

Title: **Works Information for  
Duvha Power Station  
Outside Plant Control  
Room HMI Upgrade**

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## PART 3: SCOPE OF WORK

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## C3.1: EMPLOYER'S WORKS INFORMATION

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# 1. Description of the works

## 1.1 Executive overview

The Human-Machine Interface of the Outside Plant Control Room Supervisory Control and Data Acquisition system performs two main functions – that of displaying data relating to the operation of the outside plant equipment to the operators, as well as the forwarding of this data to the station historian. Currently, no remote control operations are present in the SCADA.

The technologies used in the OPCR SCADA HMI have been obsolete for a number of years, and issues relating to the procurement of spares and the availability of maintenance skills have been increasing steadily. It has therefore been decided to replace the HMI system with a state-of-the-art industry-standard equivalent. Not only will this upgrade mitigate the existing risks associated with obsolescence, but also provide additional functionality not available when the HMI was originally installed. Of chief advantage will be the ability to perform forward engineering, and to perform remote maintenance of control equipment. Future expansion of the outside plant SCADA network will also be enabled, as the system is currently operating near capacity. This expansion will include the capacity to perform remote operator actions from the HMI system.

Some changes will be required to the SCADA network itself in order to allow communication to the new HMI, as well as to enable the additional features for example remote plant control and not just viewing capabilities. The sections to follow will provide details to this effect.

High level scope of the Works:

- (1) Engineering, design, procurement, manufacturing, factory acceptance testing, delivery, off-loading at site, storage, installation, testing, commissioning, and as-built documentation for the Duvha outside plant Human Machine Interface (HMI).
- (2) The specific sub-systems provided as part of Duvha outside plant HMI System include – but are not limited to the following:
  - i. Location in Water treatment plant server room for HMI hardware
  - ii. Existing interface to L2 connected plant via Profinet enabled gateway
  - iii. Fibre link to site historian from WTP server room
  - iv. Redundant power supply to server room
- (3) The specific sub-systems to be provided as part of the Duvha HMI system include – but are not limited to the following:
  - i. HMI system with 2 quad view operator stations extended via KVM.
  - ii. Engineering system
  - iii. Profinet control network for HMI
  - iv. GPS Time sync system
  - v. Backup & recovery system
  - vi. Electronic security perimeter
  - vii. Power distribution systems

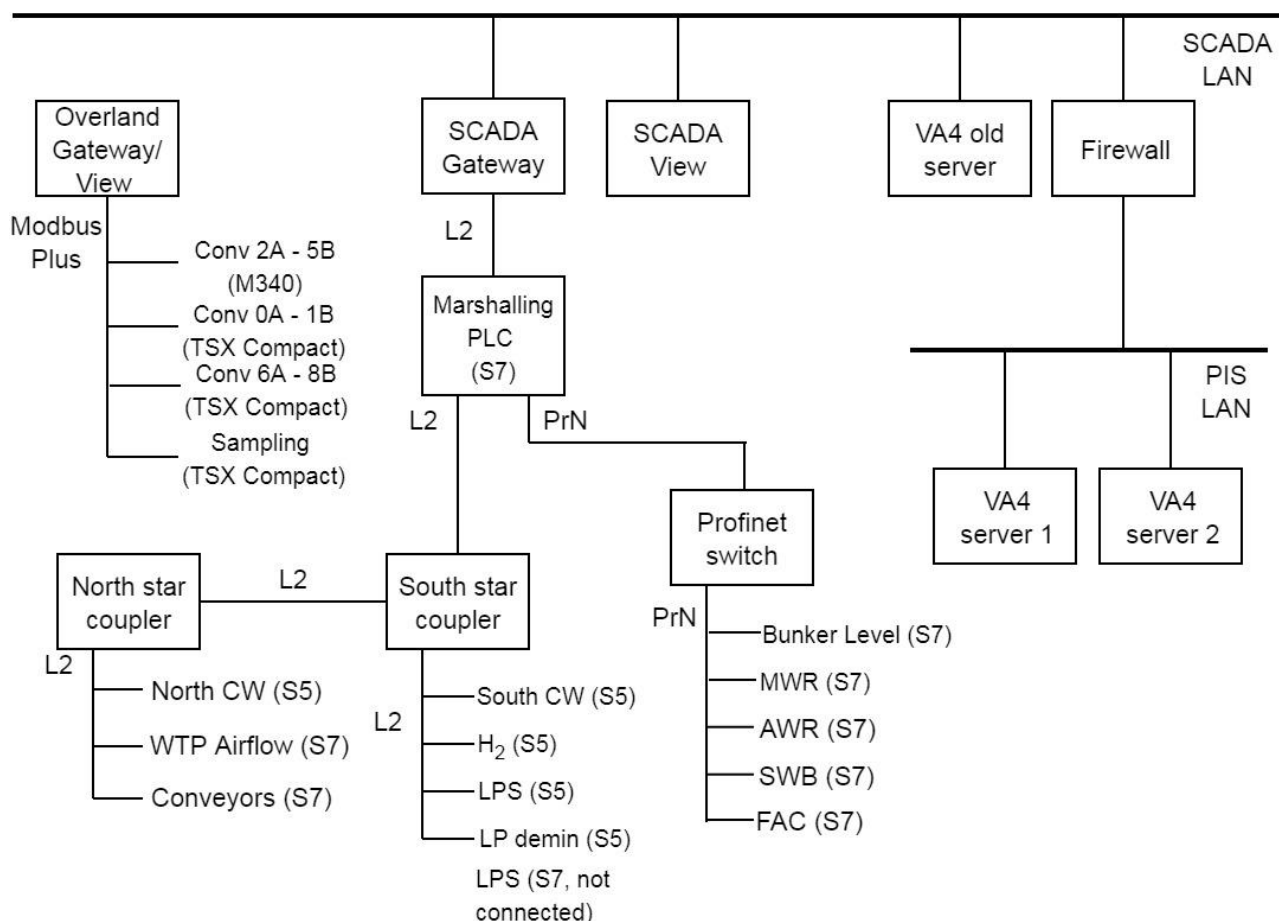
- viii. OPC connection to site historian
- (4) Connecting the FAC PLC's to the marshalling PLC and communication setup for FAC signals and alarms for HMI mimics.
- (5) Removal and/or relocation of existing equipment where required by new design
- (6) Plant and labelling of all equipment supplied as part of the works
- (7) Earthing of all equipment supplied as part of the works
- (8) Training of Operating, Engineering & Maintenance staff
- (9) All activities, services or equipment specified (special tools, consumables, etc.)
- (10) All software, license and copyright agreements for the works.

## **1.2 Employer's objectives and purpose of the works**

### **1.2.1 Background**

- (1) The Human-Machine Interface (HMI) of the outside plant Supervisory Control and Data Acquisition (SCADA) system performs two main functions – that of displaying data relating to the operation of the outside plant equipment to the operators, as well as the forwarding of this data to the station historian.
- (2) The system as currently installed comprises of:
  - i. 15 x S5 PLCs (all on L2 network)
  - ii. 16 x S7 PLCs, (2 on L2 network, 10 on Profinet network, 4 not connected)
  - iii. S7 marshalling PLC to condense data on L2 network and Profinet.
  - iv. Outside plant SCADA system (iFix v2.5 on Windows NT)
  - v. 13 x Modicon TSX Compact PLCs
  - vi. 6 x Schneider M340 PLCs
  - vii. Overland conveyor SCADA system (Wonderware on Windows XP)
  - viii. Interface to PIS network and site historian.
- (3) The Outside Plant SCADA is a network of Siemens S5 and S7 PLCs responsible for monitoring of Outside Plant equipment. All of the PLCs communicate with an S7-400 marshalling PLC located at LP services via L2 FDL serial communication and Profinet Ethernet communication. The North and South CW, H2 and LPS plants are connected to the marshalling PLC via L2 FDL. The Bunker, MWR, AWR, SWB and FAC PLCs are connected to the marshalling PLC via Profinet. The marshalling PLC reduces the amount of communication packets on the bus by concentrating the data from the plants from 27 communication packets down to 9 packets. The link between the marshalling PLC and the SCADA Gateway machine uses L2 FDL.
- (4) The SCADA gateway computer is connected to the marshalling PLC via a specialised L2 interface card. A quad-monitor View computer is used to display data captured by the Gateway on process graphics. The View and Gateway computers together form the Human Machine Interface. Intellution iFix v2.5 is used to provide the process graphics and alarm system and is currently installed on Windows NT.
- (5) The Gateway computer also feeds data to the Process Information System (PIS), over the Process Network. This connection utilises a custom written software driver, provided by the PIS vendor.

- (6) The Outside plant control room further houses SCADA equipment for the Overland conveyor system. The HMI for this separate system is implemented using a single computer, which performs both Gateway and View functions. A ModbusPlus serial card is installed in the computer, which allows communication to the Schneider PLCs located in the Overland and Staithe Substations. Wonderware software running on Microsoft Windows XP is used to display information regarding the conveyors to the operator, as well as to input commands to the PLCs.
- (7) The technologies used in the outside plant SCADA HMI have passed their usable lifetime, and issues relating to the procurement of spares and the availability of maintenance skills have been increasing steadily. It has therefore been decided to replace the HMI system with a state-of-the-art industry-standard equivalent. Not only will this upgrade mitigate the existing risks associated with obsolescence, but also provide additional functionality for example remote operations which was not available when the HMI was originally installed.
- (8) The S5 and TSX Compact PLCs are obsolete. The S7 and M340 PLCs are still supported by their respective manufacturer.
- (9) The outside plant system is presented below.



**Figure 1: Outside plant as-is**



### 1.2.2 Purpose of the works

- (1) The following are the main objectives of the *works*:
  - i. Installation of new outside plant HMI system
  - ii. Migrating existing graphics and control schemes to new HMI
  - iii. Establish new ProfiNet based network segment
  - iv. Integrating overland conveyor system into outside plant HMI
  - v. Integrated engineering system for outside plant
  - vi. Connecting FAC PLC's to the marshalling PLC.
  - vii. Communication setup for FAC signals and alarms on marshalling PLC.
- (2) Obsolescence risk of HMI on outside plant to be eliminated.

