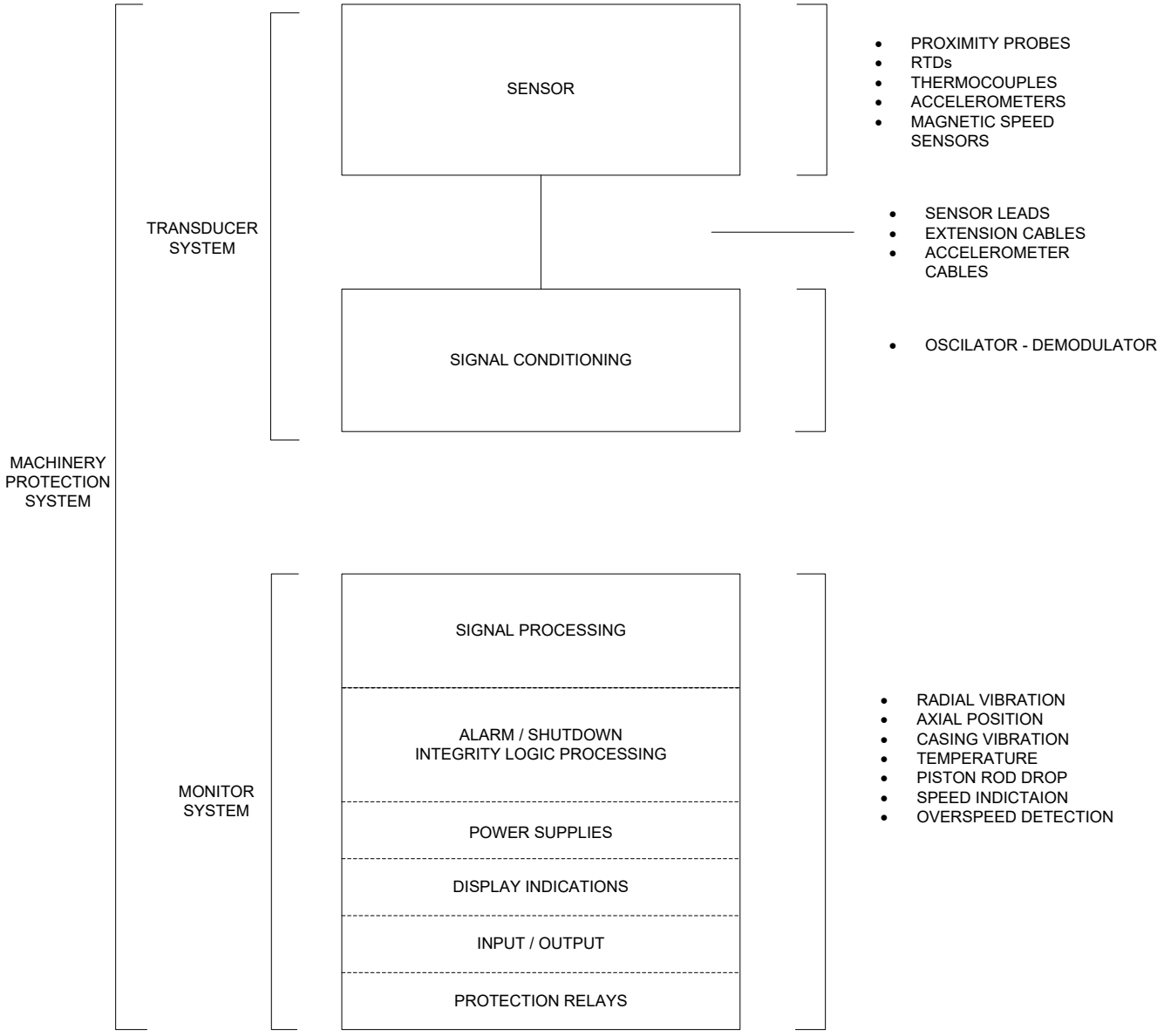

Figure 1: VMS Signal Layout

1.2 *Scope of work*

1.2.1 *Employer*'s objectives and purpose of the *works*

The *Employer's* objective is to address the obsolescence of the Vibration Monitoring System for the Main Turbine (MT), Electrical Feed Pumps (EFP) and Steam Feed Pump Turbine (SFPT) in order to improve the reliability, availability and efficiency of Units 1, 2 and 6. The *Contractor* provides a fully functional Vibration Monitoring System in accordance with the Works Information.

a) The *Contractor* designs, engineers, procures, supplies, installs, integrates, tests and commissions new VM600 Vibration Monitoring Systems for Units 1, 2 and 6 and decommissions the existing SKF M800 systems in accordance with this specification.

b) The *Contractor* performs factory acceptance testing, delivery, off-loading at Site, storage, optimisation and provides complete and accurate as-built documentation.

c) The *Contractor* reviews, verifies and investigates all existing drawings against the physical plant installation and updates all as-built drawings prior to decommissioning of the existing system.

d) The *Contractor* installs new field instrumentation meeting the functional and performance requirements for vibration monitoring on the Main Turbine, two Electrical Feed Pumps and the Steam Feed Pump Turbine on Units 1, 2 and 6.

e) The *Contractor* completes rack wiring and system configuration prior to interfacing with the existing panels in the EDS rooms and plans and executes the Works to minimise outage duration and to allow installation, integration and commissioning during short-duration opportunity outages.

f) The *Contractor* decommissions field cabling up to the junction boxes, identifies and labels all decommissioned power and signal cabling, and updates configuration management databases as well as power and signal flow drawings.

g) The *Contractor* integrates the Vibration Monitoring System with the existing ABB Distributed Control System and performs commissioning and interface testing of all vibration monitoring, alarming and protection functions as they interface with the Turbine Protection System via the DCS.

h) The *Contractor* provides correctly configured, calibrated and tested field instrumentation inputs to enable the ABB Distributed Control System to trip the Main Turbine, Electrical Feed Pumps and Steam Feed Pump Turbine in accordance with the Arnot turbine protection philosophy, with ABB South Africa implementing all protection and trip logic within the ABB Distributed Control System under the existing maintenance and engineering contract.

i) The *Contractor* networks the Vibration Monitoring System to the Eskom LAN to enable vibration system diagnostics, monitoring and remote access, including remote diagnostic capability for Rotek Engineering, and interfaces with the existing Baker Hughes Orbit 60 series condition monitoring system.

j) The *Contractor* provides, installs, connects and commissions all electrical works required to deliver a fully functional Vibration Monitoring System, including power distribution from the *Employer*-provided power supplies, network connectivity to the Eskom LAN, and configuration of remote diagnostic monitoring capability for authorised engineers and Rotek Engineering.

k) The *Contractor* designs, supplies, installs and terminates all electrical cabling, circuit breakers, protection devices and accessories from the *Employer*-provided power supplies to all Vibration Monitoring System equipment to ensure a fully functional and compliant power distribution arrangement.

l) The *Contractor* configures all field instrumentation in accordance with the *Employer's* turbine protection and monitoring requirements and ensures that, in the static condition, all instruments read zero and that all calibration is performed correctly and verified.

m) The *Contractor* provides formal training to Arnot Power Station personnel in the operation, diagnostics, configuration and maintenance of the Vibration Monitoring System.

n) The *Contractor* ensures that the complete design for all applicable disciplines is performed and verified by ECSA-registered professional engineers or technologists in accordance with statutory and Employer requirements.

o) The *Contractor* achieves minimum measurement accuracy requirements of ±2% for vibration amplitude, ±2% for phase, ±1 rpm for speed and ±1% for all process variables expressed in standard engineering units.

p) The *Contractor* ensures that the machinery protection system interfaces with rack-mounted displays, dedicated server-based operator displays, plant control system display stations and authorised remote access platforms.

q) The *Contractor* provides and configures an independent rack interface module to interface external servers for software configuration of monitoring modules, relay modules, protection parameters and rack communications, and to enable the transfer of static, steady-state and transient vibration data from the Vibration Monitoring System to the Machinery and Asset Condition Monitoring system.

r) The *Contractor* ensures that the VM600 Vibration Monitoring System interfaces correctly and reliably with ABB P13 and P14 DCS, the Baker Hughes Orbit 60 series system, TDXnet/Bentley system 1 and SKF field instrumentation.

1.2.2 Normative

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

[1] ISO 9001 - Quality Management Systems.

[2] 240-4332798 - Engineering Policy

[3] 474-34 - Project Engineering Change Procedure

[4] 240-53114002 - Engineering Change Management Procedure

[5] 240-53113685 - Design Review Procedure

[6] 36-618, Definition of Vibration Monitoring and Diagnostic System for Large Steam Turbine Centreline and Boiler Feed Pump Turbines on Eskom Power Stations

[7] API Standard 670, Fourth Edition, December 2000, Reaffirmed 2003, Machinery Protection Systems.

[8] API Standard 613, Fifth Addition, February 2003, Special Purpose Gear Units for Petroleum, Chemical & Gas Industry.

[9] ISO 10816- International Standard, Mechanical Vibration – Evaluation of Machine Vibration by Measurements on Non-Rotating Parts.

[10] ISO 10817-1 International Standard, Rotating Shaft Vibration Measuring Systems.

[11] ISO 7919 – International Standard, Mechanical Vibration of Non-Reciprocating Machines – Measurements on Rotating Shafts and Evaluation Criteria. Machinery Analysis and Monitoring, John S. Mitchell

[12] 240-56030575 - Steam Turbine Protection Functions – Requirements and Control Standard

[13] SANS IEC 60034-14, Rotating Electrical Machines – Part 14: Mechanical Vibration of Certain Machines with Shaft Heights 56 Mm and Higher – Measurement, Evaluation and Limits of The Vibration

[14] 240-56356396 - Earthing and Lighting Protection

[15] 240-55714363 – Coal Fired Power Stations Lighting and Small Power Installation Standard.

[16] SANS 0142-1 - The Wiring Of Premises Part 1: Low-Voltage Installation.

[17] 240-170000614 Cyber Security Controls Guide for Physical Security Systems

[18] 559-577223024 Generation Cyber Security Standard for Operational Technology

[19] 240-56355815 Control and Instrumentation Field Enclosures and Cable Termination Standard

[20] 240-56355754 – Field Instrument Installation Standard

1.2.3 Definitions

Terminology	Interpretation
Common Network	The network through which individual unit VMS systems communicate with the common vibration monitoring system
Computer Backup	A full backup of all boot configurations, operating systems and other installed software packages such that the computer concerned can be restored to a fully functioning state as of the date of the backup capture
Control System	The control system consists of the Operating system, Unit Engineering system, Process Automation system, Protection Automation system, Operating & Engineering network, Automation Network, Unit network management system, Unit User management system and Interfaces to 3rd Party systems that are specific to a particular unit
Cyber Security	Security measures implemented to protect the Arnot vibration Monitoring system and all associated components from unauthorised access or attack
C&I Rooms	The rooms used to house the Units 1 – 6 control system and vibration Monitoring system
Engineering System	The system via which the Vibration Monitoring System is fully engineered, maintained and configured
Engineering Tools	All diagnostic, maintenance, configuration and engineering software for every aspect of the Vibration Monitoring system. Engineering tools also include the firmware management software and any software used during design of the system
Engineering Workstation	The single human interface via which the relevant Unit's Vibration Monitoring system engineering tools are accessed with the specified number of operating display units and pointing devices
Field Cabling	All the cabling between the field equipment and first junction and/or splitter box
Field Equipment	Vibration Probes, Junction Boxes.
Functional Logic	The control logic – inclusive of all sequence control, analogue control logic, interlocks, etc. - that is contained in the automation system(s)
Functional Logic Diagrams	Diagrams depicting systems in circuit diagrams using functional logic symbols.
HMI/GUI	The human interface used for the operation and monitoring of a particular unit's C&I and vibration Monitoring system
KVM Module	A device or set of devices that allows the input/output devices of a workstation to be remotely accessed
Key Phasor	A gap-to-voltage device that consists of a proximity probe, an extension cable, and an oscillator-demodulator and is used to sense a once per revolution mark

Machinery Protection System	Consists of the transducer system, signal cables, the monitor system, all necessary housings and mounting fixtures, and documentation
Managed Network Switches	Switches that can be managed by one or more methods to modify the operation of the switches
Network Cabling	All the cabling that forms part of the automation network, operating & engineering network and common network
OEM	The OEM refers to the original equipment manufacturer. Within the context VMS project, it includes the DCS Manufacturer, Electrical OEM's (Power Distribution), VMS manufacturer and also the OEM's of the main turbine, boiler feed pump turbine and EFP's and is clarified in context of the work.
OEM best practices	Includes all of the OEM standards, best practices, guidelines and QA practices
Operator Workstation	The primary interface of the operating plant personnel via which the HMI is accessed with the specified number of operating display units and pointing devices
Proximity probe	A non-contacting sensor that consists of a tip, a probe body, an integral coaxial cable, and a connector and is used to translate distance (gap) to voltage
Plant Information	This includes all information from Arnot Power Station
Power Supply Cabling	All the cabling required to power field equipment
Radial shaft vibration	Radial shaft vibration the vibratory motion of the machine shaft in a direction perpendicular to the shaft longitudinal axis
Specification	The document/s forming part of the contract in which are described the methods of executing the various items of work to be done, and the nature and quality of the materials to be supplied and includes technical schedules and drawings attached thereto as well as all samples and patterns
Trunking	A rigid structure supporting a number of automation network cables
Trunk Cabling	All the cabling between the junction boxes or groupings of field cables and the Vibration Monitoring System.

1.2.4 Abbreviations

F	**Description**
ABB	Asea Brown Boveri
AC	Alternating Current
C&I	Control and Instrumentation
DCS	Distributed Control System
DE	Drive End
DMS	Document Management System
DMZ	De-Militarised Zone
EFP	Electric Feed Pump
ESP	Electronic Security Perimeter
FAT	Factory Acceptance Test
GUI	Graphical User Interface
HMI	Human Machine Interface
HVAC	Heating, Ventilation and Air Conditioning
KKS	Power Plant Coding System
LAN	Local Area Network
LOSS	Limits of Supply and Services
LV	Low Voltage

MCB	Main Circuit Breaker
MT	Main Turbine
NDE	Non-Drive End
OAT	Operational Acceptance Test
OEM	Original Equipment Manufacturer
OHSA	Occupational Health and Safety Act
OS	Operating Workstation
PCM	Process Control Manual
PF	Pulverised fuel
PFC	Potential Free Contacts
PS	Power Station
PTW	Permit To Work
PIS	Plant Information System
PPE	Personal Protective Equipment
QA	Quality Assurance
QAP	Quality Assurance Programme
QC	Quality Control
QMP	Quality Management Programme
RAM	Reliability, Availability and Maintainability
RH	Right Hand
ROC	Required Operational Capability
RPM	Rotation Per Minute
RAM	Reliability, Availability and Maintainability
RH	Right Hand
ROC	Required Operational Capability
RPM	Rotation Per Minute
SANS	South African National Standard
SAT	Site Acceptance Test
SER	Station Electrical Reticulation
SFP	Steam Feed Pump Turbine
SHEQ	Safety Health Environmental and Quality
SFPT	Steam Feed Pump Turbine
SI	System Integration
SIT	Site Integration Test
SRD	Stakeholders Requirements Definition
TPS	Turbine Protection System
UPS	220V Uninterruptible Power Supply
UTM	Unified Threat Manager
VDSS	Vendor Document Submission Schedule
VMS	Vibration Monitoring System
UPS	Uninterruptible Power Supply
VEL	Velocity
VERT	Vertical
VIBR	Vibration
VMS	Vibration Monitoring System

1.2.5 Execution method for outage and non-outage work

a) The duration of the plant outages is contained in the *Employer*'s outage schedule, as amended from time to time due to production constraints.

b) The *Contractor* shall ensure that all preparatory work as agreed with the *Project Manager* prior to the outages to minimise the risk of impact to the outage and hence delaying the return to service of the unit.

c) All power down/power up requirements within the outages are co-ordinated with the *Project Manager* to minimise the impact on the outages and is arranged by the *Contractor* prior to these outages.

d) Any pre-outage preparatory work carried out on a running unit does not jeopardise the operation or availability of the unit. A thorough risk assessment on all activities, in as far as potential impact on the unit operation and availability is performed and documented for acceptance by the *Project Manager*, prior to the start of the work.

e) The *Contractor* recognizes that the Outage Dates provided in **Section 6.6, Outage Dates"** may change. No compensation event is lodged if the *Employer* issues a warning 60 days before the start of the outage on the first unit and 6 weeks before the start on the subsequent 2 units. Should the outage dates exceed the overall completion date as stipulated in the Contract Data with more than 6 months; a compensation event will be raised.

f) The *Contractor* performs the engineering design activities in accordance with the phases described below. All activity starts and finish dates for each phase and stage are shown in the Accepted Programme.

g) The *Contractor* plans, prepares and sequences the *Works* such that the full scope of work, or clearly defined portions of the scope of work, can be executed during opportunity outages that are of sufficient duration, whether or not such outages form part of the planned maintenance outage schedule.

h) Where an opportunity outage arises and the *Project Manager* confirms that the duration and plant conditions are suitable, the *Contractor* executes the applicable scope of work, or part thereof, in accordance with the *Works Information,* provided that safety, quality and plant integrity requirements are met.

i) The *Contractor* structures the Accepted Programme, work breakdown structure and execution methodology to allow modular, phased or partial completion of the *Works* during opportunity outages without compromising system integrity, design compliance or final commissioning requirements.

j) Execution of work during opportunity outages does not relieve the *Contractor* of responsibility for full compliance with the Works Information, nor does it constitute a change to the scope of work, unless instructed by the Project Manager in accordance with the Contract.

k) *Execution during planned and opportunity outages:* The *Contractor* plans and executes the Works during planned maintenance outages and suitable opportunity outages, including unplanned outages arising from plant failures or other operational requirements of the *Employer*.

l) Due to the obsolescence of the existing SKF M800 Data Acquisition Systems and the associated risk of equipment failure, the *Contractor* maintains the necessary readiness and flexibility to mobilise and execute the applicable Works whenever the *Employer* identifies a suitable outage opportunity.

m) The *Contractor* structures the engineering, procurement, installation and commissioning activities to allow the Works to be executed in separate sections, depending on the duration of the outage and the operational requirements of the *Employer*. Such sections may include:

   i. replacement, configuration, integration, testing and commissioning of the VM600 Data Acquisition System only, while retaining the existing field instrumentation where technically suitable;

   ii. replacement, installation, testing and commissioning of the field instrumentation and associated equipment only, while retaining the existing Data Acquisition System until its replacement can be undertaken;

   iii. simultaneous replacement of the Data Acquisition System and the associated field instrumentation, including all necessary integration, testing and commissioning; and

   iv. execution of any other clearly defined portion of the Works that can be safely completed within the available outage duration without compromising plant protection, reliability or operational requirements.

n) The *Contractor* ensures that engineering designs, procurement activities, equipment delivery, configuration, installation preparations, resources and specialist OEM support are planned to enable execution of the Works during such outage opportunities.

o) Where the *Employer* identifies a suitable outage opportunity, the *Project Manager* notifies the *Contractor* and instructs the applicable section of the Works to be executed, subject to the agreed mobilisation arrangements, the availability of the required equipment, accepted work procedures and plant safety requirements.

p) The *Contractor* mobilises the necessary personnel, equipment, tools and specialist support within the mobilisation period stated in the *Contractor's* agreed mobilisation and availability plan and executes the instructed Works within the available outage window.

q) Where only a portion of the Works is executed, the *Contractor* ensures that the remaining equipment and interfaces are left in a safe, operational and maintainable condition, with all applicable monitoring, alarming and machinery protection functions verified before the affected plant is returned to service.

r) Execution of the Works in separate sections or during opportunity outages does not relieve the *Contractor* of responsibility for the complete scope, final system integration, testing, commissioning and compliance with the Works Information.

s) *Contractor mobilisation and availability:* The *Contractor* submits with its tender a proposed mobilisation and availability plan demonstrating its ability to respond to planned and unplanned outage opportunities, including short-notice outages arising from plant failures.

t) The proposed plan indicates the *Contractor's* availability arrangements, notification acknowledgement times, mobilisation periods, availability of personnel, equipment and specialist OEM support, and the anticipated time required to commence and complete each section of the Works.

u) The *Contractor* demonstrates its ability to execute the Works in separate sections, including replacement of the Data Acquisition System only, replacement of field instrumentation only, or simultaneous replacement of both, depending on the available outage duration and plant conditions.

v) The proposed plan identifies any dependencies, limitations or conditions affecting mobilisation and execution, including equipment availability, procurement lead times and subcontracted specialist support.

w) The proposed mobilisation and availability arrangements are subject to review and agreement with the *Employer* and, once agreed, form part of the *Contractor's* execution plan and contractual commitments and are reflected in the *Accepted Programme*.

1.2.6 Investigation phase

a) The *Contractor* together with the *Project Manager* clarifies all project management issues.

b) The *Contractor* validates any documentation provided by the *Employer* for accuracy against the existing installation to enable the detailed engineering and design by the *Contractor* for turbine centre line and feed water pumps plant.

c) The *Contractor* verifies all process and operating philosophy information for the Arnot Power Station Turbine plant system.

d) The *Contractor* verifies all current alarms and philosophy of the Arnot Power Station data acquisition of the turbine centre line and boiler feed water pumps.

e) The *Contractor* benchmarks current plant operations regarding process and control performance and uses this information during the commissioning and acceptance test phases to demonstrate to the *Supervisor* the successful translation of such information into the new data acquisition of the turbine centre line and feed water pumps.

f) The *Contractor* compiles the commissioning procedures and gives particular attention to planning to ensure that outage times are met, and that commissioning of the System is done with no safety, plant damage or plant production losses.

g) The *Contractor* works directly with the *Employer's* personnel, in liaison with the *Project Manager*, for all technical matters.

h) The documentation synopsis and master drawing register (as specified in sections 3.8 "Documentation") is submitted to the *Project Manager* and acceptance is obtained.

i) Before the investigation phase the *Contractor's* supervisor shall be appointed as an authorised supervisor as defined in the Plant Safety Regulations at Arnot Power Station. This requirement for the *Contractor's* supervisor remains until the defects date or the end of the last defect correction period.

