

## 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

Duvha Power Station is a coal fired power station built between 1978 and 1984, and is situated near Witbank. The station has six power generating units, each with an output of 600MW. The total plant capacity is 3600MW. The station has initiated a project to upgrade the Water Treatment Plant Human Machine Interface (WTP HMI), to achieve reliable and quality water (potable and demineralized) production. The WTP HMI upgraded equipment are positioned in dedicated server and automation rooms. The equipment generates heat during operation. Equipment heat load must be removed through air conditioning, to prolong the equipment lifespan, and achieve dust control through pressurization and filtration.

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

The purpose of this document is to describe the minimum requirements engineering, drawings, procurement, manufacture, quality control & assurance, supply, delivery, installation, commissioning, testing, training, and maintenance and handing over of HVAC Works.

## 1.3 Interpretation and terminology

### 1.4 Definitions

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.
Architect Engineer	Architect Engineer - When Eskom acts as the Architect 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); the design is integrated by identifying all interfaces with other packages/plant systems/assets and ensuring that these interfaces are catered for; foreseen technical risks are identified and addressed/challenged with the Design Authority; general technical oversight is provided over the design.
Design Authority	Design Authority - When Eskom acts as the Design Authority on a project/package/plant/system/asset, the reviewer(s) are to review the design documentation to ensure that: the design satisfies the design requirements; all relevant COE design standards, procedures and guidelines have been adhered to; the design is suitable and correct (calculations, philosophy, functionality, etc.); best COE practices were applied; the design is integrated by identifying all interfaces with other packages/plant systems/assets and ensuring that these interfaces are catered for.
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	Relates to systems that perform processes designed to regulate the air

<b>Definition</b>	<b>Description</b>
Conditioning (HVAC)	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.
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.

The following abbreviations are used in this Works Information:

<b>Abbreviation</b>	<b>Meaning given to the abbreviation</b>
AFC	Approved for construction
OBL	Outside battery limits
AC	Alternating Current
BMS	Building Management System
CA	Corrective Action
C&I	Control and Instrumentation
DX	Direct Expansion
ISO	International Organisation for Standardisation
HMI	Human Machine Interface
HVAC	Heating Ventilation and Air Conditioning
LOSS	Limits of Service and Supply
LPS	Low Pressure Services

MTTF	Mean Time To Failure
MTTR	Mean Time To Repair
OEM	Original Equipment Manufacture
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Procedure
RCM	Reliable Centre Maintenance
SANS	South African National Standards
VDSS	Vendor Document Supplier Submittals
WTP	Water Treatment Plant

## 2 Management and start up.

### 2.1 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, Contractor, Supervisor
Overall contract progress and feedback	Monthly on Thursdays at 13h00	Projects/ WTP Boardroom	Employer, Contractor, Supervisor
Monthly Safety meeting, weekly during implementation	Monthly on Mondays at 14h00	Projects/ WTP Boardroom	Employer, Contractor, Supervisor, Safety Officers
Quality and NCR/Defect/Concessions meeting	Monthly on Mondays at 15h00	Projects/ WTP Boardroom	Employer, Contractor, Supervisor, Quality managers and Officers
Weekly contract progress and feedback	Weekly on Mondays at 08h00	Projects/ WTP Boardroom	Employer, Contractor, Supervisor, Quality managers
Daily contract progress and feedback	Daily at 09h00	Projects/ WTP Boardroom	Employer, Contractor, 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)
- (8) 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.

## **2.2 Documentation control**

- (1) The Contractor's site manager must submit a daily log, which needs to be signed by the Employer's Supervisor / Project Manager daily.
- (2) The project manager will arrange for necessary documentations to allow component removal from Duvha P/S.

## **2.3 Health and safety risk management**

- (1) Refer to Safety, health and environmental procedure Appendix F.

## **2.4 Environmental constraints and management**

- (2) Refer to Safety, health and environmental procedure Appendix F.

## **2.5 Quality assurance requirements**

- (1) The Contractor complies with the Employer's Quality Requirements as specified in Eskom Generation Standard QM 58
- (2) Appendix C to this Standard indicates the specific application thereof.
- (3) All quality control documentation (QCP) is submitted to the Project Manager on delivery.