### 1.3 Interpretation and terminology

The following abbreviations are used in this Works Information:

Abbreviation	Meaning given to the abbreviation
AWR	Ash water return
AC	Alternating Current
AFC	Approved for construction
BMS	Building Management System
C&I	Control and Instrumentation
CA	Corrective Action
CW	Cooling water
DB	Distribution box
Demin	Demineralised water
DX	Direct Expansion
FAC	Forced air compressor
GPS	Global Positioning System
H2	Hydrogen
HMI	Human Machine Interface
HVAC	Heating Ventilation and Air Conditioning
ISO	International Organisation for Standardisation
KVM	Keyboard, video and mouse
LOSS	Limits of Service and Supply
LPS	Low Pressure Services
MAC	Media access control
MTTF	Mean Time To Failure
MTTR	Mean Time To Repair

MWR	Mine water return
NTP	Network time protocol
OBL	Outside battery limits
OEM	Original Equipment Manufacturer
OPCR	Outside plant control room
OT	Operation Technology
PIS	Process information system
PLC	Programmable logic controller
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Procedure
RCM	Reliable Centre Maintenance
SANS	South African National Standards
SCADA	Supervisory control and data acquisition
SE	System Engineer
SWB	Sluice water booster
VDSS	Vendor Document Supplier Submittals
WTP	Water treatment plant

The following definitions are used in this Works Information:

Definition	Description
Acceptance	The Employer accept the condition or design but does not take responsibility from the Contractor
Approval	Written agreement or authorization by Employer. All requests for approval must be submitted in writing and any proposed deviation from specified requirements must be fully justified and agreed by Employer.
Central Update System	The system used to deploy, manage and control the application of security patches, antivirus updates and antivirus signature files to the individual computers, network switches and UTMs of the Duvha C&I system.
Contractor	Refers to the corporation appointed to perform the engineering, procurement, and construction works required for the project.
Design freeze	Is a binding decision that defines the whole product, its parts or parameters and allows the continuation of the design based on that decision (no further changes can be made to the design, it is cut-off for the engineers)
Employer	Refers to Eskom Holdings State Owned Company
Eskom Plant Engineering	Refers to the Eskom Engineering team who will perform the reviews and provide technical assistance for the work performed by the appointed Contractor.
Heating, Ventilating, and Air Conditioning (HVAC)	Relates to systems that perform processes designed to regulate the air conditions within buildings for the comfort and safety of occupants. HVAC systems condition and move air to desired areas of an indoor environment to create and maintain desirable temperature, humidity, ventilation and air purity.

Definition	Description
Integrated engineering system	An engineering system capable interface with the PLCs over the Profinet communications network to perform remote maintenance and configuration. An engineering system must either be integrated with the HMI, or be able to provide forward engineering capabilities to the HMI, eg automatic tag generation from PLC source code
Interface	Interface in this document means either to hard wired or software interaction between the Contractors and/or other Works
Maintenance	Maintenance can be defined as the function of keeping components or equipment in, or restoring them to a serviceable condition so that they comply with design and statutory requirements and employer standards. Maintenance includes the cleaning, removal of contaminants and waste, correct adjustment and setting, tightening, testing, fixing, refill, lubrication, rust prevention, touch up, refrigeration charge, servicing, inspection, replacement, re-installation, troubleshooting, calibration, condition determination, repair, modification, overhaul and rebuilding of equipment. Maintenance can be either preventative or corrective of nature.
Maintenance Management	Maintenance Management can be described as the management (planning, organising, leading and control) actions needed to ensure effective maintenance execution to provide the most efficient and optimum availability (capable of being used) and reliability (consistent quality) of the equipment installed.
Owners Engineer	Owners Engineer - When Eskom acts as the Owners Engineer on a project/package/plant/system/asset, the reviewer(s) are to review the design documentation issued by the Design Authority to ensure that: the design satisfies the stakeholder requirements (i.e. validation of design deliverables against stakeholder requirements). General technical oversight is provided over the design.
Specification	The document/s forming part of the contract in which the methods of executing the various items of work to be done is described, as well as the nature and quality of the materials to be supplied and it includes technical schedules and drawings attached thereto as well as all samples and patterns
The Client	The end user will be Eskom who will be represented by client throughout the duration of the Project.

## 2. Management and start up.

### 1.1 Management meetings

- (1) 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 Mondays at 13h00	Projects/ WTP Boardroom	Employer, <i>Contractor</i> , Supervisor
Overall contract progress and feedback	Monthly on Thursdays at 13h00	Projects/ WTP Boardroom	Employer, <i>Contractor</i> , Supervisor
Monthly Safety meeting, weekly during implementation	Monthly on Mondays at 14h00	Projects/ WTP Boardroom	Employer, <i>Contractor</i> , Supervisor, Safety Officers
Quality and NCR/Defect/Concessions meeting	Monthly on Mondays at 15h00	Projects/ WTP Boardroom	Employer, <i>Contractor</i> , Supervisor, Quality managers and Officers

Weekly contract progress and feedback	Weekly on Mondays at 08h00	Projects/ WTP Boardroom	Employer, <i>Contractor</i> , Supervisor, Quality managers
Daily contract progress and feedback	Daily at 09h00	Projects/ WTP Boardroom	Employer, <i>Contractor</i> , Supervisor, Quality managers

- (2) 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.
- (3) Records of these meetings shall be submitted to the Project Manager by the person convening the meeting within five days of the meeting.
- (4) All meetings shall be recorded using minutes or a register prepared and circulated by the person who convened the meeting.
- (5) Such minutes or register shall not be used for the purpose of confirming actions or instructions under the contract as these shall be done separately by the person identified in the conditions of contract to carry out such actions or instructions.
- (6) Meetings of a specialist nature may be convened as specified elsewhere in this Works Information or if not so specified by persons and at times and locations to suit the Parties, the nature and the progress of the works. Records of these meetings shall be submitted to the Project Manager by the person convening the meeting within five days of the meeting.
- (7) All meetings shall be recorded using minutes or a register prepared and circulated by the person who convened the meeting. Such minutes or register shall not be used for the purpose of confirming actions or instructions under the contract as these shall be done separately by the person identified in the conditions of contract to carry out such actions or instructions.

## 2.1 Documentation control

- (1) All formal communication between the Employer and the Contractor shall take place through the Employer's Buyer
- (2) All formal communication shall be marked with the date and a reference code in the form DVP-XXX-nnn where:
  - i. XXX is the acronym of the *Contractor*
  - ii. nnn is the sequential number of the communication
- (3) All formal communication must be acknowledged by the recipient
- (4) The Contractor's site manager must keep a daily log, which needs to be signed by the Employer's Supervisor daily

## 2.2 Health and safety risk management

- (1) The Contractor's personnel is to undergo Safety Induction Training at Duvha prior to commencement of this contract and all the relevant Documentation is to be approved by Safety Officials and the Project Manager before any activities can be started on site.

- (2) The Contractor complies with the requirements of the Duvha Power Station Safety, Health & Environmental Specifications SAS 0012: Duvha Power Station Contractors safety manual
- (3) The documents are completed by the Contractor's and submitted to the Employer before taking possession of the works.
- (4) These documents are valid for the duration of the works.
- (5) The Contractor and all his personnel attend a Health and Safety Induction Course prior to starting with the works.
- (6) The induction course is presented by the Safety Risk Department at Duvha Power Station.
- (7) The Contractor makes arrangements with Safety Risk Management at telephone number 013-690-0143.
- (8) The Contractor submits all the documents as indicated in the Safety, Health & Environmental Specifications relevant to the work to Safety Risk Management before the induction course.
- (9) The Contractor completes all appointments required and ensures that the appointee and appointees fully understand their responsibilities and are competent and trained to execute their duties.
- (10) The appointees/appointee ensures that all duties are carried out and records are kept by the Contractor for review/audit by the Employer or Inspector of Machinery.
- (11) Management has the right and authority to visit and inspect the Contractor's work place or Site establishment.
- (12) The Contractor supplies and ensures that his employees wear the necessary PPE according the risk assessments performed on the specific tasks to be carried out.
- (13) The Contractor ensures that everyone entering Duvha Power Station under his supervision is medically, physically and psychologically fit to enter Duvha Power Station.
- (14) The medical examination, at the Contractors cost, is carried out by a Registered Professional Occupational Health Practitioner and the examination shall include the following tests:
  - i. Eye Test, Blood Pressure,
  - ii. Heart Function,
  - iii. Hearing Test and
  - iv. Lung Function.
- (15) A thorough examination is done and previous physical injuries, as well as occupational diseases/complications are covered.
- (16) If at any point in time during the execution of the works, the Contractor has a radiation-related incident/exposure, the onus is on the Contractor to immediately notify the Employer, the Medical Station, the Risk Manager and the Safety Risk Management Department.
- (17) The onus thereafter is for the Contractor to immediately arrange, at his/her cost, for blood samples to be taken by a Registered Laboratory and for this sample to be sent to the Accelerator Laboratory in Cape Town for full radiation exposure tests. This test results are then to be discussed with the Duvha Occupational Health Practitioners, who will then advise the Power Station Management on the risk, if any, of the incident/exposure.
- (18) The Contractor takes full responsibility and accountability for all other people/staff/personnel/labour that he/she employs or utilises, whether in full-time/part-time/contract basis, in executing the works or other work whilst on the Employers premises.