1.2.7 System engineering and design phase

a) During this phase the detailed design is done to ensure that all systems and sub-systems form an integrated and consistent whole, including verification of all interfaces, and the ability of these interfaces to create seamless connections to all systems.

b) The *Contractor* does not start on any system-specific phases until this phase is completed, i.e. design freeze is obtained following technical clarification with acceptance by the *Project Manager*.

c) In this phase all ground rules are determined, by the *Contractor* and agreed with the *Project Manager* for:

- design procedures;
- quality requirements;
- conventions;
- descriptions;
- symbols;
- representation of information in different categories and on the relevant media;
- the method of finalising the power supply and related aspects;
- process operating and control philosophies; supervisory control; and
- Information sharing and alarming philosophies.

d) All functional and performance requirements are translated, by the *Contractor*, into a conceptual design which the *Contractor* submits to the *Project Manager* for acceptance, before proceeding with the design part of this phase. Overall concepts are checked for validity and refined by the *Contractor.*

e) The *Contractor* develops with the *Employer* an alarm philosophy, which will define the criteria that must be adhered to in defining the respective alarms.

f) During the design, all functional and performance requirements are translated into specific hardware and software designs.

g) On Completion of the system engineering and design phase, the *Contractor* presents the complete system design and the detail control, operating, alarming and information sharing philosophies to the *Project Manager* for acceptance. This is performed during formal clarification meetings arranged and minuted by the *Contractor,* as shown in the Accepted Programme.

h) Assistance to the *Project Manager* for this review and acceptance process is provided by the *Employer* and the *Contractor* ensures that these *Employer* activities are planned and shown in the Accepted Programme.

i) The *Contractor* supplies three sets of the system engineering and design stage documentation the *Project Manager* for acceptance at least 15 working days prior to the start of the technical clarification discussions, as shown in the Accepted Programme.

j) The system engineering and design stage documentation is prepared in conformity with the agreed documentation synopsis.

k) Once design freeze, as shown in the Accepted Programme, is obtained and the engineering concepts are accepted by *Project Manager*, the *Contractor* may start with the design.

1.2.8 Technical clarification stage

a) During this stage the *Contractor* clarifies all technical and related issues with the *Project Manager* to enable the *Contractor* to proceed with fabrication of the equipment following design freeze.

b) The *Project Manager* is presented with the design and philosophy information for *Employer* review, approval and finalisation at the onset of this project stage, as shown in the Accepted Programme. This includes:

- System functional and performance specifications;
- Detail control and operating philosophies;
- Primary devices
- Cabling;
- Disaster recovery facilities;
- Verification of databases;
- Process servers;
- Engineering system/station;
- Integrated forward documentation system;
- Quality assurance and quality control measures and methodologies;
- Design methodologies & procedures;
- Interfacing and communication specifications;
- Interfacing to field equipment;
- Interfacing to all third party systems.
- All hardware and software interface specifications.

c) Documented proposals of the factory acceptance testing (FAT), installation and commissioning, Site integration testing (SIT), Site acceptance testing (SAT) of the System functions and performance as well as the plant process operating and performance, operational testing.

d) Documented proposals of engineering, maintenance and operating documentation

e) Documented proposals of engineering, maintenance and operating training manuals

f) Documented proposals for training, evaluation and accreditation of the *Employer*'s operators, in compliance with the *Employer*'s standards for operator accreditation.

g) Project phasing, resources to meet availability requirements.

h) Commissioning strategies and methodologies.

i) Design of the repair solution for making good of areas affected by decommissioning of old equipment.

j) Documented proposal for a procedure to maintain the same hardware and software versions for all Plant and Materials supplied as part of the works

k) The drafts (three sets) of all documentation for technical clarification are submitted to the Project Manager at least 15 working days prior to the technical clarification meeting and it is shown in the Accepted Programme.

l) The *Contractor* identifies and gathers any information and data required for the design. Where the information required is not available the Contractor collects from other sources or alternatively, generates the information.

m) The documentation management system and cabling management system is submitted by the *Contractor* to the *Project Manager* for his acceptance.

n) The *Contractor* submits the format, content and layout of all documents supplied as part of the works, to the *Project Manager* for his acceptance.

o) Inspection checklists and activity certification documents relating to format and content is submitted to the *Project Manager* for his acceptance.

1.2.9 Concept change over strategy.

a) The approach is that the minimum amount of the data acquisition and main feed water pumps systems to be de-commissioned once the unit is off.

b) Before taking any plant out of service all decommissioning requirements must be clearly understood and accepted by engineer and *Project Manager*.

c) An inventory list of all cabling, field instruments, primary devices and acquisition system.

d) All new equipment will be installed and cabling to be re-route in parallel with all the works.

e) Prior to commissioning, the de-commissioning inventory list and drawings will be used for cold commissioning and then leading to hot commission.

1.2.10 Design Freeze stage

a) In this stage the information from the technical clarification stage is submitted to the *Project Manager* and his acceptance is obtained.

b) The Contractor provides the following documentation within 10 working days of Completion of the technical clarification phase, as shown in the Accepted Programme:

- All documents required, fully describing the functional and physical design of the works.
- As-built specifications for all interfaces, hardware, application software, networks, power supplies, distribution, isolation facilities, cabling and earthing.
- HMI displays, logs, reports templates.
- Process servers and Engineering stations hardware and applications software specifications.
- Control, operating and alarming philosophy documentation.
- Project execution processes, i.e. installation and commissioning procedures and methodology;
- Proposed FAT, SIT, SAT and operational test procedures and methodologies. This covers both the requirements of the process function and performance parameters to be met as well as for the control and indicating functionality and performance.
- QA methodologies.
- Quality control check-sheets and procedures.
- Architecture and engineering functional design specification, which includes the final performance, functionality and equipment specifications of the control and indicating equipment as compiled during the technical clarification phase.
- A summary of the outcome of all the technical clarification meetings.
- During this stage the format and content of all operating, engineering and maintenance manuals and drawings; and operating, engineering and maintenance training manuals is clarified, and *Project Manager* Acceptance is obtained.
- Two first draft copies of operating, maintenance and engineering manuals and drawings are supplied by the Contractor twenty (20) days prior to Completion of the design freeze stage, as shown in the Accepted Programme and *Project Manager* Acceptance is obtained.

c) The *Contractor* obtains *Project Manager* Acceptance of all the system engineering and design phase documentation prior to the commencement of work on the next project phase, as shown in the Accepted Programme.

1.2.11 Production engineering phase

a) During this phase the *Contractor* completes all production engineering. These are the engineering activities that translate the requirements finalised during technical clarification and design freeze into a fully operational system.

b) The following documentation is submitted to the *Project Manager* for acceptance at least fifteen (15) working days prior to factory acceptance testing, as shown in the Accepted Programme:

- Two copies of the design documentation.
- Two copies of the relevant QA and QC documentation.
- Two copies of installation, commissioning and de-commissioning documentation.

c) Three copies of all other production engineering design documentation, prepared in conformity with the system engineering and design phase documentation, are issued by the *Contractor* to the *Project Manager*

for acceptance at least ten (10) working days prior to the commencement of any procurement, fabrication, detailed design or construction, as shown in the Accepted Programme.

1.2.12 Procurement and fabrication stage

a) The *Contractor* performs the proper co-ordination and execution of procurement, inspection, expediting, delivery and QC of all Plant, Materials and Equipment required to Provide the *Works.*

b) The *Contractor* procures the complete VM600 Data Acquisition Systems through the OEM or an OEM-authorised supply channel and ensures the availability of the necessary OEM technical support, configuration software, licences, engineering information and specialist assistance required for installation, integration, testing and commissioning. The *Contractor* includes equipment procurement lead times and OEM support activities in the *Accepted Programme*.

c) The *Contractor* plans procurement, equipment delivery, engineering, configuration and installation preparation to support phased execution of the Works during planned or opportunity outages. The *Contractor* identifies work packages that can be executed independently, including replacement of the VM600 Data Acquisition System, replacement of field instrumentation, or simultaneous replacement of both, and maintains an updated readiness schedule identifying the equipment, resources, OEM support and outage duration required for each work package. The readiness schedule is submitted to the *Project Manager* with each revised programme.

1.2.13 Factory acceptance testing (FAT) and delivery stage

a) Prior to transport of the new data acquisition system, the system undergoes a Factory Acceptance Testing (FAT) at the OEM's, *Contractor's* or an approved specialist testing facility suitable for the required tests, and is witnessed by the *Supervisor* and Others (e.g. the *Employer's* personnel and/or third party inspectorate).

b) With these tests the *Contractor* demonstrates that the new data acquisition Systems meet all the requirements of the Works Information. The *Contractor* submits the results of all tests to the *Supervisor* for acceptance, prior to transport to the working areas.

c) The test procedure is compiled by the *Contractor* and presented to the *Project Manager* or delegate for acceptance during the technical clarification phase and it is shown in the Accepted Programme.

d) All hardware and software are available and fully operational before the FAT commences. Following the FAT, the process control and indicating equipment runs for a continuous period of 120-hours without any failure of hardware, software or functions. All inputs and outputs will be tested beforehand and predefined simulated inputs are used for the tests.

e) The *Contractor* performs a complete functional test of all the control and indicating equipment systems before delivery to Site.

1.2.14 Construction and erection phase.

1.2.14.1 Cabling and system installation stage

This phase involves the following *Contractor* activities:

a) The installation of new cabling as specified in section 3 and any infrastructure required by the design.

b) The installation of the control and indicating system equipment

c) The integration of the equipment with third party systems and field instrumentation.

d) The installation of new field instrumentation, including junction boxes, data acquisition rack and primary field devices.

e) The installation of the control system network infrastructure.

f) The erection and installation of new cubicles/panels and any infrastructure required to house or contain equipment.

g) The erection and installation of any infrastructure required to house or contain the *Contractor's* Equipment, Plant and Materials on Site.

h) The making good of all areas after decommissioning of old equipment.

i) The storage and safekeeping by the *Contractor* of all temporary or expendable materials required for installation.

1.2.14.2 Site integration test (SIT) stage

a) The *Contractor* carries out SIT to ensure the correct performance of the control and indicating equipment's communication networks, management and monitoring. Most importantly, this is performed to ensure safety of plant and personnel, and to ensure compliance with the Works Information before commissioning of any plant commences.

b) The proposed test procedures, together with test dates, are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance during the system engineering and design phase.

c) The final test procedures are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance at least 20 working days prior to the scheduled test date. The *Contractor* shows these dates in the Accepted Programme.

d) The *Contractor* provides all test Equipment for testing the individual modules, the subassemblies and the functional groups for Site testing and commissioning. Records are kept of each SIT in a logbook defining the test to be under taken, time and date of commencement of the test, duration of the test, criteria that need to be met and results obtained of the tests. These records are submitted to the *Project Manager* for acceptance after the Completion of each of the SIT tests. In the event of an error with any test (hardware or software) the fault is notified as a Defect and is analysed by the *Project Manager* and the *Contractor.*

e) The *Project Manager* determines if the Defect is of a minor nature, the *Contractor* is given access to rectify the Defect and the item is re-tested for the full duration. Major Defects such as hardware or software failure on the CIE, communication/control network device or system management server failure, power supply failure, system stall, local or remote I/O communication failure. The *Contractor* rectifies the Defect(s) and re-starts the SIT after proving the corrected Defect by carrying out the appropriate diagnostic tests. Upon Completion of SIT, the control and indicating equipment is deemed available for commissioning.

f) Accreditation of the *Employer's* operators, in compliance with the *Employer's* standards for operator accreditation is confirmed by the *Contractor.*

g) The final update of the *Employer's* existing operator alarm response procedures is submitted to the *Project Manager* for acceptance.

h) Upon Completion of SIT, the new System is deemed available for cold commissioning (functional testing).

1.2.15 Commissioning phase

a) Each new individual system is subjected to this phase.

b) Commissioning is dependent on the plant condition as well as the *Employer*'s production requirements and outage schedule.

c) The *Contractor* confirms the final arrangement with the *Project Manager* at least 10 working days prior to commissioning, as shown in the Accepted Programme.

d) The *Contractor* provides notification to the *Supervisor* two (2) weeks prior to commencement of commissioning and testing, as shown in the Accepted Programme. The *Supervisor* inspects all parts during commissioning and is present at any of the tests performed by the *Contractor*. Should the *Supervisor* waive the witnessing of any tests it does not relieve the *Contractor* of any of his responsibilities.

e) Compliance with the *Works* Information, irrespective of any tests carried out at the manufacturer's facility during manufacture and FAT.

f) All test and calibration Equipment is provided and maintained to the required accuracy by the *Contractor*. The accuracy of test and calibration Equipment is proven to the *Supervisor* with valid certificates by an approved authority and is better than ±0,1%. The type and class of Equipment used is subject to acceptance by the *Supervisor*. During any phase of the testing the *Supervisor* may require that the Equipment be checked and verified by a SANAS (South African National Accreditation System) Calibration Laboratory.

g) The *Contractor* supplies all Equipment and resources needed for testing and commissioning.

h) The *Supervisor* co-ordinates the commissioning of all equipment forming an integral part of the plant being commissioned.

i) In those cases where various components are connected to form an integrated system, the *Contractor* carries the responsibility for the correct functioning and performance of the entire System.

j) In the event of incorrect functioning, the *Contractor* determines the cause and corrects the Defects, if the problem is within Equipment, Plant and Materials of his own supply or he directs the *Employer*'s personnel to correct Defects within the *Employer*'s equipment, in liaison with the *Project Manager*.

k) Where it is not possible to test signal transmission from the field instrument, and the *Supervisor* is in agreement, a simulated signal is injected as far back as possible, and the result verified on the HMI as well as the resultant reaction of the outputs.

l) Analogue inputs are simulated/activated from the field device level through injection of signals via a loop calibration device. The system is proven by the *Contractor* to perform in accordance with the requirements of the *Works* Information, for acceptance by the *Project Manager*. Test certificates are issued for each plant or sub-system tested and proven.

Commissioning documentation requirements:

a) The *Contractor* prepares test documentation as well as the final commissioning procedures.

b) The documents incorporate space for the *Contractor* to enter results of the testing as well as space for both parties to witness that the tests have been conducted according to the mutually agreed test procedures, successfully and meeting the *Works* Information functional and performance requirements.

c) All the documentation, manuals and drawings for the new System are put in place, by the *Contractor*, before the relevant test commences. This documentation is submitted to the *Project Manager* for acceptance at least fifteen (15) working days prior to the start of commissioning and testing, as shown in the Accepted Programme.

d) All documentation is incorporated into the commissioning and testing manuals, with full details on testing methods and procedures.

e) The *Contractor* provides a test certificate down to the individual signal level. The format of this certificate is presented to the *Supervisor* for acceptance prior to its use by the *Contractor*, as shown in the Accepted Programme.

f) The test results in the form of check sheets following each commissioning and test stage is submitted to the *Project Manager* for acceptance as a prerequisite to Completion of the applicable commissioning stage.

1.2.16 Cold commissioning stage

a) The functional tests, performed by the *Contractor*, form part of the cold commissioning of the new System and include the checking of all measurement loops, data acquisition system, sequence controls, binary and analogue signals up to the HMI.

b) The *Contractor* gives special attention to safety aspects, limits used for protection functions or as part of sequence control programmes and position indications of primary control devices.

1.2.17 Hot commissioning stage

a) Before equipment is placed into service the *Contractor* certifies that it is in a suitable and safe condition for acceptance by the *Project Manager*.

b) The *Contractor* performs the commissioning of the new data acquisition, and the verification of all signals is done from the primary elements (field equipment) to the HMI.

c) Assistance for the *Contractor* may be provided for this activity by representatives from the *Employer*'s personnel. The *Contractor* submits a written request to the *Project Manager* for this assistance, two (2) weeks prior to commencement of hot commissioning and it is shown in the Accepted Programme. The assistance from the *Employer*'s personnel does not relieve the *Contractor* of his responsibility for the commissioning of the System.

d) The *Contractor* performs the optimisation of the System, as shown in the Accepted Programme.

1.2.18 Site acceptance testing (SAT) stage

a) The *Contractor* provides a detailed site acceptance test procedure, which is submitted to the *Project Manager* for acceptance twenty (20) working days prior to the commencement of the site acceptance testing and it is shown in the Accepted Programme. The detailed acceptance test procedure covers all the activities and related documentation of the site acceptance test stage.

1.2.19 Decommissioning of old equipment stage

a) All decommissioning activities forming part of the *works* are shown in the Accepted Programme.

b) The *Contractor* decommissions and removes existing data acquisition panels, junction boxes, control room, field instrumentation, cables and primary devices.

c) After removal of the panels, the *Contractor* repairs all open areas left exposed. The *Contractor* ensures that the repaired ground area is safe for persons and their equipment working in or crossing over the area. The repaired ground area presents a neat appearance.

d) The design of the repair solution is presented to the *Project Manager* at the technical clarification phase for acceptance and it is shown in the Accepted Programme.

e) The *Contractor* carefully removes all field devices and cabling that are identified and specified in the *works* to be replaced and packs them in suitable boxes clearly marked to ensure safe storage. The equipment will be used as spares.

f) The *Contractor* compiles an inventory of all equipment that is removed from the plant as part of the *works*.

g) All the equipment that is removed from the plant remains the property of the *Employer*. The *Contractor* transports all removed equipment to a suitable location instructed by the *Project Manager*.

1.2.20 Operational test phase

a) The *works* is run continuously by the *Employer* for a period of 336 hours without any hardware or software malfunction.

b) During this period the different control modes of the System are exercised by the *Employer*'s operating personnel, within operational constraints of the *Employer.*

c) Maintenance and engineering functions are performed by the *Employer*'s maintenance and engineering staff under the supervision of the *Contractor* as part of the Operational testing.

d) In the event of any hardware or software Defect during the Operational testing phase, the *Contractor* corrects the Defect and the 336-hour test is restarted.

e) During the operational test the *works* is not deemed in use until the *Project Manager* certifies Completion.

1.2.21 Final optimisation of alarms and events received from the System is done during the Operational test stage. Availability

a) The vibration monitoring equipment shall be selected so that the availability requirements of the rotating machine are met.

b) The Contractor shall provide the mean time between failure and the mean time to repair the vibration monitoring system.

c) The availability of the vibration system shall be greater than 99.9%.

1.2.22 Maintainability

a) The VMS shall provide self-diagnostic features, and error checking features which the maintenance staff can use to check and locate hardware and software faults speedily and easily.

b) All equipment, such as vibration probes, cables, transducers, monitors and power supplies installed on each rotating machine shall be physically and electrically interchangeable. This would allow for fault-finding and repair of systems after equipment or system failure.

c) Similarly, equipment installed on multiple machines shall be interchangeable between machines.

d) Modules shall be replaced on-line, without affecting the operation of the remained of the system.

1.2.23 Expandability

a) The VMS shall be designed to allow for 20% spare capacity to accommodate future extensions or modification during the life of the system.

b) Power Supplies shall be specified to accommodate 20% spare capacity to allow for future expansion.

1.2.24 Power Supplies

a) All monitoring equipment shall be fed from a 220V AC 50 Hz uninterruptible power supply or 24V DC Battery Charger supply.

b) The power system shall be designed to power the probes and transducers as required.

c) Redundant power supplies shall be installed for all monitoring equipment.

1.3 *Contractor*'s management, supervision and key people

A detailed project organisational structure and resource plan, accompanied by CV's of key personnel, is provided in Appendix. Further detail, as required in the next paragraph, is supplied to the *Project Manager* for acceptance within 1 week after the Contract Date.

The organogram distinguishes between the various types of labour (i.e. skilled, unskilled etc.) and the position level as well as indicate the structure and responsibilities during the different phases. As a minimum it addresses the following:

a) Project management

b) Documentation management

c) Configuration management

d) Planning and programming

e) Site management

f) QA / QC

g) Safety

h) Technical Clarification

i) Design / Engineering

j) Procurement

k) Manufacturing

l) Erection and Installation

m) Commissioning

n) Acceptance Tests

1.3.1 Design Office

For the proper co-ordination and execution of the *works* from the *starting date* to the *defects date,* the *Contractor* provides suitably qualified and competent engineering personnel with relevant experience in industrial control and instrumentation systems, DCS/PLC system integration, installation, testing and commissioning. The *Contractor* ensures that the necessary specialist vibration monitoring and machinery protection expertise is available through the OEM, its authorised representative or suitably qualified specialist personnel to support the design, configuration, integration and commissioning of the VM600 systems.

1.3.2 Key technical, training and management personnel

The *Contractor* provides the following personnel resources to provide the *Works*:

1.3.2.1 The *Contractor's Project Manager*

The *Project Manager* has previous experience in handling a project of this size and complexity under the NEC 3. His responsibilities include the overall co-ordination of the project, technical and commercial aspects. He is assigned to the project on a full time basis from the Contract Date until Completion of the whole of the *works*.

1.3.2.2 Project planning personnel

An experienced full-time individual for the purposes of project planning under the NEC 3 to meet the requirements of the Contract from the Contract Date until the Completion of the whole of the *works*.