## **2.6 Programming constraints**

- (1) The Contractor submits a programme within 1 week of the contract date..

- (2) The program shall be in Microsoft Excel or Projects format (preferably 2003 version or lower)
- (3) The programme indicates
  - i. The hour duration of each activity
  - ii. The working calendar ( number of hours per day, days per week)
  - iii. The exact quantity of people per day.
  - iv. All phases and interfaces.

## **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,
- (2) 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. 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;
  - vii. (add other as required)
  - viii. Add procedures for invoice submission and payment (e. g. electronic payment instructions)

## **2.8 Insurance provided by the *Employer***

- (1) Refer to the Contract Data Section 8 – Risks and Insurance.

## **2.9 Contract change management**

- (1) The contractor or the Project Manager 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 he deems it necessary.

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

### **HVAC TRAINING**

After completion of the contract, the Contractor is required to provide training and transfer system knowledge to the building owner/manager by submitting documented Design Intent, As-built drawings, Operational and Maintenance Manual, Commissioning Records, Commissioning Report and by providing training on all the systems to the building management staff to ensure that they have all the information and understanding needed to operate and maintain the features and systems in the building.

The Contractor is to provide on-site training and training material to the Engineers, Operators and Maintenance personnel prior to taking-over of the works. The contractor will, prior to handing over of the works, satisfy the Employer or authorized representative that maintenance and operational personnel are competent and adequately trained to maintain and operate the equipment supplied.

The training is to cover the following, however not limited to:

- (1) Information provided in the design intent report (including energy/environmental features)
- (2) Review of controls set up, programming, alarms and troubleshooting
- (3) Review of O&M manuals
- (4) Building operation (start up, normal operation, unoccupied operation, seasonal changeover, shutdown)
- (5) Measures that can be taken to optimise energy efficiency
- (6) Occupational health and safety (OH&S) issues
- (7) Maintenance requirements and sourcing replacements
- (8) Obtaining and addressing occupant satisfaction feedback
- (9) Steps for Conducting On-site Training shall include:
- (10) Preparation
- (11) Introduction
- (12) Explanation
- (13) Demonstration
- (14) Practice Under Supervision
- (15) Conclusion

The operating and maintenance manual must be available during the training of site staff. Site staff must also be made familiar with the contents of that manual.

## **HVAC COMMISSIONING**

### **Pre-commissioning documents**

- (1) The following documents are supplied to the Employer by the Contractor prior to commissioning:
  - i. Dimensioned shop drawings showing the general arrangement of all plant and equipment including isometrics and P&ID's or PFD's where required. Sufficient views must be given to ensure clarity and the drawing shall have at least a plan and two different elevations or sections giving overall dimensions.
  - ii. Documents including equipment data sheets and specification for selected equipment, electrical cabling and other associated equipment.
  - iii. Manufacturer's product data highlighting Minimum Efficiency Reporting Value (MERV) for filtration media.
  - iv. Detailed electrical wiring diagrams including schematic and control circuits.
  - v. Detailed sequencing manner for installation procedure of Works.
  - vi. Detailed programme for the works in sufficient detail as to represent the units of work to enable the representative to assess the progress of the works.
  - vii. Technical literature for all items of equipment that forms part of the complete installation, including, evaporators, condensing units, refrigerant circuits, ventilation fans, electrical and control circuits etc.
  - viii. Corrosion protection systems, including data sheets for coating of equipment.
  - ix. List of recommended spares and technical specifications for the spares, part numbers and the stock levels required.
    - x. Detailed building works for complete works
    - xi. Detailed maintenance, reliability, control and operating philosophies
    - xii. Testing, balancing and commissioning procedures
    - xiii. Plant and material acceptance testing
    - xiv. Plant codification lists for each section of the Works
    - xv. Operating and maintenance manual

### **Inspection prior to testing and commissioning**

Prior to tests taking place on the completed or a section of the installation the Contractor check the following points:

- (1) That the components comprising the installation or sections of an installation are installed as described in the specification and drawings.
- (2) That the components have been installed correctly.
- (3) That the manufacturer's test data for plant and components, if necessary for testing and commissioning, has been provided and is available for reference.