- (19)The Contractor ensures that Safety Harnesses are used for all work carried out in elevated positions, as defined in the Occupational Health and Safety Act, No 85 of 1993 or any other Code of Practice or standard or the Construction Regulations.
- (20)All safety equipment or Machinery used complies with the SANS Codes of Quality and Practice or any Code as stipulated in the Occupational Health and Safety Act, No 85 of 1993, and any amendments thereto.
- (21)The Contractor at all times consider himself as “Employer” as defined in the Occupational Health and Safety Act, No 85 of 1993 and do not consider himself as under supervision or management of the Employer with regard to Health and Safety Requirements but only from a Commercial Contractual Condition of Contract. Under no circumstances does the Contractor consider himself a sub-ordinate or being given supervision.
- (22)The Contractor provides and maintains his own facilities as required in the Occupational Health and Safety Act, No 85 of 1993 or any other Code of Practice or standard or the Construction Regulations, if not agreed contractually or arranged by the Employer.
- (23)The Contractor has Safety Systems in place at his premises for the total contract period and these shall include the following:
  - (24)Safety Management Structure and Compliance to these
  - (25)Statutory Appointments
  - (26)Records and documentation of all Risk and Hazard Analyses.
  - (27)Planned Job Observations Records and Documents.
  - (28)Employment history and records of all personnel, part-time or full-time or contract labour.
  - (29) Medical History of all personnel, part-time or full-time or contract labour
  - (30)Training and Competency Records with regard to Safety, Health and Environment.
  - (31)Training and Competency Records with regard to the skills he uses to carry out the works or any other works in the Employers premises.
  - (32)Compensation Commissioner Records and proof of registration.
  - (33)Records and documentation with regard to any sub-Contractor or labour-only contracts he places or uses to carry out the works or any other works in Employers premises.
  - (34)Personal Protective Equipment and Safety Equipment Inspection, training and competency records and documentation.
  - (35)Employment contracts for all sub-Contractor or labour-only contracts.
  - (36)Compliance to a Safety System, such as NOSA or any other system that is similar in nature.
  - (37)Records of all incidents or accidents, and vehicle accidents, incurred during execution of this works or any other works in the Employers premises.
  - (38)Records of all man-hours, including sub-Contractors or labour-only contracts, the Contractor spends on the Employers premises.
  - (39)Written Safe Work Procedures for all hazardous tasks the Contractor executes on the Employers premises.
  - (40)A Fall Protection Plan for all elevated work the Contractor does on the Employers premises.
  - (41)Environmental plan and awareness training.

- (42) Induction training records of his staff by himself/herself.
- (43) Minimum wage compliance for the different skills and to which Bargaining Council compliance is made to and proof of membership, if any.
- (44) Risk Assessment of this type of works:
- (45) Risk Assessment to be completed by a team consisting of Contractor and Employer personnel,
- (46) Proof of authorisation/accreditation from Department of Labour and or other Statutory Body for this type of works, if applicable
- (47) Emergency Evacuation and Rescue Plan for the hazardous tasks related to the works.
- (48) The Contractor shall appoint a person, qualified and competent in accordance with the SHEQ requirements, as the liaison with the Eskom safety officer/delegated person for all matters related to health and safety, this person is contactable 24 hours a day.
- (49) The Contractor shall comply with the following:
  - v. Form 74 – SHE specification.
  - vi. Eskom Safety, Health, Environmental and Quality Policy: 32-727
  - vii. Eskom Life Saving Rules, Directive: 32-421
  - viii. Eskom Procedure on Smoking: 32-36
  - ix. Eskom Incident Management Procedure 32-95 Rev 3
  - x. Eskom Plant safety regulations 36-681.
  - xi. Eskom Integrated Risk management and Standards 32-391
  - xii. PGZ 45-24 HAZOP study guidelines
  - xiii. Eskom Standard SAS0012 Safety, Health & Environmental Specifications For *Contractors*
- (50) The Contractor shall comply with the health and safety requirements contained in this Works Information.

## 2.3 Environmental constraints and management

- (1) The Contractor shall comply with Eskom Duvha Waste Procedure ENVP0005.
- (2) The Contractor is responsible to keep the work area clean of any rubble.
- (3) The Employer will provide special colour coded bins for refuse disposal. The Employer will empty these bins.
- (4) The Contractor ensures that all workers under his control strictly adhere to the correct use of refuse bins. Refer to Duvha Waste Procedure ENVP0005 for refuse bin colour coding.
- (5) For the full duration of the Works, the Contractor is responsible to keep the work area clean of any rubble, and to place all refuse into the bins provided.
- (6) Removal of scrap and waste, including concrete/ash/refractory material to a location within the Duvha Power Station security gates and/or the ash dams must be included in the Price Schedule or Bill of Quantities. This must be inclusive of labour and equipment i.e. forklifts spades, shovels, transport.

## 2.4 Quality assurance requirements

- (1) All work is carried out under the supervision of an experienced supervisor.
- (2) The Contractor complies with the Employer's Quality Requirements as specified in Eskom Generation Standard QM58.
- (3) All quality control documentation (QCP) is submitted to the Project Manager within 7 days of Contract date.

## 2.5 Programming constraints

- (1) The Contractor submits a programme within 1 week of the Contract Date.
- (2) The program shall be in Microsoft Projects format
- (3) The programme indicates
  - i. The hour duration of each activity,
  - ii. The working calendar (number of work hours per day, days per week),
  - iii. The exact quantity of people per day
  - iv. All phases and interfaces

## 2.6 Contractor's management, supervision and key people

- (1) The Contractor shall provide a site Supervisor or Project Manager to supervise, monitor, control and coordinate all activities during the execution of the works
- (2) Contractor shall also provide the following staff:
  - i. Quality control supervisor
  - ii. Site Safety representatives
  - iii. Design and Testing Engineer

## 2.7 Invoicing and payment

- (1) 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.
- (2) The Contractor shall address the tax invoice to Eskom Holdings SOC Ltd and include on each invoice the following information:
  - i. Name and address of the *Contractor* and the Project Manager;
  - ii. The contract number and title;
  - iii. *Contractor's* VAT registration number;
  - iv. The Employer's VAT registration number 4740101508;
  - v. Description of service provided for each item invoiced based on the Price List;
  - vi. Total amount invoiced excluding VAT, the VAT and the invoiced amount including VAT;

## 2.8 Insurance provided by the *Employer*

- (1) Refer to the contract data.

## 2.9 Contract change management

- (1) The Contractor or the Project Manager formally notifies each other of any event which may lead to a change in agreed terms as per NEC 3.

## 2.10 Provision of bonds and guarantees

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



- (2) 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.

## **2.11 Records of Defined Cost, payments & assessments of compensation events to be kept by the *Contractor***

- (1) The *Contractor* may keep records of payment and assessments of compensation events if deemed necessary.

## **2.12 Training workshops and technology transfer**

### **2.12.1 General Requirements**

- (1) The Contractor provides training on the equipment and systems included as part of the works to the various categories of the Employer's technical staff for the duration of the works.
- (2) All training provided by the Contractor is customised for Duvha Power Station and is directly applicable to the actual equipment and software supplied for the works.
- (3) Training is focused on the specific HMI and systems' architecture, configuration, layout, equipment, software, HMI and design that the Contractor provides for the works.
- (4) Generalised training based on the Contractor's generic control system architecture, HMI and design philosophies is not acceptable.
- (5) Training facilities for the Engineering and Maintenance are provided by the Contractor.
- (6) Training material and tools are not shared by trainees during the training
- (7) The training facilities provided are:
  - i. air-conditioned and suitably sized
  - ii. accommodates all trainees comfortably
  - iii. includes all engineering tools and workstations
- (8) The training is provided as per the detailed training programme and prospectus accepted by the Project Manager
- (9) The training is completed before the start of FAT.

### **2.12.2 Training Categories**

- (1) Practical hands-on training for each individual trainee forms an integral part of each of the courses in these categories:
  - i. Training of Engineering & Maintenance Staff
  - ii. Training of Operators
  - iii. The training must be done upfront before implementation. The elements of the training are described in the subsections below.

### **2.12.3 Upfront Training of Engineering & Maintenance Staff**

- (1) Basic Engineering & maintenance training includes, as a minimum:
  - i. Usage of all sub-systems in the outside plant HMI system

- ii. Familiarisation with the documentation forming part of the works, including drawing configuration logic
- iii. Hardware familiarisation
- iv. Hardware configuration which includes the computers, network modules and all other peripheral equipment supplied as part of the works.
- v. Hardware installation
- vi. HMI and C&I system software reloading
- vii. Graphic display design, development and configuration
- viii. Drawing and hardcopy report generation
- ix. Network maintenance
- x. Operator interface familiarisation including keyboard and display functions, controls, alarms and messages
- xi. System maintenance through use and interpretation of diagnostic routines and error codes of on-line and off-line diagnostic software for the detection of faulty modules
- xii. Outside plant HMI system hardware maintenance training including the computers, network and all other peripheral equipment supplied as part of the works.
- xiii. Usage of Engineering workstations
- xiv. Installation, configuration and maintenance of all software packages forming part of the works

#### **2.12.4 Training of Operators**

- (1) Operator training includes, as a minimum:
  - i. Familiarisation with the documentation provided as part of the works, including drawing configuration logic
  - ii. Graphic display, design and configuration
  - iii. Operator interface familiarisation including keyboard and display functions, plant control, plant monitoring, navigation, alarms, messages.
  - iv. Use of the HMI during emergency operations
  - v. Training of Operating Staff must take place at Duvha Power Station.

#### **2.12.5 Trainee Participants**

- (1) The total number of participants trained is as follows:
  - i. Basic Engineering & Maintenance : 20
  - ii. Operator : 12
  - iii. Administrative : 4
- (2) The Employer bears the cost of salaries, accommodation, travelling expenses and other allowances of his personnel during the training, but all other training costs are borne by the Contractor.
- (3) The Contractor provides additional training courses as and when instructed by the Project Manager.

#### **2.12.6 Training Documentation**

- (1) The Contractor provides all course material including manuals.
- (2) The course material is in English and includes all third party documentation.
- (3) Printed and soft copies of the training documentation are supplied for each trainee plus an additional 3 hardcopy master sets and three soft copies.
- (4) All training documentation provided by the Contractor is customised for Duvha Power Station.
- (5) The training documentation contains the specific outside plant HMI and C&I systems' architecture, configuration, layout, software, equipment, HMI and design provided by the Contractor as part of the works.