1.3.2.3 Specialist engineers

The specialist engineers are responsible for the design review, verification, formulation, engineering, FAT, installation, commissioning, SIT, SAT, development and formulation training manuals as required for the *Works* from the Contract Date until Completion of the whole of the *works*

Specialist engineers in the following fields are also employed by the *Contractor*:

a) Control and indicating equipment
    i. Design and installation
    ii. Software and Hardware interfacing
    iii. Programming
    iv. Management and monitoring
    v. Alarming
    vi. Control and communication network
    vii. Graphics and layout
    viii. Power supply requirements
    ix. Management server and clients setup and configuration

Responsibilities also include the solving of technical problems and technical liaison with all major parties involved in the project for the whole duration of the contract for the purpose of providing the *Works*.

1.3.2.4 QA &QC staff

The *Contractor* provides staff with proven experience in developing QCP and maintaining QA & QC measures in accordance with section 2.5 of the *Works* Information, from the Contract Date until Completion of the whole of the *works*.

1.3.2.5 Training personnel

The *Contractor* supplies qualified and experienced staff for the purposes of formal training, in all aspects of the *works*.

1.4 Interpretation and terminology

The following abbreviations are used in this Works Information:

Abbreviation	Meaning given to the abbreviation
AFC	Approved for construction
DAS	Data Acquisition System
DCS	Distributed Control Systems
EFP	Electrical Feed Pumps
LAN	Local Area Network
MT	Main Turbine
OEM	Original Equipment Manufacturer
SFPT	Steam Feed Pump Turbine
VMS	Vibration Monitoring System

2 Management and start up.

2.1 Management meetings

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

Title and purpose	Approximate time & interval	Location	Attendance by:
Risk register and compensation events	Weekly on _____ at ___	Arnot	*Employer, Contractor and Supervisor.*
Overall contract progress and feedback	Monthly on _____ at ___	Arnot	*Employer*, *Contractor*, *Supervisor*, and ___

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

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

2.2 Documentation control

a) All contractual communications and decisions is in the form of properly compiled letters or forms attached to e-mails and not as a message in the e-mail itself. All correspondence, in the form of letters, reports and e-mails is stored in a project communication file. The sequence of which will be in dates.

All correspondence between the *Contractor,* the *Project Manager* and the *Supervisor* follows the following rules:

- All letters bears the sender's signature.
- Letters follows the numbering scheme described in point 9.
- Correspondence sent via E-mail:

2.2.1 Sender

a) The letter is saved in PDF format and sent as an attachment to the receiver.
b) The email Subject field contains only the doc reference number as described in point 9.
c) The e-mail body may contain informal text, which is not contractually binding, provided it is recorded on the meeting minutes and signed by the *Project Manager* and the *Contractor.*

2.2.2 Receiver

The receiver replies to the e-mail received, ensuring that the complete message from the sender is included in the message as an attachment. This attachment includes the letter in PDF format.

In his reply, the receiver includes the following text on the first line of the Message Body: "Acknowledgement of receipt". This acknowledgement of receipt is contractually binding and serves as proof that the letter was delivered to the receiver's address (Core Clause 13.2).

When a reply to a letter is required, e.g. "Acceptance of documentation" the receiver now becomes the sender and the procedure under for 3 a. and b. is followed with the receiver writing a new letter with a new reference number as described under point 9.

a) Correspondence delivered by hand:

- **Sender** - The sender prepares the letter with a space for the receiver to sign and date acknowledgement of acceptance. The sender signs the letter and prepares two copies of the letter for delivery.

- **Receiver** - The receiver signs both copies of the letter upon receipt and returns a signed and dated copy to the sender.

b) Correspondence by fax:

- **Sender** – The sender prepares the letter with a space for the receiver to sign and date acknowledgement of acceptance. The sender signs the letter and sends it to the receiver by fax.

- **Receiver** - Upon receipt, the receiver signs and dates the letter and returns it to the sender by fax, acknowledging receipt.

c) Drawings and other technical document transmittals:

- Transmittals are numbered as described in point 9.
- The same procedure as for letters described under point 4 is followed for transmittals.

- No other forms of correspondence are acceptable, nor will it be deemed contractually binding.

- All correspondence not transmitted with one of the methods described above will be deemed as informal communication and not contractually binding. Only when a correspondence is acknowledged for receipt by the receiver by way of points 3 b, 4 b or 5 b will it be deemed contractually binding.

d) Correspondence numbering scheme:

- To be agreed on contract award

2.3 Health and safety risk management

The *Contractor* shall comply with the health and safety requirements as described to this Works Information.

2.3.1 Compliance to 5 identified lifesaving rules:

Rule1: Open, Isolate, Test, Earth, Bond, and/or insulate before touch.

(That is, any plant operating above 1 000 V)

- No person may work on any electrical network unless:
- He/she is trained and authorised as competent for the task to be done.
- A pre-task risk assessment to identify all risks and hazards has been conducted prior to any work commencing.
- An equipotential zone is created for each worker on the job site by earthing, bonding, and/or insulating according to approved procedures.
- All conducting material is connected, all staff on site wear electrical safety shoes, and insulating techniques are applied according to standards; and
- The authorised person (team leader) has certified and shown all team members that the apparatus is safe to work on.

Rule 2: Hook up on heights

Working at height is defined as any work performed above a stable work surface or where a person puts himself/herself in a position where he/she exposes himself/herself to a fall from or into.

No person may work at height where there is a risk of falling unless:

- A pre-task risk assessment to identify all risks and hazards has been conducted prior to commencing any work at height.
- He/she is appropriately trained.
- He/she is appropriately secured during ascending and descending; and
- He/she is using an approved fall arrest system where applicable.

Rule 3: Buckle up

No person may drive any vehicle on Eskom business and/or on Eskom premises unless the driver and all passengers are wearing seat belts.

Rule 4: Be Sober

- No person is allowed to work under the influence of drugs and alcohol.
- “Under the influence" means the use of alcohol, drugs, and/or a controlled substance to the extent that
- He individual's faculties are in any way impaired by the consumption or use of the substances; or
- The individual is unable to perform in a safe, productive manner; or
- The individual has a level of any such substance in his/her body that corresponds to or exceeds accepted medical/legal standards; or
- The individual has a level of alcohol in his/her body that is greater than 0.02% blood alcohol concentration.

- This includes any level of an illegal substance in the body, irrespective of when the substance was used.

Rule 5: Ensure that you have a permit to work

- Where an authorisation limitation exists, no person shall work without the required Permit to Work (PTW), which is governed by the Plant Safety Regulations, Operating Regulations for High Voltage Systems (ORHVS) etc.
- No plant is to be returned to service without the cancellation of all permits on that plant in accordance with procedure.
- NB: In the case of live work, a "live work declaration form" is to be completed by the authorised person who is the person responsible for the safe execution of work according to relevant standards and procedures.
- Please ensure that these rules are understood and communicated with the urgency that they deserve. If any of these rules are unclear or the consequences not understood, please do not hesitate to discuss it with Eskom.
- We would like to continue our current partnership and therefore urge your support in the implementation and upholding of these rules.

2.3.2 Introduction

a) The purpose of this document is to provide clear and unambiguous Health & Safety specifications to enable the Tenderer / Principal *Contractor* to make provision for, and comply with the required Health & Safety requirements - both in terms of relevant legislation and Eskom requirements, as well as any additional or site-specific H&S requirements required by the *Client*. In response to this document, tenderers are required to prepare Health & Safety plans providing details on how they will manage Health & Safety during the prospective project(s). This document forms an integral part of the Contract and Principal *Contractor*s are required to make it an integral part of their contracts with sub-Principal *Contractor*s and suppliers.

b) This document is a GSA generic document. Before inclusion on any tender enquiry document(s) during the tender stage of a project, the end-user is required to amend the document to ensure that is project specific. The document promotes legal compliance as well as a health and safety culture amongst those working in Eskom Generation Division projects.

2.3.3 References

- Construction Safety Health & Environmental Management procedure (32-136)
- Guideline for developing a Safety Health & Environmental Specification (32-524)
- Occupational Health & Safety Act 85 of 1993
- Eskom SHE Policy (32-94)
- Eskom Cardinal Rules (32-421)
- Eskom Incident Management procedure (32-95)
- Vehicle and Driver Safety Management procedure (32-93)
- Work at Heights procedure (32-418)
- Eskom Vehicle Safety Specifications (32-345)
- Medical Surveillance Procedure (32-282)
- Plant Safety Regulations (GGR 0992)
- Operating Regulations for High Voltage Systems (ESKPVAEY6)
- Compensation for Occupational Injuries & Diseases Act

It is important that the above procedures/ documents are made available to the potential service provider in preparation of his/her health and safety management compliance to Eskom requirements. Parties using this specification shall apply the most recent edition of the documents listed above.

2.3.4 Abbreviations

H&S – Health & Safety
DOL – Department of Labour
OHSA – Occupational Health & Safety Act 85 of 1993
HIRA – Hazard Identification and Risk Assessment
GAR – General Administrative Regulations

CR – Construction Regulations
GS&A – Generation Safety & Assurance
GST&A – Generation Safety Strategy & Assurance

2.3.4.1 Health and Safety requirements

Health and Safety requirements that the *Contractor* shall comply with include: Detailed costing for Health and Safety

a) Based on the overall scope of work/ service to be performed – compulsory.
b) Demonstration of an adequate health and safety management system that the Service Provider has:
    - Does the service provider have a documented health and safety management system?
    - provide proof.

c) Examples of the above include (but are not limited to), where applicable:
    - Notification to Commence Construction Work

d) The Principal *Contractor* shall, on receipt of the letter of appointment from the *Client*, before commencement of on-site activities, notify the Provincial Director of the Department of Labour of commencement of construction work as defined in Construction Regulations of the Occupational Health & Safety Act.85 of 1993.

e) A copy of the notification letter acknowledged by the DOL shall be forwarded to the Agent and *Client* and a copy kept on the H&S file on site:
    - Compensation for Occupational Injuries and Diseases

f) The Principal *Contractor* shall submit a letter of good standing with the Compensation Commissioner or Insurer at tender stage. The letter of good standing shall be valid throughout the project period. The *Client* shall at regular intervals of time carry out inspections to ensure that the letter of good standing remains valid throughout the project period.

2.3.4.2 Appointments

a) The Principal *Contractor* shall after consideration of the risks involved in the work, make relevant Occupational Health and Safety appointments as stipulated in the OHSA, before commencement of site operations and submit to the *Client* as part of the H&S Plan.

2.4 Competency for Principal *Contractor*'s responsible persons

a) The Principal *Contractor* shall compile and maintain a current register/inventory of supervisory and management personnel appointed to the construction Site. The inventory shall include H&S and professional competencies for each person appointed. The inventory shall be submitted to the *Client* for approval at tender stage as part of the H&S plan.

2.5 Organogram

a) A site organogram clearly defining the reporting structure and legal appointment structure shall be drawn up and submitted by the Principal *Contractor* to the *Client* as part of the H&S plan at tender stage.

2.6 Hazard Identification and Risk Assessment (HIRA)

a) Using the scope of works provided as part of the tender enquiry documents, the *Contractor* should compile and submit a HIRA at tender stage with proposed control measures. The HIRA shall indicate in general the type of H&S hazards and risks anticipated in the project and shall in broad terms indicate the proposed control measures to eliminate or minimise the identified risks.

b) The *Contractor* shall ensure that a detailed HIRA is performed by a competent person before commencement of construction work and it shall form part of the H&S plan to be submitted to the *Client* for approval.

c) The HIRA is an on-going process and a review shall be submitted whenever there are changes in the scope and/or process. The Health and Safety Representative(s), the Health and Safety Committee members and *Contractor's* Representative shall be members of the HIRA team and shall ensure that all the identified hazards and risks are appropriately controlled and reviewed.

d) The *Contractor* shall be responsible for making sure that all employees under his control are conversant with the content of the HIRA, as well as putting in place appropriate measures to either eliminate or reduce the risks.

e) The HIRA must take into consideration the baseline risk assessment that will have provided by the *Client*.

2.7 Health and Safety (H&S) Plan

a) The Principal *Contractor* shall develop, compile and submit, at tender stage for approval by the *Client*, a composite H&S Plan as per the *Client*'s specifications.

2.8 Health and Safety Training

a) The Principal *Contractor* shall conduct a training needs analysis on receipt of the letter of appointment from the *Client*. The training needs analysis shall be updated before every major work change and every six months for the duration of the contract. The training conducted on each project shall be three fold, namely:

b) Induction – the Principal *Contractor* shall ensure that all his employees undergo H&S induction based on the legislative requirements, *Client*'s specification and his H&S Plan before starting work on site.

c) Awareness – the Principal *Contractor* shall continuously conduct on site toolbox talks, display posters and contract statistics regularly and before any hazardous work takes place.

d) Competency – the Principal *Contractor* shall, based on his HIRA and training needs analysis nominate relevant persons to be sent on appropriate courses. The Principal *Contractor* shall make available at the *Client*'s request copies of certificates of training.

e) All records of training attendance, contents of training and training certificates shall be kept in the site H&S file.

2.9 Documentation

a) The Principal *Contractor* shall keep and maintain H&S records to demonstrate compliance to legal requirements, the H&S specification, as well as any other Eskom requirements. All documents shall be available for inspection by the *Client*, Agent and the DOL.

2.10 Monitoring and Evaluation

a) Inspections - The Principal *Contractor* shall carry out inspections as prescribed by legislation, the H&S Plan and the *Client* H&S specification. The Principal *Contractor* shall keep records of all inspections.

b) Internal Audits - the Principal *Contractor* shall conduct regular H&S audits at least once a month to ensure compliance to OHSA and H&S specification. Records of audits shall be kept on site and non-conformances reported.

c) External Audits - the Principal *Contractor* shall ensure that regular external H&S audits are conducted to ensure compliance to H&S legislation. External audits shall be carried out by competent persons or company. All documentation held by the Principal *Contractor* shall be available for inspection by the *Client*.

2.11 Reporting, Recording and Investigation of Accidents and Incidents

a) All accidents and incidents must be reported, recorded and investigated in accordance with the OHSA and Eskom procedure 32-95. The Principal *Contractor* shall report all accidents and incidents to the *Client* within 24 hours. The Principal *Contractor* shall allow the *Client* to participate in any investigation linked to any activity within the scope of the construction project. The Principal *Contractor* shall keep an on-site record of all incidents reported in the form of OHSA GAR Annexure 1. In the case of accidents/incidents, Eskom may conduct an independent investigation. The *Client* will provide the Principal *Contractor* with 32-95 procedure

2.12 Emergency Preparedness Plan

a) The Principal *Contractor* shall, in consultation with the *Client*, develop and submit to the *Client* an emergency response plan from a review of potential emergency scenarios before commencement on site, which will include, but not be limited to:

- Escape procedures and routes.
- Employee accounting systems after emergency
- Rescue and medical duties
- Means and procedures for reporting emergencies.
- Persons to be contacted for information.
- Emergency alert systems
- Contact list of emergency service providers

b) The emergency plan shall include training of employees to deal with such emergencies and shall form part of the H&S plan. The Principal *Contractor* shall advise the *Client* or his agent within 24 hours of any site emergency occurring together with the action taken.

2.12.1 *Client's* Considerations and Management Requirements

2.12.1.1 Injury Statistics

a) The Principal *Contractor* shall report monthly injury statistics to SRM on the first of every month and in the case where the first is on the weekend then it must be reported on the first working day of the month.

2.12.1.2 *Client's* audits

a) The *Client* will from time to time conduct audits of the Principal *Contractor*'s activities to ensure compliance with *Client*'s requirements and specification.

2.12.1.3 Permits and Authorizations

a) The Principal *Contractor* shall ensure that a written work permit and/or authorisation are obtained from the *Client* prior to commencement of any work to be done on the plant. When completing the application for a permit to work, the responsible person shall ensure that any special requirements, such as hot work, or working in a confined space, is stated in the application.

All work permit requests must be accompanied by a method statement stating:

- The scope of work to be undertaken
- Identification of hazards and risk assessment of the proposed work
- Mitigation strategies to control, reduce or eliminate the identified hazards.

- Safe Working procedure
- Training strategies for employees
- Equipment to be used.
- Process for evaluation of employees' physical and psychological fitness
- Other information deemed necessary, as stipulated in the Plant Safety Regulations and Operating Regulations for High Voltage Systems.

2.12.1.4 Public Health and Safety Information

a) The Principal *Contractor* shall ensure that each person visiting a site shall be made aware of the dangers likely to arise from on-site activities and the precautions to be taken to avoid or minimise those dangers. Appropriate health and safety signage shall be posted at all times.

2.12.1.5 Facilities

a) Principal *Contractor*s shall comply with the requirements of CR 28 (We need to re look at the phrasing of this statement depending on whether the y supply or we supply).

2.12.1.6 Medical Surveillance Program

a) Where Principal *Contractor* employees are exposed to occupational health hazards and risks that may have adverse effects to their health and/or lead to occupational diseases, e.g. inhalation of dusts, exposure to noise, etc, the Principal *Contractor* shall establish a medical surveillance program. The program shall include all high-risk occupations as specified in the Construction regulations i.e. crane operators, construction vehicles, mobile plant operators,

b) Medical screening shall be conducted by an Occupational Health Practitioner with either the SA Health Profession's Council or SA Nursing council. Medical screening shall be conducted as per the following frequencies:

- Pre-employment
- Periodic medical screening
- Post-employment and
- When the scope of work or individual's medical condition (which has the potential to affect their ability to perform their duties) changes.

2.12.1.7 Non-compliance and Penalties

a) Eskom will view the following at-risk behaviour in a very serious light:

- Disregarding any requirements contained in OHSA, this document, site specific health and safety requirements and plan.
- Performing an unsafe act or creating an unsafe condition that could pose a danger to themselves or to others.
- A Principal *Contractor* allowing any of their employees or subcontractor's employees (including casual labourers, or labour broker employees) to work on any site without ensuring that each employee has received proper training.
- If any of the above (inclusive but not limited to) are noted, it may result in cancellation of the contract.

2.12.2 Safety notification Arnot Power Station GMR 2.1

a) The following serves as a compliance and notification instruction with reference to the OSHACT, Act 85 of 1993 and any amendments thereto; BCEA and LRA of South Africa.

- All safety related incidents (Category A, B&C; Fire Incidents; Usage of Fire Extinguishers and Near misses) shall be immediately notified to the ARNOT Power Station Safety Risk Management Personnel.

- All Category C incidents shall be immediately notified to the *Project Manager*, either telephonically or in person.

- All personnel are allowed to wear Safety Harnesses whilst walking through plant only if they are secured properly onto the person and no loose sections of the harness drags onto floors, gratings, etc. were it can get caught and restrict a person's movement.

- During working on elevated positions all personnel, including scaffolders to use Safety Harness, which they shall attach onto Lifelines or secure as per the *Contractor*s Fall Protection Plan, which each *Contractor* shall have written and available on site for perusal, as and when required.

- All Safety Harnesses shall comply with:

b) SABS EN 362:1992; 363:1992; 362:1992; 365:1992, 364:1992 Codes of Practice.

- In terms of Section 16.1 of the OSHACT, "Every chief executive officer shall as far as is reasonably practicable ensure that the duties of his *Employer* as contemplated in this Act, are properly discharged." Every employee, permanent/temporary/part-time/sub-contracted onto the ARNOT Site shall be treated as an "employee" in terms of the Act whilst under your "direct supervision and care".

- All employees as stated in 5 above have a right to "free issue" safety equipment, which shall be supplied to them prior to commencement of work. The equipment shall comply to the relevant SABS standards and shall be in proper working condition, clean and undamaged whilst working on the ARNOT Site.

- In terms of the BCEA and LRA all employees shall be afforded a fair minimum wage, including allowances for meals and transport, if not provided, which has been agreed and set by the relevant Bargaining Councils, which form part of the Acts.

- All employees shall be granted 3 breaks during the course of a 12 hour shift (1x 15 minute break in the morning; 1 x 30 minute lunch break midday; and 1 x 15 minute break in the afternoon). Refreshments or meals shall be provided or be the responsibility of the *Contractor* (*Employer*). Employees cannot be allowed to work without having proper meals or refreshments.

- All *Contractor* employees entering the ARNOT Power Station site shall be medically fit. A full medical examination shall have been carried out by a Registered Occupational Health Worker who shall issue a certificate confirming the medical fitness of the employee. The examination shall consist of an eye test, heart function, lung function, chest x-ray, blood pressure, hearing function, previous occupational injuries, epilepsy, allergies, asthma and verification of work in elevated/confined spaces. Basically a full evaluation (a Red Ticket) shall be done and only those that pass these examinations shall be allowed to work on ARNOT Power Station.

- In terms of Section 8.2 & 18.3 of the OSHACT, *Employer*s shall ensure that employees working at ARNOT Power Station are trained in the hazards associated with the tasks and the precautionary measures are taken in the interest of health and safety. The responsibility of shall include compliance and adherence to the Eskom Plant Safety Regulations, Permit to Work System and Emergency Care.

- All *Contractor* s to ensure that the ARNOT Emergency Alarm is activated for serious injuries and the injured shall not be 'moved' by the *Contractors* staff unless in a condition which threatens the injured or other parties life. Movement of injured persons (employees) shall be done by a trained First Aider, who shall be at the site at all times during the work phase.

- All *Contractor*s shall send a Safety Officer/Representative to all Safety Meetings arranged by the Power Station.

- Safety Officers shall be at site or as reasonably practical to ensure that all hazards risks are identified and corrective action is taken.

- All *Employer*s shall ensure that any employee disregarding a safety instruction is not allowed to be a risk to the *Contractor*, ARNOT Power Station or other parties whilst on this site. The appropriate disciplinary action shall be taken against these employees.

- The *Contractor* shall have daily Toolbox talks, periodic site inspections, job observations, risk assessments, safety equipment checks and safety talks with all employees.

- Safety Induction will be done by the Power Station on prior arrangements but is not the minimum requirement. Induction and hazards training shall be done by the *Contractor*.

- In term of Section 37.2 of the OSHACT, you the *Contractor* will ensure compliance with all requirements of the OSHACT and any instruction/notification that enhances those requirements.