### **Cleaning and flushing of ductwork and pipe work systems**

All pipe work and ductwork systems included in this contract are thoroughly cleaned internally to remove any foreign matter. The following operations shall be carried out:

- (4) The cleaning of completed pipe work and ductwork to remove dirt etc. accumulated in pipe work and ductwork during installation by flushing out the installation.
- (5) The external cleaning of all pipe work and ductwork carried out to remove surplus jointing material, paper labels, dirt and grease.
- (6) Flushing of pipework
- (7) Blow through of ductwork.

### **Testing**

The site testing of the various installations take place prior to the application of thermal insulation. High and low pressure ductwork is tested for air tightness, using the system fan or fans, by observation and air flow measurement. The sum total of measured air quantities at all outlets (supply system) and inlets (extract system) are compared with the air quantity measured in the adjacent main duct. Any discrepancy greater than plus or minus 5% for low velocity and 1% for high velocity indicate that unacceptable leakage exists and should be remedied.

All leakage tests are witnessed by the Employer and are independent of any performance tests on the whole system, which is as detailed elsewhere in this specification.

Installations or sections thereof, which is embedded in the structure or concealed in permanently sealed ducts or voids, etc., is, in addition to the above specified tests, individually tested as they are laid and before being concealed.

On completion of the installation the Contractor carry out sound tests to measure the sound pressure level in each octave band in each space, under the supervision of the Employer and with all plant running. The Contractor uses a sound analyser with one octave band range 63 to 8000 Hz to establish the sound spectrum on each space. In carrying out these analyses the Contractor pays particular regard to the following points:

- (1) All items of mechanical services plant or equipment must be running normally.
- (2) Areas adjacent to these areas being tested are unoccupied.
- (3) There should be no interference from the Contractor's machines or equipment or from any other abnormal noise source.
- (4) The microphone is between 1 and 2 meters from floor level.
- (5) Microphone is not to be held in air velocities greater than 1, 2 m/sec and in any case never nearer than 1,2m from a noise source such as grilles, diffusers etc.
- (6) An average of three readings is to be taken for each area for each octave band.
- (7) Sample readings of background noise dBA should be taken with equipment not in operation before and after noise reading in any one area.

### **Commissioning**

The Contractor does comprehensive pre-commissioning, commissioning as well as quality monitoring on all the HVAC systems in exact accordance with CIBSE Commissioning Codes C (Automatic Controls), A (Air Distribution), R (Refrigeration Systems), B (Boilers), W (Water Distribution Systems) and or ASHRAE Commissioning Guideline.

The Commissioning Report must:

- (1) Demonstrate that the services were commissioned in compliance with CIBSE Commissioning Codes or ASHRAE Commissioning Guideline for all mechanical services;
- (2) Include commissioning dates, records of all functional/commissioning testing undertaken, a list of any future seasonal testing, and a written list of outstanding commissioning issues;
- (3) Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all of the recommendations; and
- (4) Reference appended extracts of commissioning records for major plant and equipment.

The commissioning includes the setting of all controls, dampers etc., and the balancing of the systems to meet the required design air volumes. The Contractor is required to include in the commissioning manuals readings obtained at all grilles, at the air handling units and other fans, at points on the ductwork prior to branch connections and pressure and velocity readings on the supply, return and extract ducts. Ducts are tested and balanced according to SANS 10173 latest revision

The commissioning procedure to be adopted is prepared by the Commissioning Authority. During commissioning the Contractor set the installation to work and competent personnel demonstrates and explain the operation and maintenance procedures for the installation and for each item of plant to the Employer. During commissioning if any item is found to be unsatisfactory the fault is rectified and/or new components fitted and commissioned by the Contractor at their own expense. The Contractor then rebalances and commission the system or part thereof affected at their own expense.

After successful completion of the commissioning and proof period of the installation and any maintenance materials as listed in the Specification and those normally supplied by equipment manufacturer are handed over, the defects liability period commences. Items of equipment which are of a specialist nature e.g automatic controls etc. are commissioned by the manufacturer's representative who instruct the Employer on the function and proper operation of the equipment.