- (6) Training manuals are continuously updated by the Contractor up to the date of issue of the Defects Certificate for the whole of the works.

## **2.13 Project Execution Methodology**

### **2.13.1 General Requirements**

- (1) The Contractor is responsible for carrying out all activities and supplying everything to provide the works.
- (2) This includes clarification and co-ordination with process plant engineers, other equipment manufacturers/suppliers and the Project Manager.
- (3) All documentation submitted by the Contractor is in an adequate state of completeness.

### **2.13.2 Engineering Design**

- (1) Engineering design is defined as being all activities required to translate the Contractor's scope of works, into a fully functional automation system
- (2) All Engineering design activities are executed by the Contractor in active co-operation with the Project Manager
- (3) The engineering design activities are phased to suit the Accepted Programme
- (4) A plant walk is performed including, but not limited to:
  - i. Verification of location and suitability of hardware installation points.
  - ii. Verification of location and suitability of cable routing paths.
  - iii. Contractor shall submit the Investigation findings to Eskom for review/comments.
- (5) As a minimum, Engineering design consists of the development, technical clarification and acceptance of the following:
  - i. Engineering programme
  - ii. Index and master register of documents
  - iii. Documentation synopsis
  - iv. OEM best practices
  - v. Cabinet Layout Diagrams
  - vi. Cable Routing Diagrams
  - vii. Cable & Termination schedules
  - viii. Engineering and maintenance procedures
  - ix. Network Topology Diagrams
  - x. Network installation philosophy
  - xi. Switch configuration diagrams
  - xii. Cabling concept
  - xiii. Power distribution philosophy
  - xiv. Integration test procedures
  - xv. Bill of Materials (make, model, rating, quantity etc...)
- (6) The Contractor and the OEM identify any discrepancies that would lead to shortcomings in the design and makes the Employer aware of such discrepancies and provides recommendations, where applicable. The Contractor takes action on such discrepancies.

### **2.13.3 Cyber Security**

- (1) The network, system and components to be designed in order to achieve the required goals must conform to the required standards.
- (2) Cyber Security for OT systems is governed by the standard 240-55410927: Cyber Security Standard for Operational Technology Revision 2.
- (3) The Contractor is responsible to ensure the design takes all the various aspects into consideration.
- (4) The Contractor is responsible for highlighting any deviation from the standard to the Employer during detailed design stage.
- (5) Any deviation must be approved and signed off by the Employer.
- (6) Should a deviation not have been highlighted by the Contractor, correcting such a deviation will be for the Contractor's cost.
- (7) Should a deviation not be approved, the design should be duly corrected by the Contractor to accommodate the required aspect.
- (8) The aspect of backup/restore and disaster recovery must be proven on the system.

#### **2.13.4 Supply, Installation, Configuration and Testing**

##### **2.13.4.1 General**

- (1) This stage consists of the supply, installation, configuration and testing of all equipment forming part of the works as well as other items that the Employer has specified such as free issued items.
- (2) Erection and installation of the relevant equipment does not begin until the engineering documentation for the section of the plant concerned has been accepted by the Project Manager
- (3) Quality inspections and tests are carried out by the Contractor after erection to prove the compliance of the installation with the Works Information and the engineering design freeze documentation.
- (4) Erection and installation is only considered complete once the quality inspections and tests for the installation concerned have been accepted by the Project Manager
- (5) The Employer reserves the right to appoint representatives to inspect all parts during erection and to be present at any of the quality inspections and tests
- (6) The Project Manager is free to specify hold and witness points during the installation and testing stages of the project.
- (7) The Contractor gives fifteen working days advance notice to the Project Manager of holds and witness points.
- (8) The Contractor confirms hold and witness points at least seven working days prior to the test activity.
- (9) The Contractor provides all test equipment for any inspections and tests.

##### **2.13.4.2 Site Integration Test (SIT)**

- (1) The SIT only begins once the cabinets have been installed in the final location and connected to permanent power supplies
- (2) The SIT is carried out before plant commissioning commences to ensure:
  - i. Compliance with the Works Information and the engineering design freeze documentation

- (3) The Contractor prepares a detailed SIT procedure
- (4) As a minimum, the proposed SIT procedure identifies the following:
  - ii. Major test activities
  - iii. Comprehensive list and description of the individual tests to be performed
  - iv. How the tests are to be prepared and conducted
  - v. Test dates and durations
  - vi. Checklists - how the test results will be documented
  - vii. Acceptance Criteria
  - viii. How the identified discrepancies will be processed
  - ix. Retesting requirements
- (5) In the event of an error in any test (hardware or software) the fault is logged, analysed and resolved.
- (6) The Contractor is allowed to rectify the fault and retest for the full duration on condition that the Project Manager finds the fault to be minor.
- (7) Major faults such as incorrect configuration, lack of communication or major faults as determined by the Project Manager may lead to the termination of the SIT.
- (8) The Contractor rectifies the fault and re-starts the SIT after proving the compliance and performance of the rectified piece of equipment by carrying out the appropriate diagnostic tests.
- (9) A Final SIT Report is prepared by the Contractor that includes the following as a minimum:
  - x. Test procedures used during SIT
  - xi. Detailed Test results
  - xii. Discrepancies identified during the tests
  - xiii. Resolution of the discrepancies
  - xiv. Retests conducted and results thereof
  - xv. SIT certificate
- (10) The Contractor submits the Final SIT Report to the Project Manager for acceptance.
- (11) When all tests are successful and the Final SIT Report is accepted by the Project Manager, the system is classified as 'ready for use'. The system is then deemed ready for commissioning
- (12) The submission and update of all documentation shall comply with VGB R 171, 2nd edition, 2010.
- (13) SIT should not in any manner hinder or affect the running of the old HMI system.

## **2.13.5 Commissioning**

### **2.13.5.1 General**

- (1) Commissioning is defined as bringing into service all items of the works, and meeting the functional requirements and performance criteria of the Works Information.
- (2) Contractor shall submit the detailed commissioning test procedures to the Project Manager for approval.
- (3) Commissioning requires that the new HMI run in parallel to the old HMI.
- (4) Commissioning includes all testing and verification of the stated performance criteria with:
  - i. Works Information.
  - ii. The engineering design freeze documentation
- (5) The Contractor provides sufficient personnel for the satisfactory and timely commissioning of equipment
- (6) The Contractor co-operates fully with the Project Manager or Representative(s) in the commissioning.

- (7) The Contractor provides all the test equipment for the commissioning network equipment and infrastructure.
- (8) The Contractor certifies that equipment is in a suitable and safe condition for use before it is placed in service.
- (9) Commissioning also requires that the old HMI be removed from the CR while the new HMI is installed and as such will be time critical.
- (10) Change over from old to new HMI should happen as quickly as possible with minimal disruption to the operator.
- (11) The Contractor shall be fully involved in the Commissioning phase.

#### **2.13.6 “As Built” Documentation**

- (1) 'As Built' documentation is supplied by the Contractor to the Project Manager upon completions of works.
- (2) 2 hard copies and 2 soft copies of As Built documentation is provided by the Contractor as part of the works.
- (3) Acceptance of the 'As Built' documentation is a pre-requisite for the completion of the works
- (4) The documents are reviewed by the Project Manager for correctness and conformance to the accepted design.
- (5) Soft copies must be in Microsoft Office 2010 or higher format.
- (6) Drawings must be in Bentley Microstation or similar CAD format.

#### **2.13.7 Risks**

- (1) During the execution of the project, special caution should be taken as the Outside plant HMI oversees the monitoring of common plant for all operating units at Duvha Power Station.
- (2) Although the current system is decentralised control it is centralised monitoring and alarming.
- (3) As such, any work being executed should take into consideration of the operator's responsibility to monitor the plant.
- (4) Any and all risk during this project should be highlighted up front to the Employer and immediately should a new risk arise.

### 3. Engineering and the *Contractor's* design

#### 3.1 *Employer's* design

##### 3.1.1 Process, Operating and Control Description

- (1) The control room moves from pure monitoring functionality to monitoring and control.
- (2) The upgraded system must retain the functionality of the current system to monitor, alarm and control Outside Plant and Overland Conveyor processes.
- (3) The upgraded system should provide functions on one platform, implementing the SCADA functions for the Outside Plant and Overland Conveyor on a single system.
- (4) Improved viewing functionality of plant processes must be possible by adding more screens to the HMI.
- (5) Proper overview dictates 8 x 24 inch screens to be configured in 2 rows x 4 columns layout.

##### 3.1.2 System design

- (1) A separate point of access to the system should be provided to perform engineering changes and commissioning.
- (2) The system must have the possibility to add more signals, tags and alarms and upgrading the communication infrastructure needed to ensure easy integration of future projects.
- (3) The system must interface using OPC to the station historian for storage through redundant links.
- (4) All networking equipment should be tailored for industrial use.
- (5) Fibre optic cable will be 62.5/125 um multi-mode.
- (6) Redundant cable should not follow the same patch between.
- (7) All fibre patch panels and leads to utilise ST connectors

##### 3.1.3 System Specifics

- (1) All clients to utilise Windows 10 Professional, 64 bit
- (2) All servers to utilise at minimum Windows Server 2016, 64 bit
- (3) All clients and servers to be in line with current installed base.

#### 3.2 Parts of the *works* which the *Contractor* is to design

- (1) The Contractor provides the whole of the works as defined in this Works Information except where explicitly stated as otherwise.

##### 3.2.1 Design Criteria

- (1) The design needed to conform to the following criteria:
  - iii. Installation of the new HMI must require a minimum of changes to the existing control equipment and SCADA communication network in order to achieve the project objectives.
  - iv. The new HMI must be able to collect data from all PLCs using natively supported protocols (Profibus and Profinet for Siemens equipment, ModbusPlus/TCP for Modicon equipment)
  - v. The new HMI must contain an engineering system capable of interfacing with a maximum number of PLCs over the Profinet communications network
  - vi. The engineering system must either be integrated with the HMI, or be able to provide forward engineering capabilities to the HMI, eg automatic tag generation from PLC source code.