- All *Contractor*s to ensure that a Safety Manual is completed prior to working on site and the relevant appointees are fully conversant with their responsibilities are trained and competent in those requirements, training proof is available and appropriate re-training is done.

- *Contractor*s to ensure that all staff, whether permanent/non-permanent/supplied by Labour Broker are competent in their relevant disciplines that they are employed/contracted in and all proof of training, experience, etc. is available and is current. Appropriate re-training shall have been done.

- Due to all staff being under the “direct supervision and control” of yourself, they shall and will be treated as an ‘employee’, as defined in the OSHACT, Act 85 of 1993.

- All equipment, welding panels, compressors, pneumatic tools, electrical equipment shall comply with a relevant SABS Code of Practice and all documentation related to this shall be made available as and when required, except for welding panels which shall only be connected by ARNOT Electrical Department with a Certificate of Compliance submitted prior to request. All pneumatic tools shall have had an inspection covering condition of pressure components, including piping, bolting, spring loaded bolts, safety devices and controls. A certificate must be issued by the hire company to the Main/Sub-*Contractor* confirming the tool is in a good and acceptable working condition. Proof of inspections must be issued by Hire Company to lessor prior to bringing onto ARNOT Power Station Site.

c) CLARIFICATION:

- All staff whether permanent, non-permanent, part-time, sub-contracted, and labour only supply is your responsibility in terms of “direct supervision and control” and as the Main *Contractor*.
- All *Contractor*s to ensure compliance to the above requirements and any non-compliance or contravention shall be considered in breach of the contractual and legal requirements and serious action shall be taken by the *Project Manager* with or without consultation with the Department of Labour.

Contractor Site Manager *Site* Supervisor ---------- Print Name	 ---------- Signature	 ---------- Date

Contractor Director / CEO ---------- Print Name	 ---------- Signature	 ---------- Date

2.13 Environmental constraints and management

a) The management and staff at Arnot Power Station are committed to generate low-cost power without compromising its responsibility towards the natural environment. Arnot Power Station management has decided to implement and align its environmental management system in compliance with SABS ISO 14001:1996 as a means of managing impacts to and ensuring continual improvement of the environment in which it operates.

b) The Contractor need to comply with ISO 14001 on environmental management.

2.13.1 The environmental policy for Arnot Power Station is set out below:

a) We are committed to sustainable development and will actively work to reduce the impact on the natural environment resulting from the power generation process.
b) We commit to continual improvement in our performance and aspire to minimum harm to people and the environment.

2.13.2 Whenever we conduct our business, we will:

a) Develop, implement and maintain an environmental management system that is consistent with internationally recognised standards.
b) Effectively and efficiently manage the natural resources required to generate electrical power.
c) Comply with the requirements of environmental legislation and adhere to Eskom’s corporate policies and procedures on environmental management.
d) Set and achieve targets, that include preventing pollution, to address our environmental aspects and impacts.
e) Develop our people and provide resources to meet our targets.
f) Communicate and engage with our employees, clients, regulatory authorities and suppliers to build relationships based on integrity, honesty, openness and involvement to meet the requirements of this policy.
g) Increase environmental sensitivity and awareness among station management, employees and the community and achieve active involvement of all parties, with respect to environmental matters.
h) And promote Arnot Power Station and Eskom as environmentally responsible organisations to outside parties.

i) We will review and report our progress regularly and ensure this policy remains relevant to the needs of our stakeholders. We will be satisfied when we achieve our targets toward minimum harm to people and the environment and are valued by our clients and the communities in which we work.

2.14 Quality assurance requirements

2.14.1 Quality management system

a) The Contractor provides the complete QA&QC documentation including that of his Subcontractor(s), for all Plant, Material and Equipment, in compliance with SANS 9001:2008 Edition 4, “Quality Management Systems - Requirements”, and the *Employer’s* standard GGS 0462 Rev 1 “Quality Requirements for Engineering and Construction Works in Generation”.

b) The *Contractor* further ensures that the Subcontractor(s) programmes comply with the requirements of the Works Information.

c) The *Contractor* notifies the *Project Manager* of any changes to the Quality System and obtains agreement prior to implementation on existing orders and contracts, or sub orders and subcontracts.

2.14.2 Quality documents submitted with the tender.

a) The *Contractor* submits a copy of his quality policy and quality system procedures relevant to the *Works*.

b) The *Contractor* also submits a typical quality control plan.

c) The *Project Manager* evaluates the *Contractor*’s capabilities with regards to quality assurance and quality control based on these submissions and the performance history of the *Contractor*. The *Project Manager* performs pre-award assessments where necessary, giving further information to aid the selection process.

2.14.3 Quality documents submitted after the contract date.

a) The *Contractor* submits a fully detailed Quality Assurance Programme (QAP) for acceptance by the *Project Manager* within four weeks of the *Contract Date*.

b) The documents submitted by the *Contractor* shall include the following:

- Copy of the Quality Manual
- Copy of the Quality System Procedure
- Copy of the Contract Quality Management Plan
- Copy of Quality Control Plans
- Copy of the proposed index of the QA/QC, inspection and test records

c) The Contractor will further submit the following documents during the contract:

- Non-conformance reports (NCR’s) raised by the *Contractor.*
- Notification of any planned changes to the *Contractor’s* quality manual, quality system procedures, contract quality management plan or quality plan for acceptance by the *Project Manager* prior to implementation.
- Concession/production permit applications and supporting documentation.
- Data books and/or data packages.

2.14.4 Contract quality management plan requirement

a) The *Contractor* prepares a contract quality management plan that, where appropriate, indicates the following:

- Indicates the interface with the *Contractors* quality system and applicable documents such as procedures and work instructions.

- Establishes communication channels between the *Contractor* and the *Project Manager* in respect of quality and the integration of such with the prescribed contract communication channels.
- Indicates how specific subcontractors will be monitored.
- Identifies items or activities for which quality control plans will be prepared.
- Identifies the specifications, drawings and acceptance criteria for material for which quality control plans are not required.
- Identifies the areas or processes requiring special controls.
- Identifies the *Contractor's* Management Representative and personnel responsible for the control of quality activities and their relationship to the *Contractor's* management structure.
- Identifies the documents which are to be submitted to the *Project Manager*
- Indicates the *Contractor's* quality monitoring programme.

b) The *Contractor* periodically updates the contract quality management plan to reflect changes in any of the above details. The frequency of such updates is determined by the *Project Manager* but will not be greater than one year.

2.14.5 Quality control plan

a) The *Contractor* quality control plans cover inspection and test proposals for items or activities to be supplied as part of the *works*.

b) The quality control plan indicates the following as appropriate:

- The identification of the item
- The material
- A list of the sequence of operations including inspections and tests
- The identification of the specification, drawings or procedures for each operation
- The acceptance criteria with reference to the appropriate technical specification, in-house, national or international standard and relevant clause number
- The inspections and tests the *Contractor* has nominated for hold and witness points and it is shown in the Accepted Programme.
- During contract execution, no actions to provide the *Works* are implemented at any of the *working areas* before the relevant quality control plans and procedures are accepted by the *Project Manager.*
- Proof of the *Contractor's* personnel competence in terms of Reg 18 (5 and 6) of the OHS Act is submitted to the *Project Manager* for acceptance prior to the commencement of any work on Site and is shown in the Accepted Programme.

c) Quality control plans with hold and witness points are supplied to *the Project Manager* for his review and acceptance 15 days before the start of each of the following phases and or stages and it is shown in the Accepted Programme:

- Investigation phase
- Design and engineering phase
- Technical clarification stage.
- Design freeze stage

d) Production engineering phase

- Procurement, fabrication and delivery stage.
- Factory acceptance test stage

e) Construction and erection phase.

f) Commissioning phase

- SIT stage
- Commissioning stage.
- SAT stage.

g) Operational test phase.

2.14.6 Access to the *Contractor's* and subcontractor(s) premises and facilities

a) The *Contractor* and/or its subcontractor gives access to the *Supervisor* and/or the Authority/Agency and the Regulator where appropriate to their premises and facilities at reasonable times to conduct quality assessments, audits, surveillances and inspections to establish compliance with the contractual requirements.

2.14.7 Inspection and testing

a) The *Contractor* gives at least 72 hours advance notification to the *Supervisor* or the Authority for inspection/test and hold or witness points, which require their attendance. The *Contracto*r confirms readiness for inspection at least 24 hours prior to the test.

b) The *Contractor* ensures that all work has been fully inspected, accepted and documented prior to requesting any inspection by the *Supervisor*.

2.14.8 Quality records

a) The *Contractor* prepares and submits to the *Project Manager* an Index of QA/QC and inspection and test records prior to the commencement of work.

b) The *Project Manager* determines which documents are to be submitted during the performance of work and reviews the index and request changes if required. The *Contractor* conforms to the Index approved by the *Project Manager.*

c) The *Contractor* ensures all records identify the items, equipment and/or activities to which they pertain, collates indexes, and securely stores the records in such a manner that they are readily retrievable.

d) The *Contractor* implements appropriate administrative controls to limit access to prevent inadvertent loss of or damage to records.

e) The *Contractor* stores all quality records. The *Contractor* only destroys or discards quality records with the approval of the *Project Manager*.

f) The *Contractor* presents on completion of the works all quality records in the form of a data package. The package is indexed and shows the entire contents.

2.15 Programming constraints

2.15.1 Design and construction

2.15.1.1 Electrical switchgear rooms access

a) Safe access to electrical switchgear rooms will be dependent on the availability of unit outages and plant conditions.

b) It will not be possible for outages or complete isolation on certain electrical switchgear rooms i.e. DC Station Board, Battery Room etc., therefore it is of utmost importance to ensure compliance with necessary safety regulations and prescriptions for work to be carried out under these conditions.

c) This will have to be included acceptable programme with realistic time frames and in the *Contractor's* risk register.

d) The following to be noted and catered for:

- Permanent supervision, toolbox talks and proper risk assessments per area.
- Compliance to PPE category 2A under certain conditions
- Inconvenience due to outage plan changes and short notices

2.15.2 De-commissioning and removal of old equipment

a) This activity is shown in the Accepted Programme, and should as a minimum include the de-commissioning, by the *Contractor*, of the existing plant control and indicating equipment this will only take place once the *Contractor* has fully commissioned the new system for the specific detection zone *plant* area, and it is fully operational and acceptance by the *Project Manager* has been obtained.

b) As a minimum, the decommissioning involves the following:

- Removal of all control and indicating not forming part of the *Contractors* design equipment:
  I. Control panel, repeater stations, junction boxes and detectors
  II. Conduit and cabling
  III. Any associated peripheral devices to the control and indicating equipment.

- Compiling a full inventory of all old equipment that was removed.
- Transportation of equipment to a suitable location at Arnot Power Station site, specified by the *Project Manager* to dispose as per Environmental Laws.
- Making good of any areas where equipment and cabling is removed.

2.16 *Contractor*'s management, supervision and key people

a) A detailed project organisational structure and resource plan, accompanied by CVs of key personnel, is provided in Appendix. Further detail, as required in the next paragraph, is supplied to the *Project Manager* for acceptance within 1 week after the Contract Date.

b) The organogram distinguishes between the various types of labour (i.e., skilled, unskilled etc.) and the position level as well as indicate the structure and responsibilities during the different phases. As a minimum, it addresses the following:

- Project management
- Documentation management
- Configuration management
- Planning and programming

- Site management
- QA / QC
- Safety
- Technical Clarification
- Design / Engineering
- Procurement
- Manufacturing
- Erection and Installation
- Commissioning
- Acceptance Tests

2.16.1 Design Office

a) For the proper co-ordination and execution of the *works* from the *starting date* to the *defects date,* the *Contractor* provides suitably qualified and competent engineering personnel with relevant experience in industrial control and instrumentation systems, DCS/PLC system integration, installation, testing and commissioning. The *Contractor* ensures that the necessary specialist vibration monitoring and machinery protection expertise is available through the OEM, its authorised representative or suitably qualified specialist personnel to support the design, configuration, integration and commissioning of the VM600 systems.

2.16.2 Key technical, training and management personnel

a) The *Contractor* provides the following personnel resources to provide the Works:

2.16.2.1 The *Contractor's Project Manager*

a) The *Project Manager* has previous experience in handling a project of this size and complexity under the NEC 3. His responsibilities include the overall co-ordination of the project, technical and commercial aspects. He is assigned to the project on a full-time basis from the Contract Date until Completion of the whole of the *works*.

2.16.2.2 Project planning personnel

a) An experienced full-time individual for the purposes of project planning under the NEC 3 to meet the requirements of the Contract from the Contract Date until the Completion of the whole of the *works*.

2.16.2.3 Specialist engineers

a) The specialist engineers are responsible for the design review, verification, formulation, engineering, FAT, installation, commissioning, SIT, SAT, development and formulation training manuals as required for the Works from the Contract Date until Completion of the whole of the *works.*

b) Specialist engineers in the following fields are also employed by the *Contractor*:

- Control and indicating equipment.
- Design and installation
- Software and Hardware interfacing
- Programming
- Management and monitoring
- Alarming
- Mass notifications
- Control and communication network
- Graphics and layout
- Power supply requirements
- Management server and client's setup and configuration

c) Responsibilities also include the solving of technical problems and technical liaison with all major parties involved in the project for the whole duration of the contract for the purpose of providing the Works.

2.16.2.4 QA &QC staff

a) The *Contractor* provides staff with proven experience in developing QCP and maintaining QA & QC measures in accordance with the Works Information, from the Contract Date until Completion of the whole of the *works*.

2.16.2.5 Training personnel

a) The *Contractor* supplies qualified and experienced staff for the purposes of formal training, in all aspects of the *works*.

2.17 Invoicing and payment

a) Within one week of receiving a payment certificate from the *Project Manager* in terms of core clause 51.1, the *Contractor* provides the *Employer* with a tax invoice showing the amount due for payment equal to that stated in the *Project Manager's* payment certificate.

b) The *Contractor* shall address the tax invoice to invoiceseskomlocal@eskom.co.za and include on each invoice the following information:

- Name and address of the *Contractor* and the *Project Manager.*
- The contract number and title.
- *Contractor*'s VAT registration number.
- The *Employer*'s VAT registration number 4740101508.
- Description of service provided for each item invoiced based on the Price List.
- Total amount invoiced excluding VAT, the VAT and the invoiced amount including VAT.

2.18 Insurance provided by the *Employer.*

a) The *Employer's* Insurance Policies is reviewed and may be revised annually on the annual insurance policy maturity date at the end of March each year when the *Contractor* is advised to inform himself of such updates on the above website. Claims procedures and claim forms are also available from this website. If Marine insurance is applicable, the procedure for initiation of this insurance cover is also available from this website.

2.19 Contract change management.

a) To ensure a standard implementation methodology and that continuous improvements from subsequent units are back fitted to units already commissioned, the *Contractor* is responsible for the management of change of software and hardware until Completion of the whole of the *works*.

b) The *Contractor* develops implements and maintains a DCR (design change request) procedure. The DCR process is submitted to the *Project Manager* for acceptance, prior to the *Contractor* implementing it.

2.20 Provision of bonds and guarantees.

a) The form in which a bond or guarantee required by the *conditions of contract* (if any) is to be provided by the *Contractor* is given in Part 1 Agreements and Contract Data, document C1.3, Sureties.

b) The *Employer* may withhold payment of amounts due to the *Contractor* until the bond or guarantee required in terms of this contract has been received and accepted by the person notified to the *Contractor* by the *Project Manager* to receive and accept such bond or guarantee. Such withholding of payment due to the *Contractor* does not affect the *Employer*'s right to termination stated in this contract.

2.21 Training workshops and technology transfer

a) The *Contractor* provides training for the *Employer's* personnel on systems directly applicable to the *works*. Training for Operating, Maintenance and Engineering staff takes place on site or at the *Contractor's* premises. If it places at *Contractor's* premises, the *Employer* is responsible for traveling and accommodation costs.

b) No training shall be allowed off site during construction and erection phase. The *Employer*'s local training facilities are suitably sized air-conditioned rooms, as well as a trainer desk, an overhead projector and a white board.

c) At Conceptual design freeze (i.e., after clarification), the *Contractor* submits a training schedule for acceptance by the *Project Manager*, including a list of all courses and documentation for each course.

d) Practical hands-on training during the whole contract implementation forms an integral part of the training process.

e) The *Contractor* shall develop a training schedule with the consideration of staff constraints and shows these dates in the Accepted Programme.

3 Engineering and the *Contractor*'s design

a) The Contractor submits the Contractor's design for acceptance by the Project Manager in accordance with the Works Information.

3.1 *Employer*'s design

a) The objective of this project is to address the equipment obsolescence of the vibration monitoring system (VMS) for the Main Turbine, Electric Feed Pumps and Steam Feed Pump Turbine in order to improve the Reliability and Availability of the plant.

b) The Employers objectives are:

- To replaces the existing vibration monitoring system at Arnot Power Station for Unit 1, 2&6, for the Main Turbine, 2 X Electrical Feed Pumps and for the Steam Feed Pump.
- Assessment of the plant drawings and physical verification and corrections if needed, this shall be conducted prior to any works.
- Decommissioning of the existing systems as per scope of work
- To maintain the existing operational, control and protection philosophy for the vibration monitoring system, its interfaces to the DCS System and to the Protection System.

c) To ensure network connectivity of the VMS system with the Eskom LAN, and to configure remote diagnostic monitoring capability for Engineers using remote diagnostic tools via the LAN, as well as remote diagnostic capability for Rotek.

d) All probes shall be mounted in holders that permit adjustment and are retractable or removable while the machine is running. Internal mounting of probes is acceptable when approved by the rotating equipment manufacturer (OEM) or when externally mounted probes do not allow true measurement of the rotor-to-bearing relative motion, but internally mounted probes do. Mounting of probes shall provide true relative displacement between the bearing and the rotor. This can be achieved by internally or externally mounted probes depending on the installation.

3.1.1 Turbine centreline and boiler feed pump turbines

Parameter	Instrument	Rack Input	Rack Output	3rd Party Link
Shaft Speed/Phase Reference	Proximity probe	mV	4-20mA & Modbus	OPC
HP Turbine front bearing X&Y Shaft vibration	Proximity probe	mV	4-20mA & Modbus	OPC
HP Turbine front bearing X&Y Pedestal vibration	Seismic probe	mV	4-20mA & Modbus	OPC
HP Turbine rear bearing X&Y Shaft vibration	Proximity probe	mV	4-20mA & Modbus	OPC
HP Turbine rear bearing X&Y Pedestal vibration	Seismic probe	mV	4-20mA & Modbus	OPC
LP Turbine front bearing X&Y Shaft vibration	Proximity probe	mV	4-20mA & Modbus	OPC
LP Turbine front bearing X&Y Pedestal vibration	Seismic probe	mV	4-20mA & Modbus	OPC
LP Turbine front bearing metal temperature	Thermocouple - J	mV	4-20mA & Modbus	OPC
LP Turbine rear bearing X&Y Shaft vibration	Proximity probe	mV	4-20mA & Modbus	OPC
LP Turbine rear bearing X&Y Pedestal vibration	Seismic probe	mV	4-20mA & Modbus	OPC
LP Turbine rear bearing metal temperature	Thermocouple - J	mV	4-20mA & Modbus	OPC
HP/IP Turbine diff casing distortion temperature	Thermocouple - J	mV	4-20mA & Modbus	OPC
Generator front bearing X&Y Shaft vibration	Proximity probe	mV	4-20mA & Modbus	OPC
Generator front bearing X&Y Pedestal vibration	Seismic probe	mV	4-20mA & Modbus	OPC

Generator rear bearing X&Y Shaft vibration	Proximity probe	mV	4-20mA & Modbus	OPC
Generator rear bearing X&Y Pedestal vibration	Seismic probe	mV	4-20mA & Modbus	OPC
Differential expansion	Proximity probe	mV	4-20mA & Modbus	OPC
Thrust bearing shaft position	Proximity probe	mV	4-20mA & Modbus	OPC
Shaft eccentricity	Proximity probe	mV	4-20mA & Modbus	OPC
Steam Feed Pump Turbine				
Parameter	**Instrument**	**Rack Input**	**Rack Output**	**3rdParty Input**
Turbine front bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC
Turbine rear bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC
Main Pump front bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC
Main Pump rear bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC
Gearbox front bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC
Gearbox rear bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC
Booster Pump front bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC
Booster Pump rear bearing H&V Pedestal vibration	Seismic probe	mV	4 - 20mA	OPC

3.1.2 Transducer and Sensor Arrangements

Item	Description
Location & Orientation of Radial shaft Vibration Probes	**a.** Coplanar, 90 degrees (± 5 degrees) apart and perpendicular to the shaft axis (± 5 degrees). **b.** If practical, located 45 degrees (± 5 degrees) from each side of the vertical centre. **c.** Referenced such that when viewed from the driver end of the machine train i.e. (HP Turbine), the Y probe is on the left side of the vertical centre and the X probe in on the right side of the vertical centre regardless of the direction of shaft rotation. **d. Located within 75 millimetres of the bearing.** **e.** Located such that they do not coincide with a nodal point. (This should be verified

	by Original Equipment Manufacturer (OEM) or field testing)
Location & Orientation of Phase Reference Transducer	The minimum width of the marking groove shall be one and one-half times the diameter of the probe tip. The minimum length shall be one and one-half times the diameter of the probe tip and the minimum depth must be 1.5 millimetres. All edges shall be trimmed to a minimum radius of 0.8 millimetres. The one-event-per-revolution mark shall be long enough to allow for thermal expansion and rotor float. Phase reference probes shall be radially mounted to sense one-event-per-revolution mark.
Location & Orientation of Casing Transducers	Casing (seismic) transducers intended to monitor radial casing vibration shall be located on the radial bearing housing. Location and number of transducers shall be jointly developed by the machinery monitoring system supplier and the rotating equipment end user. Consideration such as case-to-rotor mass ratio and bearing support stiffness shall be taken into account.
Mounting of Probes	Probe holders shall be free from natural frequency that could be excited by machine-generated frequencies. The free-cantilevered length of a probe holder sleeve shall not exceed 200 millimetres. Longer lengths require the use of a probe holder sleeve support guide. When a probe is internally mounted, the probe holder shall be at least 10 millimetres thick. The probe lead shall be securely tied down to prevent cable whipping or chafing resulting from windage or oil. No cable connections shall be made inside the machine.
Mounting of Oscillator-Demodulators	The mounting location shall be selected so that minimum vibration is imparted to the oscillator-demodulator. The mounting location shall be selected so that the oscillator-demodulators are not subjected to ambient temperatures exceeding their operating range.
Mounting of Casing Transducers	The boss or surface must be part of the machine casing. All cables shall be enclosed in conduit. The conduit shall be attached to an enclosure, not to the seismic transducer.
Identification of Transducers	Each probe lead, extension cable and oscillator-demodulator shall be plainly marked to indicate the location and service of its associated probe or sensor. This tagging shall be visible without disassembly of the machine or removal from machine.