The contract is deemed to be complete when the following have been completed in accordance with the relevant specifications:

- (5) The Plant is erected, and commissioned.
- (6) Signed erection and safety clearance certificates.
- (7) The final drawings have been submitted.

- (8) All documentation has been submitted including testing reports and the associated certificates received. All Quality Control Plan (QCP) documentation received. Final Draft of the Technical, Operating, Maintenance manuals delivered.
- (9) The Plant and all documentation/drawings are coded and labelled.
- (10) All special tools have been supplied.

The complete system is to be subjected to performance tests under full working conditions. This is done in the last month of the defect period. The Contractor shall supply the necessary field testing instruments (thermometers and flow meters) and detailed description of field testing arrangement to prove a capacity/performance measurement accuracy of  $\pm 5\%$  for performance acceptance testing.

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

#### **1.1 Employer's design**

##### **Scope of Works**

The *Works* entail the detailed design, procurement, manufacture, quality control, supply, delivery, offloading, construction, installation, commissioning, testing, training and handing-over of all materials and equipment necessary for the completion of:

##### **HVAC**

- New 2 x 100% package cooling units (heat pump or similar)
- New return air fan
- Provide hydraulic analysis report for duct work and air flow
- Provide temporary scaffolding, hoisting, equipment rigging and temporary supports
- New local control panels
- Power and distribution cabling (i.e. from HVAC Electrical Switchgear panel to equipment)
- Structural supports and steel work for HVAC equipment
- Quality assurance
- Operating and Maintenance Manuals
- Test and commission the system
- Interface with the fire detection system

### **4**

##### **Purpose**

The purpose of the works includes the following:

- a) To ensure that Eskom Power Station's infrastructure function correctly and safely to comply with original design and statutory requirements/standards.
- b) Provide adequate cooling, ventilation to ensure long term integrity of all process control electronic equipment is maintained during its operation and maximizes plant efficiency.
- c) To provide & maintain good indoor air quality and dust control.
- d) To provide a safe environment for occupants and keep escape routes safe.
- e) To maintain internal temperatures to the limits as specified by mechanical ventilation and air conditioning.
- f) To prevent the build-up of fumes, odours and other gases during the operation and maintenance life of the station.

- g) To interface closely with the Fire Protection systems to ensure integrity of fire compartments and fire zones.

#### 4.1.1.1

#### 4.3.1 3.2 EMPLOYER'S DESIGN

**4.3.1.1 The contractor is required to *Employer's* functional requirements are based on the following:**

#### 4.3.2 Outdoor design conditions

##### 4.3.3

- a) Summer: 32°C DB, 20°C WB
- b) Winter: 2°C DB
- c) Altitude: 1600 m

### HVAC Indoor Conditions

The indoor conditions need to be kept as indicated on table 1 below to prolong the equipment lifespan.

Table1

Building s /areas with HVAC System s	HVAC Requirement s (Cooling/Heat ing/ Ventilation)	Indoor temperat ure	Humidificat ion	Filtratio n	Noise/ Attenuati on (dBA)	Fres h air as % of supp ly	Smoke Extracti on (Yes / No)	Smoke Detecti on Interfa ce – by others (Yes / No)	Operati on (hr/day)
Server room	Cooling	22 °C DB + 2 °C summer	20%-75% monitored	2 Stages, 85% dust spot efficienc y (ASHRA E)	45dBA	20%- 100 %	Yes	Yes	24hrs/d ay
Automati on room	Cooling	22 °C DB + 2 °C Summer	20%-75% monitored	2 Stages, 85% dust spot efficienc y (ASHRA E)	45dBA	20%- 100 %	Yes	Yes	24hrs/d ay

Buildings /areas with HVAC Systems	HVAC Requirements (Cooling/Heating/Ventilation)	Indoor temperature	Humidification	Filtration	Noise/Attenuation (dBA)	Fresh air as % of supply	Smoke Extraction (Yes / No)	Smoke Detection Interface – by others (Yes / No)	Operation (hr/day)
				E)					

#### 4.3.3.1 Performance requirements

The air conditioning system meets the following performance requirements:

- (1) The floor standing indoor units are positioned inside the server and construct plinth automation rooms. The outdoor condenser units are located external to the abovementioned rooms in the vicinity of the Water Treatment Plant (WTP) building.
- (2) The temperature in the Battery & UPS Rooms is designed at  $22 \pm 2$  °C and 50% RH in summer and winter
- (3) The minimum filtration efficiency complies with MERV-9 as defined in ASHRAE 52.2-2007.
- (4) The velocity across the filters is less than 2.5 m/s.
- (5) The total unit cooling and heating capacity should include for the HVAC and pedestals for the HMI cabinet equipment load, building load, HVAC Plinth fresh air load at design parameters and the unit inefficiencies.
- (6) The system is equipped with a flow monitoring device to indicate when the filters are blocked or the fan unit has failed.
- (7) The design life of the HVAC system is 15 years

The Contractor makes provisions for a dirty/blocked filter alarm to be interfaced with the Outside Plant and Water Treatment Plant DCS. The final coordination of the Interface is to be determined at site after Contract award and without commercial implications to the project.


The system is supplied complete with the following:


- a) R410A or equivalent refrigerant gas
- b) Advanced control board
- c) ON/OFF scroll compressor
- d) EC plug fans
- e) Condensing fan speed control (HP control)
- f) Areolating rubber feet
- g) Dehumidification control
- h) Compressor anti-short cycle
- i) Air flow switch
- j) Dirty filter alarm
- k) Evaporate leaving temperature control
- l) Low ambient protection
- m) G3 & F9 filters
- n) Phase sequence relay
- o) Free-cooling

The Contractor completes the equipment data sheets as indicated below:





<b>SINGLE PACKAGE COOLING UNIT – DATA SHEET</b>		<b>Data sheet no</b>	1	
<b>Power station</b>	Duvha Power Station	<b>Revision no</b>	0	
<b>System</b>	WTP HMI Automation Room & Server Room	<b>Revised by</b>	A.D. Kubyane	
		<b>Revision date</b>	03/10/ 2016	
<b>1. Data Supplied by Employer</b>				
1.1. Reference drawing		TBA		
1.2. Altitude		1600 masl		
1.3. Approx. Cooling Capacity (kW)		22		
1.4. Approx. Air flow rate (m <sup>3</sup> /s)		1.05		
1.5. Number of units		2		
1.6. Physical dimensions – L (mm) x W(mm) x H (mm)		1630mm x 1068mm x 1065mm		
1.7. Weight (kg)		343kg		
1.8. Input Power (kW)		11kW		
1.9. Input Current (A)		20.1A		
<b>2. Data Supplied by the Contractor</b>				
2.1. Manufacturer				
2.2. Country of origin				
2.3. Make				
2.4. Model number				
2.5. Physical dimensions – L (mm) x W(mm) x H (mm)				
2.6. Weight (kg)				
2.7. Nominal cooling capacity (kW)				
2.8. COP				
2.9. Air flow rate (m <sup>3</sup> /s)				
2.10. Sound power (Cooling / heating) – ( dBA / dBA)				
2.11. Sound pressure (Cooling / heating) – ( dBA / dBA)				
2.12. Refrigerant type				
2.13. Refrigerant charge (kg)				
2.14. Power supply (V – Ph – Hz)				
2.15. Compressor Motor Output (kW)				
2.16. Heat exchanger type				
2.17. Condenser Fan				
2.17.1. Air Flow Rate (m <sup>3</sup> /s)				
2.17.2. Motor output (kW)				
2.18. Refrigerant piping				
2.18.1. Liquid piping NB (mm)				
2.18.2. Gas piping NB (mm)				
2.19. Maximum number of Indoor Units Connectable				
Notes:				