### 3.2.2 Codes and Standards

- (1) The new HMI system should conform to the Eskom Standard 240-56355728 Human Machine Interface Design Requirements Standard.
- (2) This standard describes the required capabilities of HMI software and the manner in which it must be configured to display information to operators.

### 3.2.3 Key Design Driver

- (1) Elimination of obsolescence risks due to currently installed SCADA equipment
- (2) Reuse of hardware
  - i. This is required as a cost-savings exercise. The fibre optic cables used for the L2 network are also still in good condition – reuse of these is recommended due to the lack of cable ways in the outside plant, with trenching for new cables being disruptive and expensive.
  - ii. The fibre optic cables used for the ModbusPlus network can be reused.
- (3) Minimise disruption of network
  - i. The current L2 network is serial in nature, meaning incorrect configuration of the bus can result in multiple PLCs becoming unavailable.
  - ii. If the existing fibre cables are to be repurposed from the serial network to an Ethernet network, care must be taken to ensure this does not result in the entire L2 bus becoming unavailable. Similar considerations exist for the Modbus network.
- (4) Standardisation of hardware
  - i. The new HMI hardware purchased to replace obsolete equipment must be standardised with existing hardware on site to the greatest degree possible.
  - ii. Standardisation should reduce training, maintenance and spares holding requirements.
- (5) Standardisation of communications protocols
  - i. The makeup of the communications network should be as homogenous as possible, to reduce the complexity of the system and simplify maintenance and troubleshooting.
- (6) Redundancy and failure mode considerations
  - i. The level of availability required of the control hardware must be matched to that of the plant equipment being controlled.

### 3.2.4 System Architecture

- (1) The HMI system should consist of four major components: the servers, the engineering clients, the operating clients and printers
- (2) The servers should operate as the central repository for all engineering data relating to the outside plant control system, and/or all configuration data relating to the HMI. The engineering and operating functionality be present in the form of a single application suite. The engineering of the overland conveyors may require a separate software platform to that of the outside plant. In this case, it may not be cost effective to install a separate engineering server – instead a dedicated engineering station may be used to consolidate engineering data, which may be disconnected from the HMI configuration.
- (3) The servers shall be the devices primarily responsible for communication with the control devices – requests for process variables and operating/engineering/maintenance commands shall originate from the respective server, rather than from operating or engineering clients. This is primarily to ensure consistency of process and engineering data.



- (4) Process data shall be stored locally on the operating server, as well as forwarded from the operating server to the station historian using a tunnelled OPC interface. It shall be possible to maintain a local copy of all relevant process data on the operating server for a minimum of three months.
- (5) The engineering clients will be thin clients, which only act as an interface to the engineering server. .
- (6) The operating clients will be thin clients which only act as an interface to the operating server. It should not be possible for contradictory plant data to be displayed on two different operating stations.
- (7) The HMI must be licenced for 10 000 tags.
- (8) The complete HMI system should be time-synced to the Station Time Servers.

### 3.2.5 External Interfaces

- (1) The HMI system is required to interface with the following other systems:
  - i. Existing PROFINET network:
    - a. Currently this network consists of the bunker level, the Marshalling, the Driefontein Dam, AWR, SWB and FAC PLCs, which are all of the Siemens S7 family.
    - b. The HMI can connect to this network at the LP Services building or in the 16ml Boiler substations.
    - c. Any other existing PLCs capable of communicating via PROFINET should be changed from L2-FDL to PROFINET as part of this project, provided a feasible method of extending the PROFINET segment can be identified.
  - ii. Existing L2 FDL bus:
    - a. This bus should be accessed via the marshalling PLC on the PROFINET network as described above.
    - b. The Marshalling PLC will need to be reprogrammed to act as a gateway device, forwarding data from L2 to PROFINET, rather than the current configuration in which it forwards PROFINET data onto the L2 bus.
  - iii. Existing ModbusPlus bus:
    - a. A ModbusPlus to ModbusTCP converter is required, to avoid the reliance on serial interface cards.
  - iv. Plant Historian:
    - a. The new HMI network will exist as a standalone network with a new connection to the PIS network.
    - b. A tunnelled OPC link to the PIS must be established through a set of redundant firewalls.
    - c. The OPC tunnel link will utilise a server-client configuration across the redundant firewalls.
    - d. Configuration of the OPC client and Station Historian to be done utilising the OEM of the Historian.
    - e. Existing fibres will be used for the above connection with the exclusion of the new fibre patch leads which are required to be provided by the *Contractor*.
    - f. The OPC link should be capable of handling ten thousand (10000) tags

### 3.2.6 Maintenance Concept

- (1) As per C&I strategy, all computer equipment should have a life expectancy of six to eight years and be operated in a run-to-failure manner.
- (2) The proposed software should not be obsolete or be in phasing-out phase within the first six to eight years since the project implementation.
- (3) Proactive replacement of server hardware and/or software will be as per OEM recommendations, such as in instances of obsolescence or compatibility considerations.

- (4) It must be possible for all HMI components to be replaced by site personnel in the event of failure.
- (5) Upgrade of server hardware and software will be handled as a project with OEM assistance.
- (6) All server should have the following capabilities:
  - i. Use dedicated server hardware
  - ii. Hot swappable redundant power supplies
  - iii. Hot swappable redundant hard drives via a suitable RAID configuration
  - iv. 19" Rack mounted
  - v. Redundant CPU
  - vi. Redundant case fans
- (7) Printers to be colour laser.

### 3.2.7 Operating Concept

- (1) The operating concept of the control room should remain as is, with the exception of the addition of another four monitors.
- (2) The screens must be mounted on stands in two two-by-two sets to improve space utilisation.
- (3) The ability to remotely operate plant must be aligned with existing local operator interfaces to prevent conflicting operating parameters being received by control equipment.
- (4) Implementation of remote operator controls will be implemented only for non-obsolete control equipment which is connected to the PROFINET network.
- (5) Remote operator actions for plant areas that do not meet this requirement will be implemented at a later stage as control equipment at each plant location is upgraded.
- (6) The functionality provided by the HMI includes but is not limited to the following:
  - i. Operating functionality
  - ii. Indication
  - iii. Alarming
  - iv. Trending, historical and live
  - v. On-line plant performance information
  - vi. Event viewing (including operator action events)
  - vii. Access to historical operating data
- (7) Selection of any HMI graphic does not require more than two keystrokes.
- (8) Individual users have the ability to configure, save and restore the arrangement of the HMI graphic pages on the operating and overview screens
- (9) All information available to the operator from the HMI system is printable. The facility to print user-defined hard copies of specific occurrences forms an integral part of the system.
- (10) The Windows standard interface is deactivated for operators
- (11) In addition to the standard trending functionality, pre-configured trends are provided on the HMI. These trends will be decided upon during detailed design phase.
- (12) HMI Response Times:
  - i. a. The maximum time taken to completely populate a HMI graphic page or faceplate with dynamic data shall not exceed 1.5 seconds.
  - ii. b. The average time taken to completely populate any HMI graphic page or faceplate with dynamic data shall be less than 0.5 seconds.
  - iii. c. The maximum time taken to completely populate a trend with dynamic data shall not exceed 3 seconds.
  - iv. d. The average time taken to completely populate any trend with dynamic data shall be less than 1.5 seconds.

### **3.2.8 Safety Concept**

- (1) The new HMI will be implemented with standard 220V computer equipment.
- (2) No particular safety concerns are noted, other than those normally related to the installation and operation of computer equipment.
- (3) Safety concepts related to the plant areas being displayed on the HMI reside in the control equipment which will not be impacted by this project.

### **3.2.9 Information Technology Strategy**

- (1) No interfacing to IT network will be allowed directly or even through a firewall.

### **3.2.10 Operational Technology Strategy**

- (1) All communication should be by wired, Ethernet based protocols to the greatest extent possible.
- (2) The eventual field network configuration of a redundant ring should be provisioned for.
- (3) All servers should display a sufficient level of redundancy i.e. redundant, hot swappable power supply units, redundant storage devices and redundant physical servers.
- (4) A data backup and disaster recovery system should be provided. This should be automated to the greatest extent possible, eg automated backups of to a storage network or similar.
- (5) All network equipment should be managed industrial-type and passively cooled, with native support for network ring standards such as RSTP, as well as with PROFINET where required.
- (6) RuggedCom, Siemens Scalance, Moxa or Hirschman are the preferred brands to standardise with other equipment on site.
- (7) Operating voltage, mounting requirements and uninterrupted power requirements will be determined as part of the design.
- (8) Existing network switches in the LP Services building and 16m Boiler substations may need to be replaced if they are not compatible with the new equipment.
- (9) The HMI equipment must be on an independent subnet.
- (10) Either an IP address range or specific IPs will be issued by the station accordingly.
- (11) Server equipment must be powered from the Station UPS in a redundant manner – two existing 220V chargers are available to enable full redundancy of power supply.
- (12) Two operator stations are required; each shall be powered by a separate UPS.
- (13) Redundant switches shall also be provided; again each will be powered from separate supplies.
- (14) The status of all servers and computer devices forming part of the HMI/engineering system shall be visible in the HMI software, and any faults detected shall be alarmed in the HMI.
- (15) Diagnostic information relating to connected control equipment shall also be displayed and alarmed where existing control equipment provides such functionality.
- (16) The capabilities of the HMI software shall conform to Eskom Standard 240-56355728.
- (17) All HMI equipment must retain time synchronisation with the server equipment using NTP over the HMI network. All compatible control equipment must be time synched to the server equipment. The

server equipment must be synchronised to an existing GPS time clock – the practicality of connection to the various existing clocks will be investigated as part of the basic design.

(18)Interface to the plant historian must be through redundant interfacing firewalls.

(19)The rule-set will also be configured on the new firewalls.