3.1.3 Machinery Protection System Accuracy Requirements (API 670)

Table E1: Machinery Protection System Accuracy Requirements (API 670)

Components	Temperature		Accuracy Requirements as a Function of Temperature	
	Testing Range	Operating Range	Within Testing Range	Outside Testing Range but Within Operating Range
Proximity probes	0°C to 45°C (32°F to 110°F)	–35°C to 120°C (–30°F to 250°F)	Incremental Scale Factor[1]: ± 5% of 7.87 mV/µm (200 mV/mil)	Incremental Scale Factor[1]: An additional ±5% of the testing range accuracy
Extension cables	0°C to 45°C (32°F to 110°F)	–35°C to 65°C (–30°F to 150°F)	Deviation from Straight Line[2]: within ±25.4 µm (±1 mil) of the best fit straight line at a slope of 7.87 mV/µm (200 mV/mil)	Deviation from Straight Line[2]: within ±76 µm (±3 mils) of the best fit straight line at a slope of 7.87 mV/µm (200 mV/mil)
Oscillator-demodulators	0°C to 45°C (32°F to 110°F)	–35°C to 65°C (–30°F to 150°F)	Minimum linear range: 2 mm (80 mils)	Minimum linear range: same as for testing range
Accelerometers and accelerometer extension cables[3]	20°C to 30°C (68°F to 86°F)	–55°C to 120°C (–65°F to 250°F)	Principal Axis Sensitivity: 100 mV/g ±5%	Principal Axis Sensitivity: 100 mV/g ±20%
			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].	
Temperature sensors and leads	0°C to 45°C (32°F to 110°F)	–35°C to 175°C (–30°F to 350°F)	±2°C (±4°F) over a measurement range from –20°C to 150°C (0°F to 300°F)	±3.7°C (±7°F) over a measurement range from –20°C to 150°C (0°F to 300°F)
Monitor system components for measuring:				
Radial Vibration, Axial Position, Piston Rod Drop, and Casing Vibration	0°C to 45°C (32°F to 110°F)	–20°C to 65°C (0°F to 150°F)	±1% of full scale range for the channel	Same as for testing range
Temperature			±1°C (±2°F)	Same as for testing range
Speed and Overspeed			±1% of alarm setpoint	Same as for testing range

3.1.3 Junction Box Layout

a) All drawings are supplied to the *Contractor* by *Project Manager* on plant layout and junction boxes.

3.1.4 Transducer Application Design

a) COMPOUND STEAM TURBINE continuous duty - The following is the minimum acceptable transducer installation for a Critical continuous duty Compound Steam Turbine employing oil lubricated journal bearings and hydrodynamic thrust bearings:

b) Radial Vibration - Two orthogonally mounted shaft-relative non-contact proximity transducers (XY) shall be installed at each radial bearing, using a mounting position directly referenced to the bearing. This position may be on the bearing itself, or entry via the bearing pedestal outer cover. The outer cover entry may only be used if it is the primary bearing retaining device and is a structurally significant component.

c) Axial Thrust Position - Two non-contact proximity transducers in a dual-voting configuration to be installed at the HP turbine thrust bearing observing the thrust collar relative to the thrust bearing.

d) Casing Vibration - In addition to the shaft relative non-contact proximity transducers described above (and not instead of), there shall be two orthogonally mounted bearing seismic vibration transducers of velocity type at each radial bearing location, using a mounting position as close as practicable to the mounting position of the shaft relative proximity probes. This position may be on the bearing itself or, with certain precautions, externally on the bearing cover. Where the outer cover is not the primary bearing retainer or strong back, a position at the half joint between the cover and the lower bearing pedestal or housing may be suitable. Care must be exercised to ensure that the mounting position provides meaningful indication of the bearing vibration behaviour. Measurements shall be in Zero-to-Peak velocity units with the option to measure integrated velocity.

e) Eccentricity - A single shaft relative non-contact proximity transducer shall be installed top dead centre at the HP turbine (normally NDE) to observe potential rotor bow conditions. Eccentricity is the measurement of shaft bow at slow-roll speed. Measurements shall be in micrometres or mils reading Direct Eccentricity, which is the instantaneous eccentricity value, and Peak-to-Peak Eccentricity, which is the difference between the positive and the negative extremes of the rotor bow.

f) Phase Reference / Speed Measurement – (Keyphasor) One shaft relative non-contact proximity transducer shall be installed on the mechanical driver of each machine train for once-per-rev phase reference measurements and speed recording. For machines with internal-to-cover mounted phase reference transducers, a spare transducer shall be required, with associated extension lead delivered to the transducer interface housing, external to the machine.

g) Differential Expansion – Non-Contact extended range proximity transducers are to be installed to measure axial position movement of the LP (and IP if applicable) rotor to case. Differential Expansion is the measurement of the axial position of the rotor with respect to the machine casing at some distance from the thrust bearing. Changes in axial position relative to the casing affect axial clearances and are usually the result of thermal expansion during start-up and shutdown. Physically, the measurement is made with a proximity probe transducer mounted to the machine casing and observing an axial surface (e.g., collar) of the rotor.

h) Case Expansion – Two LVDT transducers shall be installed at the HP turbine. They shall be mounted on the foundation at the opposite end from where the HP turbine casing is attached to the foundation, one each side. Case expansion (sometimes referred to as shell expansion) is the thermal growth of the machine case as it expands during machine start-up and on-line operations. It shall enable operators to determine whether expected temperature growth differentials are being exceeded on the machine primarily during start-up.

i) Valve Position – An LVDT shall be installed at each inlet steam valve. By measuring the opening of these valves, the amount of steam flowing to the individual valves in the group can be monitored and adjusted to provide highest machine operating efficiency.

j) Zero Speed – Two non-contact proximity transducers shall be installed to observe the same tooth wheel on the integral turbine-generator turning-gear. Zero speed is a contributory safety methodology to ensure proper engagement of the turning gear when the system in being shut down. It is designed to prevent engagement of the turning gear before a pre-selected shaft rotational speed is reached during shutdown.

k) Temperature - Journal and Hydrodynamic Thrust Bearings - Two bearing metal temperature sensors installed at each radial journal bearing (1 in use and 1 spare). Hydrodynamic thrust bearings shall be equipped with temperature sensors in alternate pads of the active side and 2 on the inactive side. The detectors shall be resistance temperature (RTD) type as specified in API 670 4th edition.

3.2 Electrical Design

a) The existing electrical Vibration Monitoring System at Arnot Power Station is supplied from UPS DB Sub Station Board 1 respectively as follows:

Table 1: UPS Existing Power Supplies and Loads

Unit	UPS DB KKS	MCB feeder	MCB Rating	Load Description	Load rating (A)	Location
1	10BTW01GH001	11	6A, 1P, 230 V, 5kA - Hager	Vibration AMS – 10CKA01	0.8	EDS 1,2,3 Room
2	20BTW01GH001	11	6A, 1P, 230 V, 5kA - Hager	Vibration AMS – 20CKA01	0.32	
3	30BTW01GH001	11	6A, 1P, 230 V, 5kA - Hager	Vibration AMS – 30CKA01	2.3	
4	40BTW01GH001	11	6A, 1P, 230/400 V, 6kA - Siemens	Turbine Vibration AMS – 40CKA01	2	EDS 4,5,6 Room
5	50BTW01GH001	11	6A, 1P, 230 V, 5kA - Hager	Vibration System (Bentley) SKF Panel – 50CKA01	0.86	
6	60BTW01GH001	11	6A, 1P, 230/400 V, 6kA - Siemens	Vibration AMS – 60CKA01	3	

Table 2: Charger Existing Power Supplies and Loads

Unit	24 V DC Charger KKS	Feeder	Circuit KKS Feeder Rating	Load KKS	Measured Load current (A)	Location
1	10BTQ01 (Master)	F25	63 A	10CKA02	5.6	EDS 1,2,3 Room
	10BTQ02 (Slave)	F25	63 A	10CKA02	4.9	
2	20BTQ01 (Master)	F25	63 A	20CKA02	4.6	
	20BTQ02 (Slave)	F25	63 A	20CKA02	4.2	
3	30BTQ01 (Master)	F25	63 A	30CKA02	-	
	30BTQ02 (Slave)	F25	63 A	30CKA02	-	
4	40BTQ01 (Master)	F25	63 A	40CKA02	-	EDS 4,5,6 Room
	40BTQ02 (Slave)	F25	63 A	40CKA02	-	
5	50BTQ01 (Master)	F25	63 A	50CKA02	7.1	
	50BTQ02 (Slave)	F25	63 A	50CKA02	9.5	
6	60BTQ01 (Master)	F25	63 A	60CKA02	-	
	60BTQ02 (Slave)	F25	63 A	60CKA02	-	

3.3 Parts of the *works* which the *Contractor* is to design.

a) The *Works* includes the provision of a new fully integrated Vibration Monitoring System with condition monitoring and diagnostic system capability. Figure 2 gives an overview of the functional requirements necessary for the VMS installation.

b) The *Contractor* analyses the requirements set out in the Works Information and provides a design solution that complies with the functional and performance requirements of this document for acceptance by the Project Manager.

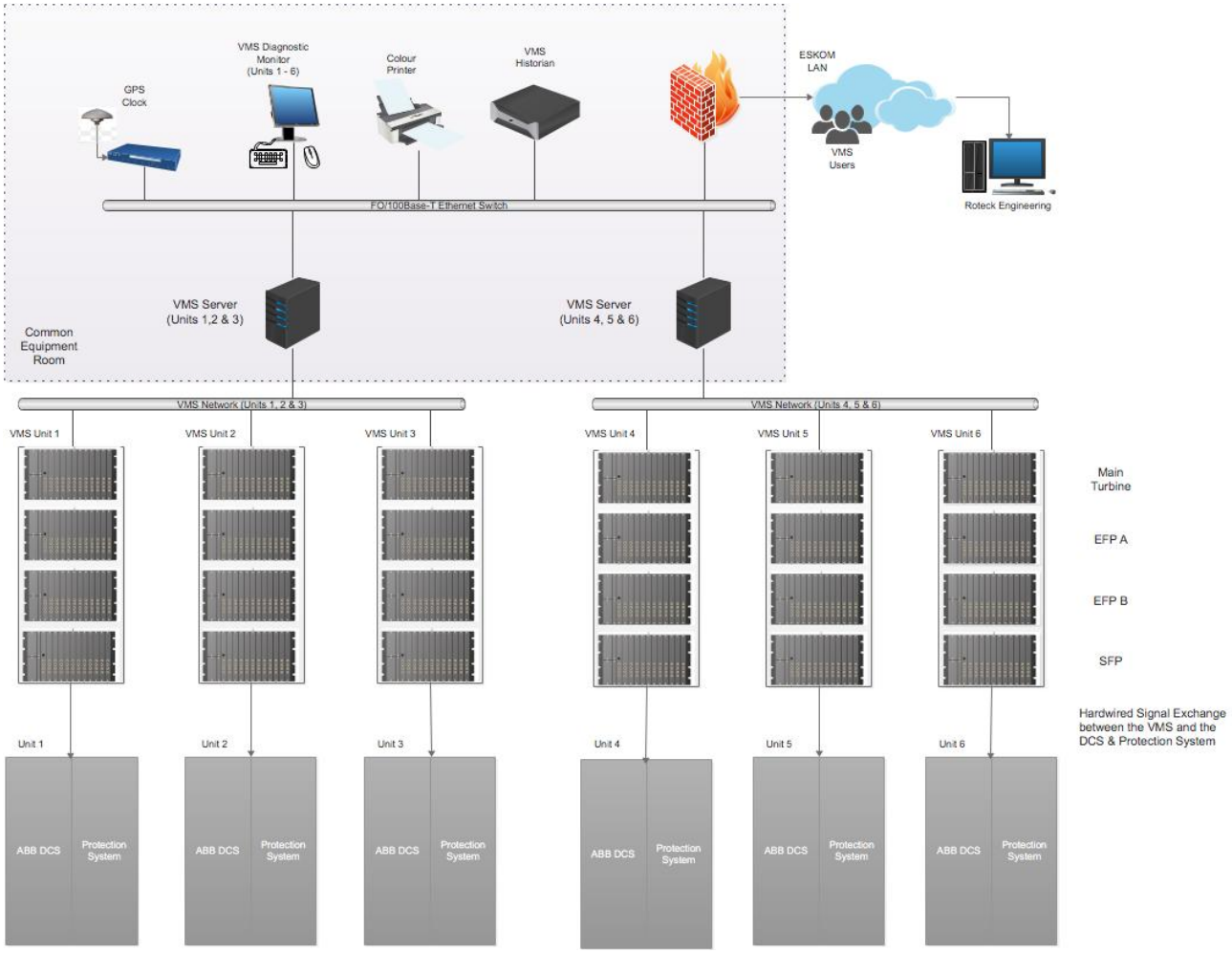

Figure 2 - VMS Functional Requirement

c) The *Contractor* performs the *Works* at the following plant areas at Arnot Power Station on Units 1, 2 and 6: the Main Turbine, Electrical Feed Pump A, Electrical Feed Pump B and the Steam Feed Pump Turbine.

d) Turbine.In addition, the *Works* includes Software Engineering, Hardware Engineering and licenses associated for all software (including operating systems) forming part of the scope.

e) The current supervisory equipment system including all field cabling, trunk cabling, hardware and specified field instrumentation shall be replaced for Units 1 – 6. The *Contractor* shall note that the supervisory equipment – Data Acquisition System will only be installed and commissioned on Units 1, 2 and 6.

f) The vibration monitoring system interfaces to the ABB DCS equipment on for Units 1, 2 and 6. The interface will be provided as analogue signals in the form of 4 – 20 mA signals and Potential Free Contacts (PFC).

g) Vibration Monitoring Systems (VMS) play an important role in the monitoring and protection of rotating machinery at Arnot Power Station. These systems shall provide an early warning of high machine vibration values and shall trip (or shutdown) plant or rotating machinery in the event of excessively high vibration values.

h) The tripping functions follow the existing operational and control philosophy of the Main Turbine, Electrical Feed Pumps and Steam Feed Pump Turbine. The MT turbine is tripped by the turbine protection system. The EFP's and the SFP is tripped by the DCS. The *Contractor* engineers, commissions and implements this functionality accordingly.

i) All engineering, design, equipment and installations comply at all times with the Works Information and meet the mandatory requirements of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993), and all applicable regulations of the Republic of South Africa.

j) The *Contractor* designs, procures, supplies, manufactures, delivers to Site, installs, decommissions, commissions and tests the Works to provide a fully functional system. The *Works* are located at Arnot Power Station in the Mpumalanga Province.

k) The Contractor is responsible for all hardware, equipment and software supplied as part of the Works and provides sufficient training to plant operating and maintenance personnel during the construction and commissioning phases to enable safe operation, diagnostics and maintenance of the Vibration Monitoring System.

l) All vibration measurements shall be in the following units:

- Displacement and Position – micrometres (μm) – (peak to peak).
- Frequency – Hertz (Hz).
- Speed – revolutions per minute (rpm).
- Velocity – millimetres per second (mm/s).
- Temperature – degrees Celsius (°C).
- Acceleration – millimetres per second squared (mm/s^2).

Table 3,4,5: Turbine Centreline, SFPT and EFP Vibration KKS

No	Description	KKS
1	MT BRG 1 LH DISPL	50MAD10CY021 XQ50
2	MT BRG 1 RH DISPL	50MAD10CY022 XQ50
3	MT BRG 1 LH VEL	50MAD10CY011 XQ50
4	MT BRG 1 RH VEL	50MAD10CY012 XQ50
5	MT BRG 2 LH DISPL	50MAD20CY021 XQ50
6	MT BRG 2 RH DISPL	50MAD20CY022 XQ50
7	MT BRG 2 LH VEL	50MAD20CY011 XQ50
8	MT BRG 2 RH VEL	50MAD20CY012 XQ50
9	MT BRG 3 LH DISPL	50MAD30CY021 XQ50
10	MT BRG 3 RH DISPL	50MAD30CY022 XQ50
11	MT BRG 3 LH VEL	50MAD30CY011 XQ50
12	MT BRG 3 RH VEL	50MAD30CY012 XQ50
13	MT BRG 5A LH DISPL	50MKD10CY021 XQ50

14	MT BRG 5A RH DISPL	50MKD10CY022 XQ50
15	MT BRG 5A LH VEL	50MKD10CY013 XQ50
16	MT BRG 5A RH VEL	50MKD10CY014 XQ50
17	MT BRG 5B LH DISPL	50MKD10CY023 XQ50
18	MT BRG 5B RH DISPL	50MKD10CY024 XQ50
19	MT BRG 5B LH VEL	50MKD10CY011 XQ50
20	MT BRG 5B RH VEL	50MKD10CY012 XQ50
21	MT BRG 6 LH DISPL	50MKD20CY021 XQ50
22	MT BRG 6 RH DISPL	50MKD20CY022 XQ50
23	MT BRG 6 LH VEL	50MKD20CY011 XQ50
24	MT BRG 6 RH VEL	50MKD20CY012 XQ50
25	MT BRG 7 LH DISPL	50MKD30CY021 XQ50
26	MT BRG 7 RH DISPL	50MKD30CY022 XQ50
27	MT BRG 7 LH VEL	50MKD30CY011 XQ50
28	MT BRG 7 RH VEL	50MKD30CY012 XQ50
33	VIBR TURB END AXIAL	50MKA01CY001 XQ50
34	VIBR TURB END RADIAL	50MKA01CY002 XQ50
35	VIBR TURB END TANG	50MKA01CY003 XQ50
36	VIBR TURB END AXIAL	50MKA01CY004 XQ50
37	VIBR TURB END RADIAL	50MKA01CY005 XQ50
38	VIBR TURB END TANG	50MKA01CY006 XQ50
39	HP ECC	50MAD10CG010 XQ50
40	IP ECC	50MAD20CG010 XQ50
41	HP DIFF EXP	50MAA01CY030 XQ50
42	IP DIFF EXP	50MAB01CY030 XQ50
43	LP DIFF EXP	50MAC02CY030 XQ50
44	THRUST 1	50MAD20CG001 XQ50
45	THRUST 2	50MAD20CG002 XQ50
46	THRUST 3	50MAD20CG003 XQ50
47	TACO	50MKD30CS001 XQ50
48	SFPT BRG 1 VERT	50XAD10CY011 XQ50
49	SFPT BRG 1 HOR	50XAD10CY012 XQ50
50	SFPT BRG 2 VERT	50XAD20CY011 XQ50
51	SFPT BRG 2 HOR	50XAD20CY012 XQ50
52	SFPT BRG 3 VERT	50LAC10CY011 XQ50
53	SFPT BRG 3 HOR	50LAC10CY012 XQ50
54	SFPT BRG 4 VERT	50LAC20CY011 XQ50

55	SFPT BRG 4 HOR	50LAC20CY012 XQ50
56	SFPT BRG 5 VERT	50LAC30CY011 XQ50
57	SFPT BRG 5 HOR	50LAC30CY012 XQ50
58	SFPT BRG 6 VERT	50LAC40CY011 XQ50
59	SFPT BRG 6 HOR	50LAC40CY012 XQ50
60	SFPT BRG 7 VERT	50LAC50CY011 XQ50
63	SFPT BRG 8 HOR	50LAC60CY012 XQ50
64	High Speed TACHO	50LAC30CS001 XQ50
66	THRUST 1	50XAD20CG001 XQ50
67	THRUST 2	50XAD20CG002 XQ50

EFP Temperature Protections	**KSS**
T MOTOR BRG NDE EFP B(degrees celsius)	10LAC20CT001
T Motor BRG DE EFP B	10LAC20CT002
T GXB MOTOR DE EFP B	10LAC20CT003
T GXB MOTOR NDE EFP B	10LAC20CT004
T EFP B GBX MTR NDE	10LAC20CT005
T EFP B GBX PUMP DE BRG	10LAC20CT006
T EFP B PUMP DE BRG	10LAC20CT007
T EFP B PUMP NDE	10LAC20CT008
T MOTOR BRG NDE EFP A	10LAC30CT001
T Motor BRG DE EFP A	10LAC30CT002
T GXB MOTOR DE EFP A	10LAC30CT003
T GXB MOTOR NDE EFP A	10LAC30CT004
T EFP A GBX MTR NDE	10LAC30CT005
T EFP A GBX PUMP DE BRG	10LAC30CT006
T EFP A PUMP DE BRG	10LAC30CT007
T EFP A PUMP NDE	10LAC30CT008
T EFP A PUMP THRUST BRG	10LAC30CT009
T EFP A PUMP THRUST BRG	10LAC30CT010
EFP B DE BRG VIBRATION (mm/s)	10LAC20CY013
EFP B NDE BRG VIRATIONS	10LAC20CY014
EFP B THRUST POSITION (mm/s)	10LAC20CY015
EFP A DE BRG VIBRATION	10LAC30CY013
EFP A NDE BRG VIBRATIONS	10LAC30CY014
EFP A THRUST POSITION	10LAC30CY015

KKS CODE	**SIGNAL**	**SIGN DISCRIPTION**
10LAC60CY012	XQ50	SFP BSTR NDE BRG HOR VEL

10LAC50CY011	XQ50	SFP BSTR DE BRG VERT VEL
10LAC40CY012	XQ50	SFP GBX LSP BRG HOR VEL
10LAC40CY011	XQ50	SFP GBX LSP BRG VERT VEL
10LAC30CY012	XQ50	SFP GBX HSP BRG HOR VEL
10LAC30CY011	XQ50	SFP GBX HSP BRG VERT VEL
10LAC20CY012	XQ50	SFP BRG NDE HOR VEL

m) The vibration monitoring systems for all machinery forming part of the scope of supply shall operate under all plant operating conditions and provide vibration information to the plant operator in the control room.

n) The plant operator shall verify that the main turbine, electrical feed pumps and steam feed pump is operating within safe operational limits, and in the event of excessive vibration, the protection system shall trip the plant to protect the plant from damage.

o) All equipment shall be suitable for the specific environment in which they are located. Equipment shall operate at the temperatures, humidity, vibration level and exposure to contaminants that prevail in their respective installation locations.

p) This Technical Specification describes the functional requirements for the Vibration Monitoring System to monitor and to protect the rotating machinery at Arnot Power Station.

q) The range of machinery includes:

- The Main Turbine (MT),
- 2X Electrical Feed Pumps (EFP),
- Steam Feed Pump (SFP)
- For all six units at the station.

r) The VMS consists of the following equipment, but is not only limited to these and the *Contractor* is to perform a full technical assessment of the scope and to provide for all required equipment necessary to meet the functional requirements of the scope of work:

- Vibration probes, accelerometers, and vibration equipment.
- Cabling, wiring and junction boxes.
- Transducers.
- Vibration monitors.
- Network connectivity.
- Diagnostic software and data management.
- Installation of equipment.
- Bracket design and installation.

s) The vibration equipment, type and amount of equipment selected shall meet the requirements of the specific rotating machine.

t) The *Contractor* shall perform as a minimum the following engineering, design and installation services:

- System design and layout.
- Mechanical designs, mechanical installation.
- Rotating machinery train diagrams for each rotating machine.