<b>AXIAL FAN – DATA SHEET</b>		<b>Data sheet no</b>	2	
<b>Power station</b>	Duvha Power Station	<b>Revision no</b>	0	
<b>System</b>	WTP HMI Automation Room & Server Room	<b>Revised by</b>	A.D. Kubyane	
		<b>Revision date</b>	03/10/ 2016	
<b>1. Data Supplied by Employer</b>				
1.1. Reference drawing		TBA		
1.2. Altitude		1600masl		
1.3. Number of units		1		
1.5. Approx. Air flow rate (m <sup>3</sup> /s)		0.85m <sup>3</sup> /s		
1.6. Fan Motor Power (kW)		0.55kW		
1.6. Indoor room conditions ( °C DB)		Max 40 °C		
<b>2. Data Supplied by the Contractor</b>				
2.1. Manufacturer				
2.2. Country of origin				
2.3. Make				
2.4. Model number				
2.5. Type of Impeller				
2.6. Class				
2.7. Arrangement				
2.8. Air flow rate (m <sup>3</sup> /s)				
2.9. Speed (rpm)				
2.10. Blade pitch (angle)				
2.11. Type of Drive (Belt / Direct)				
2.12. Enclosure / Protection				
2.13. Electrical supply (Voltage – Phase – Frequency)				
2.14. Finish				
2.15. Total pressure (Pa)				
2.16. Fan Motor Power (kW)				
2.17. Operating Temperature ( °C)				
2.18. Average noise level (dBA)				
Accessories:				

#### 4.43.3 Parts of the works which the Contractor is to design

The *Contractor* is responsible for the supply and design of the below mentioned *Works*. The design must be submitted to the *Project Manager* in advanced in order for the *Employer* to review and accept. A method statement, clearly defining the execution of the *Works*, must be submitted to the *Project Manager* for approval as part of the design package:

#### HVAC

The Conditions of Contract and the Particular Conditions state that the *Contractor* is responsible for the detailed design, supply, delivery, installation, testing, commissioning, training, upholding during the trial operation period and the defects liability period of all HVAC equipment related to Duvha Power Station in this tender. These specifications are to be read in conjunction with the rest of this Contract in its entirety, including tender drawings & general standard technical specifications.

During the period of the *Works*, the *Contractor* will become aware of technical matters which require attention. The *Contractor* is responsible for communicating these to the *Project Manager*, who will manage the matters in accordance with the applicable contractual conditions. The conditions and/or general standard specifications in this document are to be regarded as the absolute minimum

requirement. More stringent similar conditions and/or specifications stated in the detail works information must take preference to those in the general standard technical specifications.

Tender prices for articles and equipment described by means of trade names or catalogue references must refer to the type and manufacture specified. If it is desired to use substitutes, the onus is on the *Contractor* to prove that such substitutes are similar and equivalent to the articles specified and meet with the acceptance of the *Employer*. The decision as to whether to use the specified or alternative articles rests solely with the *Employer*.

Once the installation has commenced with the appropriate acceptance for using any type and make of article or equipment, the same type and make of article or equipment are used throughout the project for that specific application unless otherwise specified.

### **Site inspection before detailed design**

Before tendering, it is recommended that the *Contractors* should visit the site and acquaint themselves with all the local conditions, the accessibility of the site, the full extent and nature of the operations, the supply of and conditions affecting labour, carriage, carting, unloading, storage and safe custody of materials, workshop accommodation, the scaffolding, tackle and tools necessary for the execution of the contract generally. Claims on the grounds of lack of knowledge in such respects or otherwise will not be entertained at all.

The *Contractor* is responsible for the detailed design of the HVAC *works* based on the Employer's requirements and that such detail designs be submitted to the *Employer* for acceptance prior to purchase and manufacture of any system and *equipment*.

The design data specified in this *works* information and those dimensions shown on the tender drawings are intended for tendering purposes only. The *Contractor* is required to take the actual measurements onsite before proceeding with design & manufacture of the HVAC *works* as dimension accuracy remains the responsibility of the *Contractor*.