### 3.2.11 Cyber Security

- (1) The *Employer* is required to adhere to standards as set apart by its head office.
- (2) The design of the *Contractor* should conform to the requirements as set out in the following standards:
  - i. 240-55410927 - Cyber Security Standard for Operational Technology Rev 2
  - ii. 240-79669677 - DMZ Designs for OT Rev 1
  - iii. 240-56355728 - Human Machine Interface Design Requirements Standard Rev 2

### 3.2.12 Alarm Management System

- (1) Re-design the alarm system such that advanced filtering is available to enable nuisance and unnecessary alarms to be disabled via the HMI interface, this must also be done for all the tags.
- (2) A comprehensive and integrated alarm handling system is employed. The alarm handling system clearly distinguishes between different alarm types and provide alarm filtering functionality.
- (3) Alarm information is not lost or inaccessible whilst navigating through displays. Alarm presentation is dynamically provided to the operator with information matched to the current situation and its criticality.
- (4) Nuisance alarms are not repeated on the alarm pages.
- (5) Users are able to navigate directly from any alarm to the alarm response sheet for that specific alarm.
- (6) The filtered alarms must still be available on the Engineering System
- (7) Nuisance alarms are not repeated on the alarm pages.
- (8) Users are able to navigate directly from any alarm to the alarm response sheet for that specific alarm.
- (9) Alarm response sheets are provided for all configured alarms including alarms specific to the C&I system.
- (10)All alarm response sheets comply with the requirements of 240-56355466, Alarm Management System Guideline.

### 3.2.13 Malware Protection System

- (1) A MPS is employed to ensure the protection of the system.
- (2) Antivirus software is installed on all workstations and servers.
- (3) The individual antivirus software on all workstations and servers is centrally managed from the central update system

### 3.2.14 Central Update System

#### 3.2.14.1 General

- (1) The central update system is defined as being the system which is used to deploy, manage and control the application of security patches, antivirus updates and antivirus signature files to the individual computers, network switches and UTMs of the Duvha C&I system.
- (2) The central update system consists of the following components:

- a. An update server from which security patches, antivirus updates and antivirus signature files are deployed to all computers, network switches and UTMS in the Duvha C&I system
- b. An update server application via which the deployment of updates are managed and controlled
- c. Test environment in which all downloaded security patches, antivirus updates are tested before deployment to the update server

#### **3.2.14.2 Functional Requirements**

- (1) Antivirus signature files are downloaded automatically from the antivirus service provider – via the DMZ – to the update server without any human intervention.
- (2) Antivirus signature files are deployed automatically and immediately from the update server to the individual Duvha C&I system components without any human intervention.
- (3) The deployment of the antivirus signature files is logged.
- (4) Antivirus software updates & patches and security patches are not downloaded automatically to the update server.
- (5) OEM approved updates and patches are obtained from the OEM via suitable removable media
- (6) The OEM approved updates and patches are first tested on the test environment for compatibility with the Duvha C&I system.
- (7) The test environment is a non-productive environment.
- (8) If the compatibility test of the OEM approved updates and patches is successful, the OEM approved patches are then loaded onto the update server.
- (9) The successfully tested and OEM approved updates and patches are deployed individually to each C&I system's components with minimal human supervision.

#### **3.2.15 GPS Time Sync System**

##### **3.2.15.1 General**

- (1) The GPS time sync system is defined as being a complete GPS based time synchronisation system to synchronise the entire Duvha C&I system according to the local time offset with relation to GPS time
- (2) The GPS time sync system should consist of:
  - a. Redundant GPS clocks
  - b. Fibre to Copper converters
- (3) The GPS time sync system should utilise existing equipment:
  - a. GPS antenna
  - b. GPS antenna signal splitter
  - c. Redundant fibre

##### **3.2.15.2 Functional Requirements**

- (1) The GPS time sync system is fully redundant
- (2) In the event of a failure of one GPS clock, the redundant GPS clock assumes the time synchronisation function automatically, seamlessly and without intervention.
- (3) Direct synchronisation is used for the complete HMI system

- (4) Workstations, servers and network equipment are synchronised to the GPS time sync system using the NTP protocol
- (5) The GPS time sync system is capable of synchronising equipment using any of the following signal types:
  - a. IRIG-B
  - b. PPS
  - c. DCF
  - d. Serial data strings
  - e. NTP
- (6) The accuracy of all equipment synchronised by direct GPS time synchronisation signals is 1 ms or better
- (7) The accuracy of all equipment synchronised by the use of NTP is 1ms
- (8) On the loss of a GPS signal, the accuracy of the GPS clock, i.e. deviation from UTC, is less than 50ms per day
- (9) The GPS time sync system determines its installation position automatically, i.e. if no data with regards to position co-ordinates, time, calendar and ephemeris are known, i.e. the GPS time sync system is self-calibrating
- (10) Power supply voltage variations do not affect the GPS time sync system's integrity in any way.
- (11) The GPS time sync system retains critical data (by means of non-volatile memory or battery back-up) in the event of power supply failure.
- (12) In the event of a complete loss of power to the GPS time sync system, the GPS time sync system is fully operational (according to the accuracy requirements) within 5 minutes of power being restored.
- (13) Time synchronisation to the plant, after recovery from any GPS time sync system failure is automatic.

### **3.2.16 Civil**

#### **3.2.16.1 HMI Cabinets Pedestals**

- (1) Due to the false floor safe working load being unknown; Pedestals are required to support the HMI cabinets. These Pedestals are to distribute the cabinet load directly onto the ground slab under the false floor. Thus bypassing the false floor completely.
- (2) The pedestal needs to accommodate the cables entering the cabinets.
- (3) The designs are to include details on how the existing false floor will be modified to accommodate the Pedestals. The method of construction must be clearly defined and accepted prior to construction.
- (4) All designs to compile with the latest SANS standards and Eskom Standards (240-56364545 Structural Design and Engineering Standard Revision 2), and all design documents to be submitted to the Eskom Civil & Structural department for review prior to construction.

#### **3.2.16.2 Electrical**

- (1) The new HMI Upgrade must be supplied from new rack mount, dual redundant Uninterruptible Power Supplies (UPSs).
- (2) Each UPS should not be loaded at more than 50% when powering all associated equipment.

- (3) The Contractor supplies and installs and commissions the following:
- i. 2 x circuit breakers for the new HMI cabinets to power the new HMI equipment.
  - ii. 2 x 220V, 3 core (neutral, live and Earth) power cable from the DB to new new HMI equipment.
  - iii. Terminate the 220V power cable on both ends.
  - iv. The DB is located in the same room as the cabinet location and additional details will be provided during detailed design.

### **3.2.17 Licenses**

- (1) All licenses covering the equipment, standard software and application software provided are included as part of the works.
- (2) All licenses remain valid in the event of the failure and replacement of faulty equipment
- (3) All licenses provided are valid for the entire life of the Duvha C&I system.
- (4) All licenses are site licenses for use at Duvha Power Station Site.
- (5) Installation disks are provided for all licensed software provided

### **3.2.18 Other requirements**

- (1) The FAC PLC's to be connected to the marshalling PLC.
- (2) Communication setup and programming for FAC signals and alarms.
- (3) Marshalling PLC to be programmed to allow for FAC data to be pulled and displayed on the HMI at the control room.
- (4) All indications/readings and alarms of each FAC to be displayed on the HMI.

## **3.3 Procedure for submission and acceptance of *Contractor's* design**

- (1) The Contractor submits any drawing or documentation that will fulfil the requirements of this works
- (2) All drawings or documentation are submitted to the Project Manager in a formal communication
- (3) Statement of design acceptance or a list of design faults will be issued within two weeks of design receipt by the Project Manager

## **3.4 Other requirements of the *Contractor's* design**

- (1) The equipment requirements are defined in this Works Information and also in the following documents:
  - i. Appendix 1 – List of documents required from the Contractor
  - ii. Appendix 2 – Limits of Supply and Services
  - iii. Appendix 3 – List of Standards
  - iv. Appendix 4 – Testing Requirements and Acceptance criteria

## **3.5 Use of *Contractor's* design**

- (1) The design will become the intellectual property of the Employer.
- (2) No design information may be withheld from the Employer.

- (3) All information pertaining to the design must be handed over to the Employer after completion of the Works.



## **4. Procurement**

### **4.1 People**

#### **4.1.1 Minimum requirements of people employed on the Site**

- (1) The Contractor shall comply with Basic Condition of Employment Act and Labour Relation Act for the use of labour in executing the works to give effect to the right to fair labour practices referred to in section 23 (1) of the Constitution by establishing and making provision for the regulation of basic conditions of employment; and thereby to comply with the obligations of the Republic as a member state of the International Labour Organisation; and to provide for matters connected therewith.
- (2) The contractor must have at least 2 of Supervisory and Artisan staff authorized in Plant Safety Regulations and/or High Voltage Regulations. In order for any person to do work at the Power Station, this person should be authorized to take out a permit to work.
- (3) The courses for this will be presented free of charge to contractors and bookings must be done via the Project Manager.
- (4) N.B Access to the switchgear/equipment rooms the Contractor to comply to the following prior to access being granted:
  - i. The Contractor's Supervisor to attend the Arc Flash Course (PSR Module 5) and pass the required test. The course will be offered by the Employer at no cost and Course dates will be announced after Contract Award.
  - ii. Contractor to ensure that all personnel working in the room wear special overalls due to the nature of equipment in the rooms.
- (5) Overall specification – Arch Flash Proof Overall Class 2, Material: Protera (ATPV 12CA/cm2) Colour: Blue. Suggested Supplier: Quality Safety 1990 Pty Tel 016 365 5770.

#### **4.1.2 BBBEE and preferencing scheme**

- (1) Eskom's policy is to maximise purchases from Black or Black Empowering Enterprises (BEE's) whether Black Woman-owned, small or Large Black or Black empowering suppliers. The purpose is to promote entrepreneurship in black communities and give black business access to the mainstream of business opportunity.
- (2) Eskom will concentrate its development efforts on black suppliers in manufacturing, construction and mining /extraction sector.

## **4.2 Subcontracting**

#### **4.2.1 Preferred subcontractors**

- (1) Subcontracting the OEM of Visual Automation will be required in order to setup the interface from the new HMI system to the existing Plant Information System.