- Vibration probe, transducer installations.
- Loop checks, testing and commissioning.
- Vibration monitor configuration.
- VMS system security design.
- Hardware and software configuration.
- Software and system optimization.
- System reports.
- All project documentation
- System diagnostics and supporting services.
- Remote monitoring and diagnostics (via Eskom LAN & Rotek Engineering)

u) The scope of work describes the major activities and plant and material that falls within the scope of the *Contractor*. The *Contractor* shall be responsible to ensure that all the activities are carried out and all equipment, plant and materials are supplied to complete the works in every respect.

- The *Works* comprises the following:
- Detail Design
- Manufacture and procurement
- Delivery to and offloading at site
- Installation
- KKS labelling
- Interfacing with existing plant
- Commissioning, testing and optimisation
- Training of *Employer*'s personnel in the operation and maintenance of the system
- Documentation as specified
- Quality management for all activities
- Safety and plant signage
- Storage on site

v) The *Contractor* shall be responsible for the provision of a detailed operating and control philosophy as per the *Contractor's* detailed design of the works and submits this to the *Project Manager* for acceptance prior to commencing with the construction activities.

w) The *Contractor* shall provide a detailed maintenance philosophy for the plant which includes a preventative maintenance plan for the plant as a whole and for each component within the plant.

x) The *Contractor* shall provide a critical spares list for the works.

y) The *Contractor* shall also provide the necessary periodic maintenance inspections required for the plant together with the maintenance philosophy.

3.4 Diagnostic Monitoring functions

a) The vibration monitoring system of all MT's, EFP's and SFP's shall interface with a diagnostic system in a location that is suitable for production engineering and maintenance engineers and shall make provision for diagnostic functionality via the Eskom LAN.

b) The diagnostic system shall be loaded with software that will permit the following analyses as a minimum:

- Orbit display.

- Shaft centreline.
- Spectrum plot.
- Bode plot.
- Polar plot.
- Waterfall plots.
- Nyquist plots.
- Transient spectrum plots.
- Trending shall be for temperature and vibration.

c) The vibration monitoring system shall provide operational personnel with information for determining the condition of the rotating machinery and alarms of changes in machinery conditions.

d) This functionality shall be engineering configured, engineered within the diagnostic HMI for all rotating machinery. The HMI displays shall be representative of the actual machine being monitored.

e) The HMI on the DCS shall follow the existing HMI philosophy, and where changes in vibration philosophy is applicable, the *Contractor* shall ensure that the HMI is an accurate reflection of the As Built, Commissioned and Installed installation.

f) The system shall assist maintenance personnel with early problem identification to be able to do predictive maintenance.

g) The monitored information shall be protected against spurious power failures.

h) Access to protected information and the configuration of the system shall be limited by means of a key or password.

i) All alarms shall be printed with the corresponding times and sequence of occurrence.

j) Printed alarms shall be described by a short message to easily identify the specific alarm.

k) Historic data up to at least 24 hours immediately prior to the alarm or trip condition shall be captured. Appropriate intervals according to the specific application shall be used.

l) The system shall be able to display and print the following management information as a minimum requirement:

m) Sequence of events on an alarm condition.

n) Historical trend graph with the vibration level and corresponding time for every point being monitored for at least 60 days.

o) Alarm summary.

p) End of shift report with a short description of the monitoring point, current vibration over the shift, corresponding time and date.

3.5 Vibration Instrumentation

a) All vibration measurement instrumentation, probes and sensors used in the measurement of vibration parameters shall be recorded and made available as part of the hard over documentation. The type, model, serial numbers and the latest certified calibration certificates and calibration dates of all equipment used in vibration measurement loop shall be provided for by the Contractor.

b) Vibration equipment shall be calibrated by a qualified instrumentation laboratory, and all calibration of measurement instruments shall be traceable, and calibration certificates provided.

c) All measurement system equipment (probes, cables, transducers and mounting bracketry) used in the vibration measurement loop, shall be calibrated for measurement system accuracy over the selected frequency range of response of the measurement required.

d) The locations of where vibration instrumentation and measurement locations of vibration probes or sensors shall be documented, with machine layout drawings showing the installation orientation, system specifications and machine installation descriptions shall be provided. Typical documented information shall be:

- Component.
- Location.
- Sensor.
- Orientation.
- Sensor Axis Orientations.
- Direction of Motion.
- Example, shaft A, bearing number 3, single axis accelerometer positioned 90 degrees counterclockwise from zero, mounted radially, normal motion.
- This shall be provided for each measurement location, for each machine (MT, 2X EFP's & SFP), for every Unit (1 – 6).

e) Probes typically consist of a tip, probe body, coaxial cable and a connector, and where applicable shall function with a transducer to convert the distance between the tip of the probe and the conductive metal surface on the machine to a voltage signal.

- Proves shall be suitable for the operational conditions of where it is located (such as temperature, pressure, humidity and vibration etc.). All the materials used for the probe assembly shall be suitable for the application.
- The sensing face of the probe tip shall be 5mm or 8mm in diameter. The *Contractor* shall confirm the correct probe specification fit for the appropriate application.
- Integral to the probe installation is the coaxial cable, shall terminate in a coaxial connector where is connects to the transducer converter module where applicable.
- Probes shall be mounted is such a manner that it can be adjusted while the machine is running.
- Probes shall be mounted securely against vibration or tampering.

f) Where applicable temperature measurement shall be dual type K thermocouples or RTD.

g) In cases where the rotating machine is located within a hazardous location, all components of the VMS system shall meet the requirements for intrinsically safe (IS) instruments. Definitions as defined by SANS 60079-11 and SANS 10108.

3.6 Procedure for submission and acceptance of Contractor's design

a) The *Contractor* undertakes all phases of engineering and design and is shown in the Accepted Programme from the investigating phase, concept phase, system engineering & design through technical clarification, design freeze, procurement and production engineering to installation, commissioning and testing and addresses the following throughout the execution of the different project phases:

- The translation and incorporation of plant layout drawings, C&I P&ID, Electrical interfaces, Mechanical functionality, and third party documentation as specified in the *works* onto the *Contractor's* documentation to ensure an integrated documentation system.
- The design, engineering, commissioning and testing of all interfaces are performed by the *Contractor*.
- The detailed engineering of the field interfaces and interfaces within the control and indicating equipment, for both the hardware and software configurations.

- Strict adherence to the plant outage duration's during de-commissioning and removal of old equipment. Emphasis is placed on planning and up front work to achieve the prescribed outage times, prevent rework.

- The *Contractor's* design and engineering takes into account the performance requirements as specified for the control and indicating equipment's management and monitoring facilities as well as system. In particular an integrated and working control and indicating equipment's is provided which meets safety, reliability, availability, operability and maintainability criteria, performs all protection functions, supervisory control functions, and information sharing functions.

- The *Contractor* provides the various documents during the various phases as per the Accepted Programme and Completion of each *section* of the *works* is when the relevant documents are accepted by the *Project Manager*.

3.6.1.1 Investigation phase

a) The *Contractor* together with the *Project Manager* clarifies all project management issues. The Contractor validates any documentation provided by the *Employer* for accuracy against the existing and new installation to enable the detailed engineering and design by the Contractor for the analogue addressable fire detection and alarm system.

b) The *Contractor* benchmarks and test against functional design specifications that was developed from the investigation phase and accepted by the *Project Manager.* This information shall be used during the commissioning and acceptance test phases to demonstrate to the *Project Manager* the successful translation of such information into the control and indicating equipment.

c) The available existing documentation and drawings as referred to in section 6.7 is made available, by the *Employer*, to the *Contractor*

d) There is no involvement of an intermediate engineering function, and the *Contractor* works directly with the *Employer's* personnel, in liaison with the *Project Manager*, for all technical matters.

e) Before the investigation phase the *Contractor's* supervisor shall be appointed as an authorised supervisor as defined in the Plant Safety Regulations at Arnot Power Station. This requirement for the *Contractor's* supervisor remains until the defects date or the end of the last defect correction period.

f) The documentation synopsis and drawing register is submitted to the *Project Manager* and acceptance is obtained as a prerequisite to Completion of the investigation phase.

3.6.1.2 System engineering and design phase

a) During this phase, the detailed design is done to ensure that all systems and sub-systems form an integrated and consistent whole, including verification of all interfaces and the ability of these interfaces to create seamless connections to all systems.

b) In this phase all ground rules, design procedures, quality requirements, conventions, descriptions, symbols, representation of information in different categories and the method of finalising the power supply and related aspects, process operating and control philosophies, supervisory control, information sharing and alarming philosophies are determined, by the *Contractor*.

c) All functional and performance requirements are translated, by the *Contractor*, into a conceptual design which the *Contractor* presents to the *Project Manager* for acceptance, before proceeding with the design part of this phase. Overall concepts are checked for validity and refined by the *Contractor.*

d) The *Contractor* does not start on any system-specific phases until this phase is completed, i.e. design freeze is obtained following technical clarification with acceptance by the *Project Manager*.

e) Once design freeze is obtained and the engineering concepts are accepted by *Project Manager* the *Contractor* may start with the design. During the design, all functional and performance requirements are translated into specific hardware and software designs.

f) On Completion of the system engineering and design phase, the *Contractor* presents the complete process control and monitoring system design and the detail control, operating, alarming and information sharing philosophies to the *Project Manager* for acceptance. This is performed during formal clarification meetings arranged by the *Contractor* in accordance with the Accepted Programme.

g) Assistance to the *Project Manager* for this review and acceptance process is provided by the *Employer* and the *Contractor* ensures that these *Employer* activities are planned and included in the Accepted Programme.

h) The *Contractor* supplies three sets of the system engineering and design stage documentation in softcopy the *Project Manager* for acceptance at least ten (10) days prior to the start of the technical clarification discussions and it is shown in the Accepted Programme.

i) The system engineering and design stage documentation is in a logical format complete and prepared in conformity with the agreed documentation synopsis.

3.6.1.2.1 Technical clarification stage

a) During this stage, the *Contractor* clarifies all technical issues with the *Project Manager* to enable the *Contractor* to proceed with fabrication of the equipment following design freeze.

b) The *Project Manager* is presented with the design and philosophy information for *Employer's* review, acceptance and finalisation in the initial stage of this project stage.

c) As a minimum, this includes:

- System functional, and performance specifications.
- Communications and control system network(s).
- Control and indicating equipment allocation & distribution.
- Operator interface including all operating philosophies for GUI and LCD local control panels
- System management server and clients pc's and peripheral device distribution and specifications as well as space, power and ventilation specifications.(For Interface with civil *Contractor*)
- New civil building design layouts
- Emergency lighting for new civil building design layouts
- GUI interface design.
- Operating displays and navigation.
- Interfacing and communication specifications.
- Interfacing to field equipment.
- All hardware and software interfaces.
- Detail control and operating philosophies.
- Mechanical designs (HVAC, control and indicating equipment, etc).
- Alarm/event handling.
- Historical data and alarm retrieval and backup facilities.
- Information handling, storage, backup and disaster recovery facilities.
- Verification of databases.
- Calculations (Nodes, System management server and clients, Data servers)
- Power supplies specifications, allocation and distribution, lockable isolation facilities (220VAC and 24VDC) and earthing.
- UPS and batteries specifications
- Integrated forward documentation system/station.
- Quality assurance and quality control measures and methodologies.
- Design methodologies & procedures.

d) Documented proposals of the factory acceptance testing (FAT), installation and commissioning procedures, Site integration testing (SIT), Site acceptance testing (SAT) both of the process control

and monitoring system functions and performance as well as the plant processes operating and performance, operational testing.

e) Documented proposals of engineering, maintenance and operating documentation.
f) Documented proposals of engineering, maintenance and operating training manuals.
g) Project phasing, resources to meet availability requirements.
h) Roll out/ commissioning methodologies.

i) The drafts of all documentation for technical clarification are presented to the *Project Manager* at least ten (10) working days prior to the technical clarification meeting and it is shown in the Accepted Programme.

j) The *Contractor* is responsible for the identification and gathering of any information and data required for the design. Where the information required is not available, the *Contractor* is responsible for the collection or alternatively, the generation of the information.

k) The documentation control system e.g. cabling management system, installation and shop drawings management system section is presented by the *Contractor* to the *Project Manager* for acceptance at the technical clarification stage as a prerequisite to Completion of the technical clarification stage.

3.6.1.2.2 Design Freeze stage

a) In this stage the information from the technical clarification stage are presented to the *Project Manager* for acceptance.

b) The *Contractor* provides the following documentation within ten (10) working days of Completion of the technical clarification phase and it is shown in the Accepted Programme:

- All documents required, fully describing the functional and physical design of the *works*.
- Build-to specifications for all interfaces, hardware, application software, networks, power supplies, distribution, isolation facilities and earthing for the control and indicating equipment.
- GUI displays, logs, reports templates.
- System management server and clients, control network hardware and applications software specifications.
- Control, operating, alarming and information sharing documentation.
- Detailed project execution processes, i.e. installation, commissioning and roll out procedures and methodology.
- Proposed FAT, SIT, SAT and operational test procedures and methodologies. This covers both the requirements of the process function and performance parameters to be met as well as for the control and indicating functionality and performance.
- Quality assurance and control methodologies.
- Architecture and engineering functional design specification (FDS), which includes the final performance, functionality and equipment specifications of the control and indicating equipment as compiled during the technical clarification phase.
- A summary of the outcome of all the technical clarification meetings.

c) During this stage the format and content of all operating, engineering and maintenance manuals and drawings, and training manuals is clarified and agreed.

d) Two first draft copies of operating, maintenance and engineering manuals and drawings are supplied by the *Contractor* ten (10) days prior to Completion of the design freeze stage and *Project Manager's* acceptance is obtained as a prerequisite to Completion of the design freeze stage.

e) The *Contractor* obtains *Project Manager* Acceptance of the system engineering and design phase documentation as a prerequisite to Completion of the design freeze stage and prior to the commencement of work on the next project phase.

3.6.1.3 Production engineering phase

a) During this phase, the *Contractor* completes all production engineering (engineering activities that translate the requirements finalised during technical clarification and design freeze into an operational system).

b) The following documentation is presented to the *Project Manager* at least fifteen (15) working days prior to factory acceptance testing and it is shown in the Accepted Programme:

- Two copies of the design documentation.
- Two copies of the relevant QA and QC documentation.
- Two copies of installation, commissioning, switchover, and de-commissioning documentation.

c) Review and acceptance by the *Project Manager* does not relieve the *Contractor* of his responsibility for the correctness of the design and the ability of the w*orks* to satisfy the requirements of the *Works* Information.

d) Three copies of all other production engineering design documentation, prepared in conformity with the system engineering and design phase documentation, are issued by the *Contractor* to the *Project Manager* for acceptance at least ten (10) working days prior to the commencement of any procurement, fabrication, detailed design or construction and it is shown in the Accepted Programme.

3.6.1.3.1 Procurement and fabrication stage

a) The *Contractor* performs the proper co-ordination and execution of procurement, inspection, expediting, delivery and QC of all Equipment required, providing the Works.

b) Items of Equipment identified for payment in the activity schedule is delivered to either the Site or the *Contractor's* works and assessed for payment upon verification and marking by the *Supervisor*.

3.6.1.3.2 Factory acceptance testing (FAT) and delivery stage

a) Prior to transport of the fire detection system to site, the system must undergo Factory Acceptance Testing (FAT). With this test, the *Contractor* demonstrates that the fire detection system meets all the requirements of the Functional Design. The tests are witnessed by the *Supervisor* and Others (e.g. the *Employer's* personnel and/or third party inspectorate).

b) The test procedure is compiled by the *Contractor* and presented to the *Project Manager or delegate* for acceptance during the technical clarification phase and it is shown in the Accepted Programme.

c) All hardware and software are available and operational before the FAT commences. Following the FAT, the process control and indicating equipment runs for a continuous period of 120-hours without any failure of hardware, software or functions. All inputs and outputs will be tested beforehand and predefined simulated inputs are used for the tests. The *Contractor* performs a complete functional test of all the control and indicating equipment systems before delivery to Site.

3.6.1.3.3 Factory acceptance testing minimum requirements.

a) The facilities provided with the process control and monitoring system are used to monitor performance, diagnose states and to demonstrate functionality listed below. Each individual device and the control and indicating equipment system as a whole are tested, using all the I/O for the conditions stated below:

- CIE CPU and COMS functions, performance, card fail over tests.
- Power supply functions, performance, failure handling.

- Control and Communication network functions, performance, failure handling.
- I/O functions, performance, failure handling.
- Remote I/O performance, failure handling.
- Test of common mode failures (Battery chargers, network devices)
- Printer functions, performance, failure handling.
- System management and client functions, performance and failure handling.
- Engineering functions, performance and failure handling.
- General system performance and failure handling.
- Worst case data avalanche loading of CIE.
- Object orientated integrated forward documentation system functions, performance and failure handling.
- Correct functioning of all hardware and software is demonstrated in terms of the Works Information requirements.

b) The purpose of these tests is to demonstrate that the control and indicating equipment meets the functional and performance requirements and is fit for shipment to Site, but this does not relieve the *Contractor* of his responsibility for the satisfactory functioning and performance of the control and indicating equipment during site acceptance testing (SAT).

c) The proposed test procedures, together with test dates, are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance during the system engineering and design phase.

d) The final test procedures are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance at least ten (10) working days prior to the scheduled test date. The *Contractor* shows these dates in the Accepted Programme.

e) FAT is performed by the *Contractor*, on each individual system and the system as a whole to demonstrate the interoperability.

f) The hardware used for the FAT, when successfully completed, is shipped and delivered to the Site for the Site acceptance testing (SAT).

3.6.1.4 Construction and erection phase

a) This phase involves the following *Contractor* activities:

- The installation of the control and indicating system equipment.
- The integration of the equipment and installation field detectors and sensors
- The installation of the relevant GUI equipment, and peripheral devices and engineering room equipment.
- The installation of the communications and control networks systems.
- The erection and installation of new cubicles/panels and any infrastructure required to house equipment in the engineering room and plant.
- The erection and installation of any infrastructure, in addition to the civil work done, required to house or contain the *Contractor's* equipment.
- The *Contractor* is responsible for the provision and storage of all temporary or expendable materials required.

3.6.1.5 Commissioning phase

a) Commissioning depends on the plant condition as well as production requirements refer to section 2.7. The *Contractor* shall at all endeavour to adjust his programme by switching systems due for implementation to cater for plant availability.

b) The *Contractor* confirms the final arrangement with the *Project Manager* at least 2 working days prior to commissioning and is shown in the Accepted Programme.