### **Detailed design required from the Contractor**

The *Employer's* concept design at section 4.1 above in conjunction with the rest of this contract in its entirety, including tender drawings & general standard technical *specifications* are to be used to provide the detailed design for the complete HVAC *works*. The detail design requirements for complete *Works* is to include the following as minimum, but not limited to the following:

- (1) Detailed design of complete package cooling system and with its recirculation.
- (2) Sound attenuator selection on equipment.
- (3) Detailed design of refrigerant piping
- (4) Detailed design of the control system and Interfacing with fire detection system for complete HVAC *works*
- (5) Detailed design of the electrical power system and associated interfaces, for complete HVAC *works*
- (6) Steel structures required for access to equipment.
- (7) Builder 's and civil requirements for complete HVAC *works*
- (8) Detailed design for provision of painting and corrosion protection for complete HVAC *works*

## **4.5     3.4 Procedure for submission and acceptance of Contractor's design**

## General

The *Contractor* must follow procedures for the submission and acceptance of his designs as per 4.9 as a minimum. Where otherwise specified, the *Contractor* must accept the more onerous option with regards to delivery times and must include all items requested as per 4.9 and applicable section below where applicable.

The *Employer* rejects the design by the *Contractor* should the designs not be up to standard according to the *Employers* requirements. The *Contractor* is expected to address all comments before resubmitting the designs to the *Project Manager* for an additional review cycle.

The *Contractor* may be required to present the design to an *Employer* 's design review committee for final approval.

## HVAC

The following documents are supplied to the *Employer* by the *Contractor* as a minimum:

- a) Detailed design including equipment data sheets and specification for selected HVAC equipment, addition of circuits to existing switchgear panel, electrical cabling, controls and instrumentation, and other associated equipment
- b) Dimensioned detail drawings showing the general arrangement of all system and equipment including isometrics and P&ID's or PFD's where required. Sufficient views to ensure clarity on the drawing with at least a plan and two different elevations or sections giving overall dimensions.
- c) Dimensioned detail drawings showing proposed method of fixing of all the system and equipment
- d) Steel structures required to support equipment
- e) Detailed electrical wiring diagrams including schematics and control circuits.
- f) Detailed sequencing manner for installation procedure of *Works*
- g) Detailed programme for the *works* in sufficient detail as to represent the units of work to enable the representative to assess the progress of the *Works*
- h) Technical literature for all items of equipment that forms part of the HVAC installation including, evaporators, condensing units, refrigerant circuits, ventilation fans, door grilles, remote controllers, electrical and control circuits etc.
- i) Proposed corrosion protection systems, including data sheets for coating proposed of equipment
- j) List of Recommended Spares and Technical specifications for the spares, part numbers and the stock levels required
- k) Detailed building & Civil *works* for HVAC and potable water supply *Works*
- l) Detailed maintenance, reliability, control and operating philosophies
- m) Supply of end of manufacturing reports for complete HVAC and potable water supply *Works*
- n) System Codification Lists for each Section of the *Works*

The *Contractor* submits all documents according to the accepted VDSS as appended to this *Works* information. The *Employer* reviews the submission and responds at least 10 days or less after the review

### 4.6 3.5 Other requirements of the *Contractor*'s design

The *Contractor* submits a request to the *Project Manager* to assign a resource from the *Employer*'s team to assist in the codification of plant.

## General

The *Contractor* provides all system, equipment, materials and services and executes all work necessary to fulfil all requirements specified in this *Works* Information.

The *works* complies with professional practices and standards for fossil fuel power systems, and are designed for the environmental conditions prevailing at Duvha Power Station.

The *Contractor* liaises with the *Employer* and the *Others* to ensure the successful completion of contract requirements. This is a site activity and is coordinated by the *Project Manager*.

The *Contract* includes the provision of the following:

- a) AKZ labels (*Employer* provides the AKZ codes)
- b) Contract management including site management (and *Subcontractors*)
- c) Contract programming
- d) Provision of draftsman (drawing) services
- e) Cost control and progress reporting
- f) Quantity surveying documentation
- g) Quality assurance
- h) Quality control
- i) Acceptance testing and handing over to the *Employer*
- j) Documentation

The *Contractor* is required to guarantee the complete installation, in accordance with the conditions of this document.

### **Life expectancy**

The HVAC system is to be designed to ensure safe and satisfactory operation for a life expectancy of at least 15 years for DX system under the conditions prevailing at Duvha Power Station.