#### **4.2.2 Subcontract documentation, and assessment of subcontract tenders**

- (1) The Contractor shall submit the proposed contract data for each subcontracting for acceptance to the Project Manager.
- (2) The Contractor shall prepare subcontracting document as according to NEC contract.

- (3) The Contractor must inform the Employer's representative when intending to subcontract some of the works from the contract scope.
- (4) The Contractor shall take full responsibility for the subcontractor's quality of work.

#### **4.2.3 Limitations on subcontracting**

- (1) The Contractor shall not subcontract more than 25% of the contract scope

#### **4.2.4 Attendance on subcontractors**

- (1) The Contractor shall in writing inform the Employer's representative about the subContractor intentions for site visit

### **4.3 Plant and Materials**

#### **4.3.1 Quality**

- (1) All work is carried out under the supervision of an experienced supervisor.
- (2) The Contractor complies with the Employer's Quality Requirements as specified in Eskom Generation Standard QM58. The Contractor, when using materials that are required to comply with a standard specification
- (3) Shall, if so ordered, furnish the Engineer with certificates showing that the materials do so comply.
- (4) Where so specified, materials shall bear the official mark of the appropriate standard.
- (5) Samples ordered or specified shall be delivered to the Engineer's office on the Site.
- (6) Unless otherwise specified, all proprietary materials shall be used and placed in strict accordance with the published instructions of the relevant manufacturer.
- (7) All quality control documentation is submitted to the Project Manager within 7 days of Contract date.

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

- (1) The Employer will provide power supply, water and land for the storage of equipment and material.
- (2) The Contractor shall supplies all the necessary equipment and material required to execute the Works.
- (3) Should the Contractor require using of any of the Employer's Equipment, including compressed air, electricity, water supply and crane age, it must be specified in the Works Information supplied by the Contractor.
- (4) The Employer does not guarantee continuity of supply of any of these items required in point 3.
- (5) Any site establishment will be discussed and agreed upon between the Project Manager and the Contractor.

#### **4.3.3 *Contractor's* procurement of Plant and Materials**

- (1) The Contractor shall make use of SABS approved plant and material.
- (2) Test certificates shall be given to the Project Manager of the project.
- (3) The Contractor's material should comply with the Eskom Standards as a minimum.

#### **4.3.4 Spares and consumables**

- (1) The Contactor must supply a recommendation for spares holding based on the project requirements and the Employer's goals.

#### **4.4 Tests and inspections before delivery**

- (1) The Contractor does not bring to the working area those plant and material which the works information states are to be tested or inspected before delivery until the supervisor has notified the Contractor that they have passed the test.

#### **4.5 Marking Plant and Materials outside the Working Areas**

- (1) All plant and materials outside working areas are to be marked "for Contractor" until such time that they are tested and installed at the site/plant.

## 5. Construction

### 5.1 Temporary works, Site services & construction constraints

#### 5.1.1 *Employer's* Site entry and security control, permits, and Site regulations

- (1) The Contractor applies for access permits for all works exceeding four (4) weeks via the Project Manager, who will co-ordinate this.
- (2) The Contractor applies for Contractor's Permits for all his employees and/or subContractors at the Security gate, at least 24 hours prior to entry of the Duvha Power Station Security Area. .
- (3) The Contractor completes the specific form in the Duvha Power Station Contractors Safety Manual, listing all of the personnel that he intends using on site.
- (4) The completed list, identified with the Contractor's name, contains the following information:
  - i. Employee Name
  - ii. Employee ID Number
  - iii. Eskom Safety Co-ordinator signature
  - iv. Eskom Project Manager signature
  - v. Validity Date
- (5) No permits are issued to personnel who have not attended safety induction.
- (6) The Contractor photocopies the first page of the ID book of every one of his employees; reduced to the size 65%.
- (7) This completed list, together with the certified photocopies of the ID books is delivered to Protective Services for the preparation of the Contractor's Permits.
- (8) The Contractor allows at least 24 hours for the preparation of the security permits, before he collects the permits from the Protective Services offices.
- (9) The Contractor's personnel are required to be in possession of a Contractor's Permit at all times inside Duvha Power Station.
- (10) All Contractors' permits are submitted back to Protective Services when the workers leave the site after completion of the works. Failure return the permits will result in a R50,00 penalty for each non returned permit.
- (11) The Contractor compiles detailed Tool Lists (obtainable from Protective Services) of all tools and equipment to be taken on site before arriving at the power station.
- (12) Authorised copies of these lists are retained to be used again when the tools and equipment is removed from site.
- (13) The Contractor's visitors and all personnel conform to the security arrangements in force at Duvha Power Station.
- (14) Application forms for visitors are filled in by the Contractor's Site Manager and approved by the Project Manager, and submitted to the Employer's Protective Services office one day prior to the visit.
- (15) Visitors will not be allowed on site if the necessary forms are not in the possession of security staff.
- (16) The Chief Security Officer may, with valid cause, remove any of the Contractor's personnel from the site, either temporarily or permanently. He may deny access to the site to any person whom, in the opinion of the said Chief Security Officer, constitutes a security risk.

- (17) No unauthorised vehicles will be allowed on site. Only Contractor's vehicles with displayed Contract Vehicle Permits disks will be allowed on site. Contract Vehicle Applications are directed to the Project Manager for consideration and approval.
- (18) The Contractor is restricted to the Site. The Contractor is forbidden to enter any other areas, and ensures that his employees abide by these regulations.
- (19) Parking inside the power station is strictly forbidden, except for loading purposes.
- (20) No recruiting of casual labour may be done on Eskom premises, including the area outside the Power Station Security Gate.
- (21) Security personnel may search any premises, property or person within the security area of Duvha Power Station
- (22) No Photographic equipment will be allowed within the security area of the Power Station without obtaining permission.
- (23) Application forms for such permission is available from the Protective Services offices.
- (24) Any person found in possession of such equipment will be prosecuted in terms of the National Key Point Act
- (25) The Contractor shall comply with SHE Specification 74 and Eskom Standard 36-681: Plant Safety Regulations.

#### **5.1.2 Restrictions to access on Site, roads, walkways and barricades**

- (1) Pedestrian crossing are made on the road they should be used when crossing the road
- (2) Inside the plant walkways are clear makes they should be used when walking inside the plant to keep safe on any object that might fall.
- (3) Barricades are provided where there are open trenches and around the sumps and manholes.
- (4) The Contractor shall occupy only such ground as is necessary to carry out the works.
- (5) All fences and other structure that have been damaged or interfered with by the Contractor shall be restored to be a condition at least equivalent to their original condition

#### **5.1.3 People restrictions on Site; hours of work, conduct and records**

- (1) The LAR is for the person in charge of the plant to maintain control over activities taking place on his plant that are not covered by the Plant Safety Regulation and Operating Regulations for High Voltage Systems.
- (2) Activities that are allowed to be carried out under the LAR must not require a permit and must satisfy the following criteria:
- (3) They must not involve danger to the person carrying out the activity;
- (4) No plant isolations must be required;
- (5) The activity must be performed by a skilled person and there must be no risk of a production loss;
- (6) The duration of the activity must be less than 24 hours
- (7) The Supervisor accompanies the Contractor during the first instances of working under a LAR on a specific plant area.

- (8) It is very important that the person who plans to do an activity on a plant under the LAR for that relevant area, informs the person in charge of the plant of what will be done.
- (9) This means verbally telling the person in charge of the plant what will be done and not just signing the LAR book. The LAR book is also signed.
- (10) It is also important that as soon as the activity is completed the person, who was doing the activity, notify (verbally) the person in charge of the plant that conditions are back to normal and that the LAR has been signed off. Just signing the LAR book is not sufficient.
- (11) For more information please refer to Plant Safety Regulation C11.

#### **5.1.4 Health and safety facilities on Site**

- (1) The Contractor provides a First Aid service to his employees and sub-Contractor. In the case where these prove to be inadequate, like in the event of a serious injury, the Employer's Medical Centre and facilities will be available.
- (2) Outside the Employer's office hours, the Employer's First Aid Services will only be available for serious injuries and life threatening situations. The Employer shall be entitled, however, to recover the costs incurred, in the use of the above Employer's facilities, from the Contractor.
- (3) The Contractor to ensure that qualified and competent First Aiders and Emergency Care staff is permanently on site and at actual construction site for emergency situations, as and when they arrive.
- (4) The Contractor or his staff shall not move the injured party from the incident position and site unless the person's/persons' life is in danger or the person is moved by a qualified and trained Emergency Care Worker.

#### **5.1.5 Environmental controls, fauna & flora, dealing with objects of historical interest**

- (1) No fauna or flora will be collected or removed from any farm by any visitor without written permission of the landowner, in which case cognizance will be taken of appropriate provincial legislation pertaining to fauna and flora.
- (2) Under such cases Eskom Holding's ethical policies and guidelines will be strictly applied.

#### **5.1.6 Title to materials from demolition and excavation**

- (1) The Contractor has no title to an object of value or historical or other interest within the site
- (2) The Contractor shall notify the Project Manager when such an object is found and the Project Manager will instruct the Contractor how to deal with it.
- (3) The Contractor does not move the object without instruction.

#### **5.1.7 Publicity and progress photographs**

- (1) Should publicity and progress photographs be required an application shall be made via the Project Manager.

#### **5.1.8 Contractor's Equipment**

- (1) Any equipment brought to site by the Contractor must be declared on entry to security personnel
- (2) Said equipment will be issued a permit, which will be required to remove the equipment from site

#### **5.1.9 Equipment provided by the Employer**

- (1) Should the Contractor require using of any of the Employer's Equipment, including compressed air, electricity, water supply and crane age, it must be specified in the Works Information supplied by the Contractor.
- (2) The Employer does not guarantee continuity of supply of any of items in point (1).
- (3) The Employer shall be entitled to withdraw use of the said Equipment, should proper maintenance and cleanliness not be ensured.
- (4) In the event of point (3), the Contractor shall be obliged to provide the necessary Equipment at his own cost.
- (5) The Contractor is responsible for the repair, replacement or correction as necessary of all pieces of tools and equipment supplied by the Employer which are damaged and / or lost whilst in the Contractor's custody and control.
- (6) The Contractor's site manager must ensure that any one of his employees or Sub-Contractor, operating hoist equipment belonging to the Employer, is authorised by an Accredited Company and retraining is done annually.
- (7) Arrangements for training courses can be made via Duvha Power Station Maintenance Training but the Contractor will absorb costs.
- (8) A copy of this accredited and valid training certificate must be given to the Employer's Supervisor, who will then arrange access for usage.