3.6.1.5.1 Commissioning documentation requirements

a) The *Contractor* prepares test documentation as well as the final commissioning procedures for all plant areas and its associated control and indicating equipment system as a whole.

b) The documents incorporate space for the *Contractor* to enter results of the testing as well as space for both parties to witness that the tests have been conducted according to the mutually agreed test procedures, successfully and meeting the Works Information functional and performance requirements All the documentation, manuals and drawings for the control and indicating equipment are put in place, by the *Contractor*, before the relevant test commences. This documentation is submitted to the *Project Manager* for acceptance at least three (3) weeks prior to commissioning and testing and is shown in the Accepted Programme.

c) All documentation is incorporated into the commissioning and testing manuals, with full details on testing methods and procedures.

d) The *Contractor* provides notification to the *Project Manager* two (2) weeks prior to commencement of commissioning and testing and it is shown in the Accepted Programme. The *Supervisor* inspects all parts during commissioning and is present at any of the tests performed by the *Contractor*. Should the *Supervisor waive* the witnessing of any tests it does not relieve the *Contractor* of any of his responsibilities.

e) Any tests required by the *Supervisor* are carried out during commissioning to prove compliance with the Works Information, irrespective of any tests carried out at the manufacturer's facility during erection and FAT.

f) All test and calibration Equipment is provided and maintained to the required accuracy by the *Contractor*. The accuracy of test and calibration Equipment is proven to the *Supervisor* with valid certificates by an approved authority to be better than ±0, 1%. The type and class of Equipment used is subject to acceptance by the *Supervisor*. During any phase of the testing, the *Supervisor* may require that the Equipment be checked by the SABS.

g) The *Contractor* provides a test certificate for each section of the plant groups and detection zones of the control and indicating equipment up to detection device. The format of this certificate is presented to the *Supervisor* for acceptance prior to its use by the *Contractor*.

h) The test results in the form of check sheets following each commissioning and test stage is submitted to the *Project Manager* for acceptance prior to the *Contractor* progressing to the next phase or stage.

i) The *Contractor* supplies all Equipment and resources needed for testing and commissioning.

j) The *Supervisor* co-ordinates the commissioning of all equipment forming an integral part of the plant being commissioned.

k) In those cases where various components are connected to form an integrated system, the *Contractor* carries the responsibility for the correct functioning and performance of the entire control and indicating system.

l) In the event of incorrect functioning, the *Contractor* determines the cause and corrects the *Defects*, in liaison with the *Project Manager*.

m) Where it is not possible to test signal transmission from the field instrument and the *Supervisor* agrees, a simulated signal is injected as far back as possible, and the result verified on the GUI and system management server as well as the resultant reaction of the supervisory and monitoring outputs.

n) The system is proven by the *Contractor* to perform in accordance with the requirements of the Works Information, for acceptance by the *Project Manager*. Test certificates are issued for each plant or sub-system tested and proven.

- Testing (acceptance testing and operational testing)

o) All components designed, procured and fabricated, by the *Contractor*, are subjected to acceptance and integration tests. These tests are planned and included in the Accepted Programme and are witnessed by the *Supervisor*.

- Inspection checklists and certification of activities

p) Results of inspections, tests and other activities performed in accordance with the *Contractor's* QC procedures and plans are recorded on standardised checklists and certificates (refer to GGP 03490 Rev 0, "Procedure for onsite commissioning for low pressure systems", for the format) it also includes any additional checklists.

3.6.1.5.2 Site integration test (SIT) stage

a) The *Contractor* carries out SIT to ensure the correct performance of the control and indicating equipment's communication networks, management and monitoring. Most importantly, this is performed to ensure safety of plant and personnel, and to ensure compliance with the Works Information before commissioning of any plant commences.

b) The proposed test procedures, together with test dates, are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance during the system engineering and design phase.

c) The final test procedures are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance at least twenty (20) working days prior to the scheduled test date. The *Contractor* shows these dates in the Accepted Programme.

d) The *Contractor* provides the entire test Equipment for testing the individual modules, the subassemblies and the functional groups for Site testing and commissioning. Records are kept of each SIT in a log book defining the test to be under taken, time and date of commencement of the test, duration of the test, criteria that need to be met and results obtained of the tests. These records are submitted to the *Project Manager* for acceptance after the Completion of each of the SIT tests. In the event of an error with any test (hardware or software), the fault is notified as a Defect and is analysed by the *Contractor* and the solution reported the *Project Manager.*

e) The *Project Manager* determines if the Defect is of a minor nature, the *Contractor* is given access to rectify the Defect and the item is re-tested for the full duration. Major Defects such as hardware or software failure on the CIE, communication/control network device or system management server failure, power supply failure, system stall, local or remote I/O communication failure, UPS or Battery Charger failures, etc. terminates the SIT. The *Contractor* rectifies the Defect(s) and re-starts the SIT after proving the corrected Defect by carrying out the appropriate diagnostic tests. Upon Completion of SIT, the control and indicating equipment is deemed available for commissioning.

3.6.1.5.3 Commissioning stage

a) Before equipment is placed in service, the *Contractor* certifies that it is in a suitable and safe condition, subject to acceptance by the *Project Manager*.

b) The *Contractor* performs the commissioning of the entire control and indicating equipment and all tests for signals are done from the primary element (field equipment) to the GUI and common repeater stations. Assistance for the *Contractor* may be provided for this activity by representatives from the *Employer's* personnel. The *Contractor* submits a written request to the *Project Manager* for this

assistance, two weeks prior to commencement of commissioning and it is shown in the Accepted Programme.

c) The *Contractor* performs the optimisation of the control and indicating equipment as a prerequisite for Completion of commissioning and it is shown in the Accepted Programme.

- Loop checks

d) After installation of field equipment associated with the control and indicating equipment has been completed, the *Contractor* checks each loop to ensure that each addressable device is allocated as per zone design and all management and monitoring functions is as required by the *works*.

e) Notwithstanding the *Contractor's* QA or QC checks, the *Project Manager* has the right to inspect the system during erection and to be present and witness any tests.

3.6.1.5.4 Site acceptance testing (SAT) stage

a) The *Contractor* provides a detailed site acceptance test procedure, which is presented to the Project Manager for acceptance at least twenty (20) working days prior to the commencement of the site acceptance testing and it is shown in the Accepted Programme. The detailed acceptance test procedure covers all the activities and related documentation of the site acceptance test stage.

- Site acceptance tests

b) After Completion of installation and commissioning of the control and indicating equipment in conjunction with the plant, the *Contractor* demonstrates that the control and indicating equipment correctly performs in the following modes:

c) All the functions and performance requirements as specified in the Works Information at all the levels of the control and indicating are exercised.

3.6.1.5.5 Operational testing phase

a) The *Employer runs the works continuously* for a period of 336 hours without any hardware or software malfunction. During this period, any and all management and monitoring functions may be exercised.

b) In the event of any hardware or software Defect, the *Contractor* corrects the Defect and based on the nature/merit of that Defect, the *Project Manager's* sole discretion can then allow the 336-hour test to continue or inform *Contractor* that the test be restarted.

c) This testing phase will entail a 336 hour window for a fully function emergency management system.

d) During the operational test, the w*orks* is not deemed in use until the *Project Manager* certifies Completion.

3.7 Other requirements of the *Contractor*'s design

N/A

3.8 Use of *Contractor*'s design

N/A

3.9 Design of Equipment

a) On some complex projects requiring sophisticated temporary works, it could be in the Parties best interests that some details of the *Contractor*'s design or proposed design of Equipment are shared with the *Project Manager*, not necessarily for his acceptance but as an assurance that the Equipment will be able to allow the *Contractor* to Provides the Works efficiently and without delay. For example a tunnel boring machine, or specialised shuttering for a bridge or caisson. Draft in such a way that there is no doubt that the liability for such design and use of the Equipment remains with the *Contractor*. Clause 23.1 is always available to the *Project Manager* if this section is not used.

3.10 Equipment required to be included in the *works*

a) The defined term 'Equipment' in core clause 11.2(7) makes a cross reference to the Works Information concerning any Equipment which the *Contractor* is required to include in the *works*. Complete here or if not applicable either delete the heading or retain the heading and state 'None'.

List of Equipment required

3.10.1 Transducers

The following transducers will be supplied:

3.10.1.1 Turbogenerators (6)

- 16 x Proximity Probes for the 8 measuring areas in an X-Y configuration (shaft relative)
- 18 x Velomitor Transducers (2 per measurement point and 2 gen axial
- 3 x Thrust position probes (Axial)
- 2 x Eccentricity Proximity Probes (HP, IP)
- 1 x Differential Expansion Probes (HP – standard configuration)
- 4 x Differential Expansion Probes (IP and LP – Complimentary configuration)
- 2 x LVDT's for the HP Casing Expansion
- 1 x Keyphasor Proximity Probe

3.10.1.2 Steam Feed Pump Sets (6)

- 14 x Velomitors for the following radial bearings:
  i. Turbine Front (2)
  ii. Turbine rear (2)
  iii. Main pump front (2)
  iv. Main pump rear (2)
  v. Gearbox HS (2)
  vi. Gearbox LS (2)
  vii. Booster Pump Front (1)
  viii. Booster Pump Rear (1)
- 2 x Thrust position probes for turbine
- 1 x Keyphasor Proximity Probe for the booster pump
- 1 x Keyphasor Proximity Probe for the main pump

3.10.1.3 Electric Feed Pumps (12)

- 2 x Velomitor Transducers for the following bearings:
    I. Booster pump Front (1)
    II. Booster Pump Rear (1)
- 1 x Thrust Position Probe for the main Pump
- 2 x Reverse Rotation Proximity probes for the Main pump (also keyphasor)

3.10.2 Transducer Accessories

3.10.2.1 Junction Boxes

The *Contractor* assesses the condition, suitability and capacity of the existing junction boxes during detailed engineering. Existing junction boxes may be retained where they comply with the technical requirements of the new VM600 installation. The *Contractor* supplies and installs replacement or additional junction boxes where required to deliver a fully functional and compliant system.

3.10.3 Racks

a) The *Contractor* designs, procures, supplies, installs, configures, integrates, tests and commissions complete Parker Meggitt VM600 Data Acquisition System racks for Units 1, 2 and 6. As a reference design, each of the units will be supplied with two new monitoring racks. Each rack will have a 19" rack chassis, a dual power supply, a communication interface and the requisite VM600 monitoring and I/O modules to match the transducers in the field. The first rack shall house the main Turbine requirements, while the second rack will be for the steam feed pump and two EFP's. The reference rack configuration is as follows:

3.10.3.1 Main Turbine

a) Rack 1 – Vibration rack

- 19" Panel mount rack chassis
- Dual Power supplies (220Vac)
- Transient data Interface
- One 3500/25 2-channel Key phasor Monitor
- Two 3500/33 16-channel relay modules
- Nine 3500/42 4-channel Prox/Seismic Monitors (16 radial probes, 18 Velomitors and 2 Eccentricity probes)

b) Rack 2 – Position Rack

- 19" Panel mount rack chassis
- Dual Power supplies (220Vac)
- Transient data Interface
- Two 3500/33 16-channel relay modules
- Four 3500/45 4-channel Position Monitors (5 x Diff-ex probes, 2 x casing LVDT's and 3 x Thrust Position Probes

3.10.3.2 Steam Feed Pump and Electric Feed Pumps

- 19" Panel mount rack chassis
- Dual Power supplies (220Vac)
- Transient data Interface
- One 3500/25 4-channel Keyphasor Monitor
- Three 3500/33 16-channel relay modules
- Four 3500/42 4-channel Prox/Seismic Monitors for the SFP (8 Velomitors, 2 Thrust probes)
- One 3500/42 4-channel Prox/Seismic Monitors for EFP 1 (2 Velomitors, 1 Thrust probe)
- One 3500/42 4-channel Prox/Seismic Monitors for EFP 1 (2 Velomitors, 1 Thrust probe)
- One 3500/50 2-channel Tacho Monitor for EFP 1 reverse rotation
- One 3500/50 2-channel Tacho Monitor for EFP 2 reverse rotation

b) The proposed configuration shall accommodate the Main Turbine, Steam Feed Pump Turbine and Electrical Feed Pumps A and B, including all required vibration, thrust position, differential expansion, eccentricity, speed and other applicable monitoring functions.
c) The VM600 systems shall include the necessary rack chassis, power supply modules, monitoring and processing modules, communication interfaces, relay and analogue output interfaces, software, licences and spare capacity to meet the functional and performance requirements of the *Works Information*.
d) The *Contractor* shall verify the final rack quantities, module selection, channel allocation and interface requirements during detailed engineering, subject to acceptance by the *Project Manager*. The design shall retain the required machinery protection functions and comply with the applicable technical specifications.

3.10.4 Networking

a) We are not proposing any changes to the existing networking on site. All network cabling will be replaced.

3.10.5 Software

a) Due to the fact that System 1 already exists on site and that it covers only the main turbine, we have assumed that the servers and a technical support agreement shall be purchased prior to this project. Due to this, it is assumed that the System 1 shall be of the latest version before installation or upgraded to another brand/OEM. In this case, we only require upgrading the existing licenses from TDXnet type to TDI Transient Points on the main turbine, while supplying new licensing for the BFPs. Contractor shall supply licenses of all systems installed.

b) The System 1 licensing will be supplied as follows:

- Licensing media

c) The *Contractor* identifies, procures and supplies all software and licences required for the configuration, operation, maintenance and integration of the VM600 systems. The *Contractor* verifies compatibility with the existing machinery condition monitoring systems and identifies any required interface upgrades or modifications during detailed engineering, in accordance with the *Works Information*.

3.10.6 Cabinets

a) We have not provided for the supply of new cabinets, but we shall modify the existing cabinets to fit the required racks.

3.10.7 Server Computers

a) We have assumed that the servers on site shall be upgraded before the beginning of this project.

3.10.8 Cabling

a) We have made provision for the supply and installation of new field cabling for all the transducers.
b) We have considered the following lengths:

- We have considered the supply of 8 triad cabling for all junction boxes.

3.11 As-built drawings, operating manuals and maintenance schedules

3.11.1 Documentation synopsis

a) The contract documentation synopsis, prepared by the *Contractor*, consists of documentation that is produced for the *works*.

b) The *Contractor's* documentation synopsis is a summary and general overview of the whole documentation package forming part of the *works.* It provides the *Project Manager* with a clear indication of its contents for assessment and acceptance of site-specific documentation.

c) The synopsis lays down the structure and content of documentation supplied as part of the *works* and includes a list with test procedures and drawings allowing the *Project Manager* to visualise what is supplied during the various project phases and stages.

d) The *Contractor* includes standard documentation and procedures such as:

- Standard brochures, catalogues, descriptions
- Design standards, codes of practice, design guidelines, installation, test, commissioning and optimization procedures
- Drawing system description and index
- Document management procedures
- Quality assurance documents
- Design modification procedures
- Data sheets of control and indicating equipment (detectors, sensor, sounders, modules, printed circuit boards etc.)

e) The format, content, layout and quality of all documentation are subject to acceptance by the *Project Manager*.

3.11.2 Failure to supply documentation and drawings.

a) In the event of completed drawings, instruction manuals, procedures, switchover methodologies, schedules and programmes not being in the possession of the *Project Manager* within the specified period five days (5 days) prior to Completion for each project phase, the *Contractor* does not proceed to the next project phase or stage until the documents are supplied by the *Contractor* and accepted by the *Project Manager*.

b) Dates of supply of documentation are planned by the *Contractor* and shown in the Accepted Programme.

3.11.3 Documentation and drawings of third-party equipment

a) All third-party equipment used by the *Contractor* to Provide the Works is accompanied by the following documentation:

- All technical drawings (layout, circuit diagrams, etc.)
- Design standards, codes of practice, design guidelines, installation, test, commissioning and optimization procedures
- Maintenance, operating manuals and engineering manuals.
- User manuals.
- Software copies of manuals.
- Settings and configuration (HW and SW) as applicable to the Arnot Power Station control, monitoring, supervising and communication system as required to Provide the Works.

3.11.4 Documentation and drawing general requirements.

a) All the documentation and drawings are provided by the *Contractor* within the specified periods for the various project phases and stages as shown in the Accepted Programme.

b) Documentation requirements covers the life cycle of the project from the initial engineering stages through to installation and commissioning including operating, maintenance and the training stages of the project. Not only should these documents be comprehensive and complete but also comply with strict document control and revision procedures.

c) The *Contractor* supplies the following as minimum:

- Standard brochures, catalogues, descriptions.
- Design standards, codes of practice, design guidelines.
- Installation, test, commissioning procedures.
- Installation, test, commissioning results.
- QA&QC documents as specified.
- Design modification procedure:
- Change/modification control
- Optimisation procedures and results
- Reverse Engineering
- Documentation that indicates all Arnot Power Station specific settings of all components of the process control and indicating equipment systems.
- Operating and maintenance manuals.
- Engineering manuals.
- Documentation detailing the verification, formulation and design & engineering of operating and control philosophies.
- All drawings, manuals and schematics are uniquely identified and cross referenced with all related documents, whether produced by the forward documentation system or not.
- Third party documentation, drawings, as built settings.
- Spares listings.
- “As built” documentation is supplied indicating at least the following.

- Drawing and Documentation system description and index.
- Document management procedures.
- Copies of all test certificates pertaining to the contract.
- Installation and shop drawings.
- Cable and wiring schedules.
    i. Specification
    ii. Size and type of cables
    iii. Cable routes
- Equipment rack, panel and junction box layout drawings.
- Single line diagrams and schematics.
- Termination schedules/diagrams.
- Each fire zone panel.
- Isometric view of extinguishing distribution system, showing the length and diameter of each pipe segment and node reference numbers relating to the flow calculations.
- Drawings, to an indicated scale of extinguishing distribution system, including containers, location of containers, piping and nozzles, valves and pressure reducing devices and pipe hanger spacing.
- Enclosure cross-section, full height or schematic diagram.
- The positions of all equipment that may require routine attention or replacement (e.g. short circuit isolators);
- A list detailing each of the recommended Agents or Suppliers, together with full postal addresses and contact details, for each item of equipment called for and installed by the *Contractor* as required to Provide the Works.
- Spares listings.
- Settings and configuration (HW and SW) as applicable to the Arnot Power Station control, monitoring, supervising and communication system as required to Provide the Works.
- Software registration codes and or authentication reports.
- Password and or access codes.
- Upon handover of an installation, a set of clear laminated and framed copy of the following drawings, etc. shall be supplied by the *Contractor* and wall-mounted at the locations indicated.

4 Procurement

4.1 People

4.1.1 Supplier Development and Localisation

a) Supplier Development and Localisation: Local to site people will be appointed and there will be skills development during the contract period.

4.1.2 BBBEE and preferencing scheme

a) **BBBEE Compliance**

b) BBBEE status targeted for this transaction is Level 1-4
c) (contractor/s will be required to submit plans to achieve the target level if not met at contract award)

4.1.3 Accelerated Shared Growth Initiative – South Africa (ASGI-SA) currently known as Supplier Development, Localisation and Industrialisation

a) The *Contractor* complies with and fulfils the *Contractor's* obligations in respect of the Accelerated and Shared Growth Initiative - South Africa in accordance with and as provided for in the *Contractor*'s ASGI-SA Compliance Schedule stated below:

Commodity	Components	Local Content Threshold
Electrical and Telecom Cables	Cables	90%

Targeted subcontracting percentage

b) 30% Subcontracting to a Qualifying Small Enterprise or Exempted Micro Enterprise that is 51% or more black owned.

c) CIDB Skills Development:
- It is mandatory for the Supplier to match Eskom's
- targets below:

Description	Eskom Target CSDG Percentage (%)	Tenderer Commitment
Electrical Engineering works (Infrastructure)	**0,25%**	

NOTE 1: Commitment Letter for the above CIDB Skills Development is therefore mandatory and must be a tender returnable at Tender Stage.

d) Mandatory Compliance for Contract Award: Skills Development targets

e) The contractors are required to propose skills development against Eskom's targets:

Eskom's Target			
Category	Number	Entry Level	Output
1.Technicians 2. Artisans	2 2	S4 and S5 Matric/ N3	P1 and P2 Technical Trade
Suppliers Commitments			
Category	Number	Entry Level	Output
1. 2.			

Local Procurement Content

f) Local Procurement Content" refers to value added in South Africa by South African resources. Where a single contract involves a combination of local and imported goods and/or services, the tender response must be separated into its components as per the Price Schedule included with the tender documents. Local procurement content is total spend minus the imported component.

Local Procurement Content	Eskom Target	Tenderer Proposal
	100%	

g) The *Contractor* shall keep accurate records and provide the *Project Manager* with reports on the *Contractor*'s actual delivery against the above stated ASGI-SA criteria.

h) The *Contractor*'s failure to comply with his ASGI-SA obligations constitutes substantial failure on the part of the *Contractor* to comply with his obligations under this contract.

4.2 Subcontracting

4.2.1 Preferred subcontractors

a) The *Contractor* submits to the *Project Manager,* for his acceptance, the names of any proposed Subcontractor(s) and the *Contractor,* only with the *Project Manager's* consent in writing, subcontracts with any person for the Provision of the Works*,* or any part thereof or for the manufacture or supply of any of the Plant, Materials or Equipment used on the *works* other than for any part of the *works* of which the makers are named in the contract.

b) The *Project Manager* is entitled to withhold acceptance of any proposed Subcontractor or to rescind acceptance of any Subcontractor, in which case the connection of such Subcontractor with the *works* ceases and he immediately withdraws from the Site.

c) All Subcontractors work according to the OHSACT 85 of 1993 and applicable regulations, and the *Contractor's* safety file updated with their information in compliance with the construction regulations.

4.2.1.1 Preferred subcontractors and Black Economic Empowerment

a) Preference is given to South African companies as possible Subcontractors. Where possible, local resources are utilised.

b) A predetermined and mutually agreed value of this contract, at the Contract Date, is attributable to Eskom Holdings Limited Classified Black Economic Enterprises (BEE) / Small Medium & Micro Enterprises (SMME) or Black Woman Owned (BWO) Enterprises.

c) The value attributed to such enterprises is monitored by the *Contractor* and submitted to the *Project Manager* for acceptance by means of a monthly statement of expenditure.

4.2.2 Subcontract documentation, and assessment of subcontract tenders

a) The *Contractor* will provide the *works* as if he had not subcontracted and are liable and accountable for all actions of his subcontractors.