#### **5.1.10 Site services and facilities**

- (1) The Employer will provide the Contractor access to toilet facilities free of charge.
- (2) The Contractor or any of his employees or Sub Contractors will not be allowed to use the Employer's dining facilities, unless a specific agreement has been made between the Contractor and Eskom Catering and Accommodation Services (ECAS).
- (3) The Contractor or any of his employees or Sub Contractors may buy take away meals from the fast foods outlet on site.
- (4) The Contractor provides a First Aid service to his employees and Sub Contractors. In the case where these prove to be inadequate, like in the event of a serious injury, the Employer's Medical Centre and facilities will be available.
- (5) Outside the Employer's office hours, the Employer's First Aid Services will only be available for serious injuries and life threatening situations.
- (6) The Employer shall be entitled, however, to recover the costs incurred, in the use of the above Employer's facilities, from the Contractor

- (7) For the full duration of the works, the Contractor is responsible to keep the work area clean of any rubble, and to dispose all refuse to a registered dumpsite. There is no such dumpsite available at Duvha Power Station.
- (8) All waste introduced and/or produced on Eskom's premises by the Contractor for this Contract, must be handled in accordance with the minimum requirements for the Handling and Disposal of Hazardous Waste in terms of Government Legislation as proclaimed by the Department of Water Affairs and Forestry Act 1994 Ref.: ISBN0621 - 16296-5.

#### **5.1.11 Facilities provided by the *Contractor***

- (1) The provision of accommodation for Contractor's personnel shall be the responsibility of the Contractor

#### **5.1.12 Underground services, other existing services, cable and pipe trenches and covers**

- (1) A survey must be carried out to determine if any underground cabling and services will hinder the design and execution of the project.
- (2) If no up-to-date drawings are available for such purposes as in point (1), the onus falls on the Contractor to perform an on-site survey.
- (3) Any cables identified during the survey must be marked on the drawing.
- (4) If during execution of the project any damage to identified or unidentified underground cabling and services occur, the cost of repair will be for the Contractor.

#### **5.1.13 Control of noise, dust, water and waste**

- (1) The Contractor ensures that all necessary notices and barricading are set up to ensure safety of people working in the area of the works.
- (2) All necessary precautions should be made to minimise impact of dust or noise.

### **5.2 Completion, testing, commissioning and correction of Defects**

#### **5.2.1 Work to be done by the Completion Date**

- (1) On or before the Completion Date the Contractor shall have done everything required to Provide the Works except for the work listed below which may be done after the Completion Date but in any case before the dates stated.
- (2) The Project Manager cannot certify Completion until all the work except that listed below has been done and is also free of Defects which would have, in his opinion, prevented the Employer from using the works and Others from doing their work.

	<b>Item of work</b>	<b>To be completed by</b>
	As built drawings of 2.13.6	Within 5 days after Completion
	Performance testing of the <i>works</i> in use as specified in paragraph 5.2.5 of this Works Information.	See performance testing requirements.



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### 5.2.2 Commissioning

- (1) Refer to Section 2.13.5

### 5.2.3 Take over procedures

- (1) During take over, the *Contractor* is responsible to demonstrate to the relevant parties the completed works.
- (2) If any concerns are raised during the demonstration, the onus falls on the *Contractor* to address and correct.
- (3) If any concern as per point (2) was part of the works, the final signoff will be postponed until such concerns have been addressed.

### 5.2.4 Access given by the *Employer* for correction of Defects

- (1) If the *Contractor* is required to correct any defect, a Permit To Work (PTW) will be issued based on the defect which is to be corrected.
- (2) The availability of the PTW will be dependent on the plant accessibility and constraints.

### 5.2.5 Performance tests after Completion

- (1) The performance of the system will be verified and tested during normal production cycles.
- (2) If any defect or deviation from the required performance is identified, it will be treated as a defect and applicable clauses will apply.

## **6. Plant and Materials standards and workmanship**

### **6.1 Investigation, survey and Site clearance**

- (1) Investigation of the site must be conducted in order to gather any information required to complete the requirements of Section 3.
- (2) A site survey, which includes equipment and control rooms must be carried out in order to ensure the ergonomics aspect of the design is not limited by physical plant equipment or material.

### **6.2 Electrical & mechanical engineering works**

#### **6.2.1 General**

- (1) Refer to Appendix 3 for 240-56227443 Requirements for Control and Power Cables for Power Stations Standard for Electrical cabling requirements.

### **6.3 Process control and IT works**

#### **6.3.1 General**

- (1) All equipment is available in South Africa as commercially- off- the-shelf (COTS) products.
- (2) All equipment is to conform to TIA-1005

#### **6.3.2 Control & Instrumentation Requirements**

##### **6.3.2.1 Network/Equipment Cabinet**

- (1) Rack height of 42U
- (2) Ventilated front and back doors
- (3) Width x Depth - 800mm x 1000mm

##### **6.3.2.2 Fibre Patch Panels**

- (1) Fibre Patch Panels are fitted with ST connectors as per IEC61754-2

##### **6.3.2.3 Copper Patch Panels**

- (1) Copper patch panels are fitted with 8P8C (RJ45) Keystones as defined in TIA-568.
- (2) 8P8C Keystones are wired according to the T568A standard.

##### **6.3.2.4 Fibre Optic Ethernet Cabling**

- (1) All fibre optic cabling is 50/125um Multimode cabling operating at 850nm.
- (2) No segment of fibre cabling exceeds 450m in length.
- (3) All fibre optic cables excluding fibre pig tails are terminated in patch panels and not in splice boxes.
- (4) Fibre optic cabling segments form a ring.
- (5) Redundant portions of the ring are physically separated unless agreed upon and approved by Employer
- (6) Fibre optic cabling installation conforms to TIA568-C.3

##### **6.3.2.5 Copper Ethernet Cabling**

- (1) All copper Ethernet cabling is Category 5e or Category 6.
- (2) No segment of copper cabling exceeds 50m in length.
- (3) All copper cables entering a network cabinet are terminated onto a patch panel.
- (4) The field end of a copper cable may be fitted with an 8P8C jack as defined in TIA568.
- (5) All 8P8C jacks are wired according to the T568A standard unless a crossover cable is required.

- (6) Copper cable installation conforms to TIA568-C.2

#### **6.3.2.6 Trunking**

- (1) The *Contractor* may make use of network trunking running along the 16m boiler wall and the 33m turbine wall. This trunking may only be used for fibre optic cables.
- (2) The *Contractor* may make use of network trunking running from Unit 1&2 new equipment room to the Main Admin Building server room. This trunking may only be used for fibre optic cables.
- (3) The *Contractor* may make use of network trunking running from Unit 3&4 new equipment room to the Main Admin Building server room. This trunking may only be used for fibre optic cables.
- (4) Boxed trunking is provided for all network cabling
- (5) The boxed trunking used for network cabling is dedicated to the network cabling and is not used for any other cabling
- (6) Any new trunking should be installed such as to prevent dust, ash or water collecting within the trunking.
- (7) Trunking is specified such that it fulfils the requirements of TIA568-C.2, TIA568-C.3 and TIA1005

#### **6.3.2.7 Cabling and Wiring**

##### **6.3.2.7.1 General**

- (1) The design, supply, installation, termination, labelling, testing and commissioning of all wiring and cabling is provided
- (2) All cables as a minimum are insulated with flame-retardant, halogen-free PVC outer sheath
- (3) Internal cores of all multi-core cables must be colour coded
- (4) The routes for power supply cabling, network cabling and the trunking is of a consistent and integrated design, that takes into account different cabling and racking routes for common modes of failure and the redundancy concepts of the automation system design
- (5) The cable routes are designed such that equipment can be removed for maintenance without causing damage to the cables.
- (6) All cables and wires provided are secured with suitable cable glands, straps or clamps
- (7) All cables terminating in cubicles are such that, maintenance is achieved easily on faulty cables; thus the number of cables per access way is restricted to facilitate this.
- (8) Durable cable numbering /labelling is provided for all cables entering the cubicles, the numbering /labelling is such that maintenance on cables is easily achieved
- (9) Conduit and trunking to conform to standards listed in Appendix 3.
- (10) All wire terminations to use appropriate lugs
- (11) Any termination to conform to standards listed in Appendix 3.
- (12) Cabling shall comply to Eskom standard 240-56227443 Requirements for Control and Power cables for Eskom Power stations

##### **6.3.2.7.2 Cable Schedules**

- (1) Accurate records are kept in Cable Schedules by the *Contractor* for all cabling forming part of the Works.
- (2) The cable schedules are provided inclusive of origin, target, type, size and termination details.
- (3) Termination schedules are provided for all cables

##### **6.3.2.7.3 Cable Management**

- (1) A cable stock schedule is kept by the *Contractor* to record all cables delivered to and removed from Duvha site.
- (2) The installed cabling is reconciled with the cable stock schedule.

7. List of drawings

7.1 Drawings issued by the Employer

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.

Drawing number	Revision	Title

## C3.2 *CONTRACTOR'S* WORKS INFORMATION

This section of the Works Information will always be contract specific depending on the nature of the *works*. It is most likely to be required for design and construct contracts where the tendering contractor will have proposed specifications and schedules for items of Plant and Materials and workmanship, which once accepted by the *Employer* prior to award of contract now become obligations of the *Contractor* per core clause 20.1.

Typical sub headings could be

- a) *Contractor's* design
- b) Plant and Materials specifications and schedules
- c) Other

This section could also be compiled as a separate file.

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