4.2.3 Limitations on subcontracting

a) The *Contractor* under no circumstances recruits labourer(s) at Arnot Power Station's security gates.

b) The *Contractor* may be requested by the *Employer* to submit details of the qualifications and experience for each category of personnel and specialists for which a rate is submitted.

4.2.4 Attendance on subcontractors

a) Not applicable to this contract document.

4.3 Plant and Materials

4.3.1 Quality

a) The *Contractor* complies with the *Employer*'s quality requirements.

4.3.2 Plant & Materials provided "free issue" by the *Employer.*

a) The *Employer* does not free-issue any new Plant and Materials under this contract. The *Contractor* is responsible for the procurement and supply of the complete VM600 Data Acquisition Systems, including racks, modules and associated equipment, in accordance with the *Works Information*. Existing *Employer*-owned equipment and infrastructure may be reused only where expressly permitted by the *Works Information* and accepted by the *Project Manager*.

4.3.3 *Contractor*'s procurement of Plant and Materials

a) The *Employer* requires warranties from suppliers to be in favour of the *Employer.* Also, include requirements for vendor data, which the *Employer* may need after Completion of the whole of the *works*.

4.3.4 Spares and consumables.

a) Refer to the relevant Works Information documents.

4.4 Tests and inspections before delivery

a) Core Clauses 40 and 41 both make reference to the Works Information regarding tests and inspections.

4.4.1 Factory acceptance testing

4.4.1.1 General

a) Factory acceptance tests (FAT) are performed to test the functionality of equipment and to test whether the equipment meets the requirements in the Works Information. These tests are performed by the *Contractor* commissioned to do the work and are witnessed by the *Supervisor.* This takes place prior to the delivery of equipment.

b) Each item that forms part of the acceptance test is detailed and signed off indicating acceptance by both the *Contractor* and the *Supervisor.* Any exceptions or deviations are noted as a Defect and are analysed by the *Contractor* and the solution reported to the *Project Manager or delegate.*

c) The *Project Manager or delegate* determines if the Defect is of a minor or major nature. The *Contractor* rectifies the Defect, and the item is re-tested for minor Defects, for major Defects, the *Contractor* re-starts the FAT test.

d) The *Project Manager or delegate* has the authority to select a representative or group of representatives to inspect all parts during the manufacture of equipment and is present at any of the tests being performed.

4.4.1.2 Pre - FAT

a) During Pre - FAT, the *Contractor* conducts a pre - factory acceptance test at the *Contractor*'s factory as preparation for the factory acceptance test with the *Project Manager*'s representatives.

b) All pre - FAT tests are documented as part of the quality assurance and control procedures by the *Contractor'*s engineers and are available to the *Project Manager* or delegate prior to the beginning of the FAT.

4.4.1.3 Factory Acceptance Test

a) Prior to transport of the fire detection system to site, the system must undergo Factory Acceptance Testing (FAT). With this test, the *Contractor* demonstrates that the fire detection system meets all the requirements of the Functional Design. The tests are witnessed by the *Supervisor* and Others (e.g. the *Employer's* personnel and/or third party inspectorate).

b) The test procedure is compiled by the *Contractor* and presented to the *Project Manager or delegate* for acceptance during the technical clarification phase and it is shown in the Accepted Programme.

c) All hardware and software are available and fully operational before the FAT commences. Following the FAT, the process control and indicating equipment runs for a continuous period of 120-hours without any failure of hardware, software or functions. All inputs and outputs will be tested beforehand and predefined simulated inputs are used for the tests. The *Contractor* performs a complete functional test of all the control and indicating equipment systems before delivery to Site.

d) Correct functioning of all hardware and software is demonstrated in terms of the Works Information requirements.

e) The purpose of these tests is to demonstrate that the fire detection system meets the functional and performance requirements and is fit for shipment to Site, but this does not relieve the *Contractor* of his responsibility for the satisfactory functioning and performance of the process control and indicating equipment systems during site acceptance testing (SAT).

f) The applicable test procedure together with the test dates is prepared by the *Contractor* and submitted to the *Project Manager or delegate* for acceptance during the system engineering stage. The final test procedures are prepared by the *Contractor* and submitted to the *Project Manager or delegate* at least 10 working days prior to the scheduled test dates. The *Contractor* shows these dates in the Accepted Programme.

g) FAT is performed by the *Contractor*, on each individual system and the system as a whole to demonstrate the interoperability.

h) The hardware used for the FAT, when successfully completed, is shipped and delivered to the Site.

4.5 Marking Plant and Materials outside the Working Areas.

a) Core clauses 70.1 and 71.1 require the Works Information to state how the *Contractor* is to "mark" Plant and Materials which is outside the Working Areas if they are to be paid for before delivery to the Working Areas.

b) The *Contractor* is requested to mark all identified items of Plant and Material with the Contract and Order numbers.

c) Plant and Material is delivered to either the Site or the *Contractor's* works.

d) The following requirements apply to the off-Site marking of Plant, Materials and Equipment:

- The *Contractor* gives two (2) weeks' notice to the *Supervisor* and it is shown in the Accepted Programme.

- The notification to the *Supervisor* is accompanied by a comprehensive inventory of all Plant, Materials and Equipment ready for marking by the *Supervisor*.

- Plant, Materials and Equipment located at the *Contractor's* Subcontractor/s or sub-suppliers are not considered ready for marking.

- Only Plant, Materials and Equipment physically located at the *Contractor's* facility are considered ready for marking.

4.6 *Contractor*'s Equipment (including temporary works).

a) The *Project Manager* is free to specify hold and witness points during the installation, inspection and testing of the control and indicating equipment. The *Contractor* issues preliminary notification of such hold and witness points by ten (10) working day advance notice to the *Project Manager* and confirm such hold and witness points at least five(5) working days prior to the activity.

b) The *Contractor* installs, inspect and test all equipment within his scope of supply including any other items/equipment the *Project Manager* has specified (free issue items).

c) The *Contractor* conducts the installation, inspection and testing of the *works* within the limitations of the existing plant, maintenance work pre-formed by others, access restrictions to services such as crane usage, process conditions of other interdependent plant areas online etc.

5 Construction

5.1 Temporary works, Site services & construction constraints

5.2 Temporary works, Site services & construction constraints

5.2.1 *Employer*'s Site entry and security control, permits, and Site regulations.

a) All Site access is controlled through the designated access gate.

b) The *Contractor* is informed of the access procedures through Site regulations and that such procedures may change depending on the prevailing security situation.

c) The *Contractor* is to comply with all Site regulations and instructions. The onus is on the *Contractor* to ensure his familiarity with the Employer's Site regulations and inspections.

d) Recruitment outside the *Employer's* security office is not allowed. Local privately owned recruitment offices to be utilised.

e) No person will be issued with an access permit without proof that the person did attend the local Arnot Power Station induction course.

f) A one-day access permit will be issued for persons attending the induction course. It is the *Contractor's* responsibility to arrange with the *Project Manager* one week in advance for a course booking.

5.2.2 Restrictions to access on Site, roads, walkways and barricades.

a) All vehicles must be driven with due consideration for personnel and property. A maximum speed limit of 40 kilometres per hour will be adhered to on the premises at all times. No personnel at the back of any vehicle.

b) The *Contractor* shall provide and install fixed barricades and warning devices to ensure that equipment and persons are not exposed to danger or to prevent access to dangerous areas.

c) All welding, flame cutting and grinding work shall be properly screened to protect persons from arc flashes or eye injuries.

d) All grating shall be covered with an adequate protective screening when welding or flame cutting.

5.2.3 People restrictions on Site; hours of work, conduct and records.

a) Restrictions and hours of work may apply on some Sites. It is very important that the *Contractor* keeps records of his people on Site, including those of his Subcontractors which the *Project Manager* or *Supervisor* have access to at any time. These records may be needed when assessing compensation events.

5.2.4 Title to materials from demolition and excavation

a) The *Contractor* has no title to materials from excavation and demolition.
b) All reusable equipment will remain the property of the *Employer*.
c) All scrap daily to the scrap yard.

5.2.5 Cooperating with and obtaining acceptance of Others

a) This sub-paragraph could be used to deal with two issues.

- The cross-reference from core clause 25.1 about cooperation generally as well as details about others with whom the *Contractor* may be required to share the working areas. See clause 11.2(10) for the definition of others.
- Requirements for liaison with and acceptance from statutory authorities or landowners.

5.2.6 *Contractor's* Equipment

a) Records are to be kept of Equipment on Site including whether it is owned or hired. The *Contractor* is responsible to provide his own scaffolding, lifting equipment, mobile cranes and fork lifts where required.

5.2.7 Equipment provided by the *Employer*

a) The *Employer* will make available his fixed overhead cranes. Only authorised personnel allowed operating these.

5.2.8 Site services and facilities

5.2.8.1 *Contractor's* Yard

a) A site for the *Contractor's* yard is provided by the *Employer*. A written request, indicating the *Contractor's* requirements in locality and area of storage, office and Work Shop sites is submitted to the *Project Manager* as soon as possible after the Contract Date.

5.2.8.2 Potable water

a) Potable water for construction purposes is also available free of charge. Any installation is for the *Contractor's* account.

5.2.8.3 Sanitary Facilities

a) Sanitary facilities are provided by the *Employer*.

5.2.8.4 Conditions of Power supply for Erection

a) In order to comply with the Electrical Installation Regulations under the Occupational Health and Safety Act, no 85 of 1993 the following requirements are met before electricity is supplied it is expected that the *Contractor* is in possession of a valid certificate of compliance. Your electrical installation is inspected and tested by an accredited person to ensure that it complies with the requirements of the Occupational Health and Safety Act, 1993 and the code of Practice for wiring of premises, SANS 10142. After you have obtained the certificate of compliance, the *Employer* is to inspect your electrical installation and if satisfied, it is connected and supplied from the construction power supply.

b) The *Contractor* provides at his own expense all temporary wiring and cabling to lead power from the *Employer's* supply points, to where it is required, maintain same and remove on completion. These points of supply are the points designated by the *Project Manager*.

c) Warning:

- Phase rotation may change during power supply breaks. *Contractors* are responsible to check rotation of their Equipment before recommencing work.

- There is no charge for electricity used for construction purposes and no connection fee is levied for the point of supply.

d) The Contractor shall provide everything else necessary for providing the Works.

5.2.9 Facilities provided by the *Contractor.*

a) The *Contractor* provides, erects and maintains for own use, adequate size office accommodation and stores together with such drainage, lighting, heating and hot and cold-water services as may be required in the area designated by the *Project Manager*.

b) The *Contractor* is to dismantle and clear off site all such temporary structures and associated foundations and infrastructure.

5.3 Completion, testing, commissioning and correction of Defects

5.3.1 Work to be done by the Completion Date.

a) Each individual system forming part of the control and indicating equipment shall be installed and tested in accordance to the requirements of NFPA 72 and SANS 10139.

5.3.2 Work to be done by the Completion Date.

a) Completion of each section of the *works* is when the following is approved by the *Employer* in accordance with the Works Information.

- Investigation phase
- Design and engineering phase

  i. Technical clarification stage.
  ii. Design freeze stage

- Production engineering phase

  I. Procurement, fabrication and delivery stage.
  II. Factory acceptance test stage

- Construction and erection phase.
- Commissioning phase

  I. SIT stage
  II. Commissioning stage.
  III. SAT stage.

- Operational test phase.

5.3.3 Use of the *works* before Completion is certified.

a) The *Employer* uses the *works* to return the part of the *works* to service in order to commission and perform the Site Acceptance and Operational testing before Completion of the *section* of the *works.*

5.3.4 Commissioning

Each individual system is subjected to this phase. This means that each sub system as well as the system as a whole is subjected to this phase. This phase shall be done in accordance with the requirements of and SANS 10139.

5.3.4.1 Commissioning procedures and Test Certificates

The *Contractor* prepares commissioning procedures and test certificates for the commissioning of the control and indicating equipment. The format of this procedure and certificate is for the *Project Manager*'s acceptance.

5.3.4.2 Installation activities

The *Contractor* is responsible for planning, organising, and execution of the various functions involved in the different segments as part the installation scope of work. The works are subjected but not limited to the following:

a. The installation of the control and indicating system equipment.

b. The installation of the relevant GUI equipment, and peripheral devices and engineering room equipment.

c. The installation of the communications and control networks systems.

d. The erection and installation of new cubicles/panels and any infrastructure required to house equipment in the engineering room and plant.

e. The erection and installation of any infrastructure, in addition to the civil work done, required to house or contain the *Contractor's* equipment.

f. The *Contractor* is responsible for the provision and storage of all temporary or expendable materials required.

Note: The sequence of supply and installation to be reflected in the activity schedule and accepted program.

5.3.4.3 Site integration tests (SIT)

a) The *Contractor* carries out SIT to ensure the correct performance of the control and indicating equipment's management and monitoring functions. Most importantly, this is performed to ensure safety of plant and personnel, and to ensure compliance with the Works Information

b) The proposed test procedures, together with test dates, are prepared by the *Contractor* and submitted to the *Project Manager* for acceptance during the system engineering and design phase.

5.3.4.4 Control and indicating optimisation.

a) The *Contractor* performs the optimisation of the control and indicating equipment to meet the performance requirements of the *works*.

5.3.4.5 Site acceptance test (SAT).

b) With this test the *Contractor* demonstrates that the fire detection system meets all the requirements of the Functional Design

5.3.4.6 Operational testing

a) The *works* is run continuously by the *Employer* for a period of 336 hours without any hardware or software malfunction. During this period, all management and monitoring functions may be exercised.

b) In the event of any hardware or software Defect, the *Contractor* corrects the Defect and based on the nature/merit of that Defect, the *Project Manager's* sole discretion can then allow the 336-hour test to continue or inform *Contractor* that the test be restarted.

c) This testing phase will entail a 336-hour window for a fully function Emergency Management System.

d) During the operational test, the w*orks* is not deemed in use until the *Project Manager* certifies Completion.

5.3.4.7 Verification

a) A third-party inspection is conducted on the completed installation to confirm operability and conformance to the code of practice. The following to be submitted with tender documents:

- Third party inspector's proof of accreditation
- Include in the price list

b) If any rectifications are necessary to provide full compliance and certification of the installation, costs will be for the *Contractor's* account.

5.3.5 Access given by the *Employer* for correction of Defects.

a) Clause 43.4 requires that the *Project Manager* arranges for the *Employer* to allow the *Contractor* access to and use of a part of the *works* which has been taken over if needed to correct a Defect. After the *works* have been put into operation, the *Employer* may require the *Contractor* to undertake certain procedures before such access can be granted.

5.3.6 Performance tests after Completion

a) The *Contractor* must demonstrate after completion of the *works* that *his* design and installation is compliant to the reference standard used in this specification.

5.3.7 Training and technology transfer

a) Included in the Works is extensive training for the *Employer's* personnel on all aspects for the Engineering, Maintenance and Operating personnel.

5.3.7.1 Training of the *Employer's* personnel

a) Product training of advanced maintenance and engineering staff is required before the commencement of any design work.

b) Training provided by the *Contractor* is directly applicable to Arnot Power Station control and indicating equipment system hardware and software components.

c) Training for the *Employer's* Operating, Maintenance and Engineering staff takes place off-site and at Arnot Power Station.

d) All the training material and manuals, provided by the *Contractor*, including third party documentation are in English.

e) Training dates are indicated in the Accepted Programme. At design freeze the *Contractor* submits the final training programme for acceptance by the *Project Manager*.

f) Training for the *Employer's* Engineering and Maintenance staff to commence after the Design Freeze phase. For the *Employer's* Operating staff, the training is completed before SIT commences.

g) Training manuals are continuously updated by the *Contractor* up to Completion of the whole of the *works*. The training programme on the updated manuals relating to modifications necessary to achieve the Completion of the whole of the *works* is presented to the *Project Manager* for acceptance one week prior to the operational test phase. The training relating to the updated training manuals in the different training categories are presented during the operational test phase.

h) Practical hands-on training, by the *Contractor*, of the *Employer's* personnel during the whole implementation forms an integral part of the training process.

i) Training on all the components of the control and indicating equipment for the *Employer's* maintenance and engineering staff are official and accredited.

j) On completion of the training programmes the *Employer's* personnel are tested, evaluated and declared competent by the *Contractor*.

5.3.7.2 Training categories

There are four (4) categories of training provided by the Contractor:

a) Basic Maintenance staff training, the training includes as a minimum: (Applicable to all the components and levels of the control and indicating equipment)

- Familiarisation with documentation including drawings and system configuration.
- Hardware and software familiarisation.
- Change panel text, zone text, individual point text.
- Add/delete addressable devices.
- Modify addressable devices.
- Change individual point addressed.
- Programs storage, backup and reloading.
- Archived data storage, backup and reloading.
- Control and communication network configuration
- Hardware installation, configuration and planned maintenance.
- Software installation, configuration and planned maintenance.
- Maintenance of the control and indicating equipment through the use and interpretation of diagnostic, maintenance and monitoring functions, routines and error codes on-line for fault finding and the detection of faulty equipment on the detection zones, right through to the network.
- Basic process of the control and indicating algorithms, control, zones, detection loops, and operations as applied at Arnot Power Station to Provide the Works.
- Utilisation of the SMS server to access and generate required documentation for maintenance purpose for all the levels of the process control and monitoring system.
- Power distribution and isolation facilities (220V AC and 24VDC)
- UPS and Battery Chargers maintenance, diagnostic and configuration functions.

b) Operating personnel training includes as a minimum:

- Familiarisation with the process of control and indicating equipment.
- Familiarisation with documentation i.e. operating manuals.
- GUI operating functions including mouse & keyboard handling, interpretation of displays, supervisory plant control, plant monitoring, navigation, alarms, messages, user configurable displays and functions, display conventions, logs, reports, retrieval of historic information, use of peripheral devices.
- Power distribution and isolation facilities (220VAC and 24VDC)
- UPS and Battery Chargers operating and diagnostic functions.
- Alarm & Event Viewer user training.

c) Training of engineering staff includes as a minimum: (Applicable to all the components and levels of the control and indicating equipment)

- Software development, debugging and testing.
- Software configuration and high level programming.
- Development and configuration of GUI displays, LCD displays, logs, reports and navigation design.
- Database administration, configuration.
- Backup, archiving and disaster recovery of all software components.
- Control and communication network design, configuration and fault finding.
- Development, configuration, administration and operation of the integrated forward documentation system.
- Security administration at all the levels of the control and indicating equipment.
- Engineering drawings updates, modification implementation on all the levels of the control and indicating equipment, administration.
- Power distribution and isolation facilities (220V AC and 24VDC)
- UPS and Battery Chargers maintenance, diagnostic configuration functions.

d) End user training

- Familiarisation with the control and indicating equipment.
- The LCD operating and navigation functions.
- Generation of reports.

e) The *Employer* bears the cost of salaries, accommodation, other allowances and travelling expenses of his personnel, but all other costs are borne by the *Contractor.* The *Contractor* provides a quotation with rates for additional (repeat) training courses, if required by the *Employer*, with a validity period of one (1) year after Completion of the whole of the *works*.

5.3.7.3 Participation of the *Employer's* staff

a) The *Employer* intends to second staff part and full time to the *Contractor's* team without affecting the Prices. The aim is to allow "on the job" training in order to become familiar with all the equipment.

b) The *Employer* also intends to second engineering personnel during the design, engineering, and installation and commissioning up to the testing phases.

c) *Employer's* seconded staff is not to be viewed as part of the *Contractor's* resources required to provide the Works. The *Employer* may withdraw such staff at any time.

d) The *Contractor* provides any requisite training to the *Employer's* staff before secondment.

5.3.7.4 Training constraints

a) Maintenance and engineering personnel

- Two sessions are performed by the *Contractor*.

b) Operating personnel

- Two sessions are performed by the *Contractor*.

c) Operating personnel

- Two sessions are performed by the *Contractor*.

d) End user staff

- Two sessions are performed by the *Contractor*.

5.3.8 Operational maintenance after Completion

a) The *Employer* may require the *Contractor* before the *defects date* to perform certain duties after Completion and take over which relate to maintenance of the *works*.

6 Plant and Materials standards and workmanship

6.1 Investigation, survey and Site clearance

N/A

6.2 Building works

N/A

6.3 Civil engineering and structural works

N/A

6.4 Electrical & mechanical engineering works

N/A

6.5 Process control and IT works

N/a

6.6 Outage dates (Subject to change)

Unit	Outage dates
1	18/06/2026 – 08/08/2026
2	Current – 31/12/2026/12/31
6	2028/10/08– 2028/12/12

List of drawings

6.7 Drawings issued by the *Employer.*

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

Note: Some drawings may contain both Works Information and Site Information.

Table 4: Eskom Issued Drawings

Drawing number	Revision	Title
		All drawings shall be provided to Contractor by PM or engineer
26.41/62464, 26.41/35591-99,26.41/35600-610	0	Main Turbine Steam flow
ML3120-3124	1	Main Turbine Connections to data acquisition system
ML3112-3129	1	Main Turbine Connections to data acquisition system
ML3057-3066	1	Main Turbine Connections to data acquisition system
26.41/3130-3150	1	Main Turbine Connections to data acquisition system
26.41/3149, 26.41/3174	1	Main Turbine Connections to data acquisition system

6.8 Technical Specifications

Table 5: Technical and General Specifications.

Title	Date or revision	Tick if publicly available
General Specifications:		
Health and Safety requirements		
Environmental requirements		
Site regulations and access control		
Eskom Waste Management Standard		
QM-58: Supplier Contract Quality Requirements Specification		
(National Environmental Management Act, 1998 [Act No 107 of 1998])		
Technical specifications:		
NWS 1525 (C&I cables for power stations) GGS 0386 (Requirements for control and power cables for power stations) NWS 1220 (Specification for cable junction and reduction boxes for power stations)		