The *Contractor* provides the following support services after defects correction period at *Employer's* request as and when required during the life of the plant:

- a) full service
- b) spares and
- c) training support

### **Power Supply interruptions**

The *Contractor* ensures that the supplied equipment are capable of safely shutting down the system without damage in the event of partial or total loss of electrical power, and must be designed to accept a sudden restoration of electric power, without damage and without operator intervention.

#### **4.6.1**

### **Design Philosophy**

The philosophy supplied by the *Employer* ensures the optimal performance and maintenance of the system and must be achieved by the *Contractor's* design. In order to achieve the philosophy requirements, the operating range within which the system must perform are defined in the Works Information to which the *Contractor* must comply.

The *Employer* will review the detailed design to ensure compliance with the philosophy. The *Contractor's* function is to ensure:

- a) Adherence to requirements as stipulated in these works information and supporting documents attached as part of the works information.

These objectives are to be realised not only in the short term but also to meet the requirements of the system life expectancy and mentioned above.

The HVAC system is to be designed to cost effectively improve the safety, reliability, production, operation, minimise maintenance, training and life cycle costs, by means of appropriate:

- a) standardisation of components and system with inter-changeability of equipment as a focus point;
- b) reduction of interfaces
- c) advanced control concepts
- d) correct man-machine interfaces
- e) compatibility and alignment of the *Contractor's* designs with *Others*; and
- f) Effortless diagnostics.

The *Employer's* Schematics for the Project is to be used as a baseline for a comprehensive detailed design for the *works*.

## **HVAC System Interface**

The *Contractor* is responsible for all system interfaces which forms part of the *works*. The Employer will provide the relevant information defining the system interfaces. The *Contractor* caters for all identified interfaces.

The following major interfaces must be catered for in the design and the execution of the works:

- a) Interface with *Others* including but not limited to the existing LV switchgear.
- b) The *Contractor* uses the floor plan layouts to determine whether the HVAC equipment fit into the respective rooms. It is the *Contractor's* responsibility to ensure that the equipment offered fits into the allocated space.

## **Transportation**

- a) The *Contractor* is required to transport all the Plant and Material to the temporary storage and then  
to the disposal area located on site.
- b) The *Contractor* is also required upon completion of packaging to transport the System and Material  
to the permanent storage area.

## **Technical Risk Assessments**

The following technical risk assessments are to be carried out by the *contractor*:

- a) The Contractor must carry out formal Hazardous Locations (HAZLOC) Studies on all systems in their design.

## **General and sundry items**

- a) Provide as-built documentation, control & operating philosophy, operating and
- b) maintenance manuals. "As built" drawings to be provided in Micro Station and PDF version on CD. 3-off final hard-copies of the Installation, Operation and Maintenance Manual prior to the issue of the Taking-Over Certificate.
- c) Provide operating Instructions and Signage, including AKZ coding and tagging.
- d) Inspections, tests, etc. of equipment, and quality control and assurance throughout the complete Works by the contractor. Arrangements are made for Employer to inspect equipment before they are dispatched to site. The contractor must make arrangements that these inspections are carried out within the boundaries of South Africa.
- e) Provision of all Test Certificates.
- f) Checking, starting up, testing and commissioning of the complete Works. Balancing of

- the refrigerant flows for the entire system. Pressure testing of the complete refrigerant piping system and Balancing of the complete ducting system.
- g) Operational Acceptance Testing of the complete works and Trial Operation Period of at least 30 days prior to the issue of the Taking-Over Certificate.
  - h) On-site training and training material to the Employers, Operators and Maintenance personnel prior to taking-over of the works. The training must preferable be offered during the 30 day Trial Period for a minimum of ten (10) personnel. The contractor must, prior to handing over of the works, satisfy Eskom or authorized representative that maintenance and operational personnel are competent and adequately trained to maintain and operate the equipment supplied.
  - i) Maintaining the Works during the Defects Liability Period of 12-Months from the date of taking – over of the works and Maintenance inspection in accordance with Scope of Work

## 4.7 3.6 Design of Equipment

The *Contractor* is responsible for the detailed design of the HVAC Works based on the *Employer's* outline concept design and that such detail designs be submitted to the *Employer* for acceptance prior to purchase and manufacture of any system and equipment.

The design data specified in this works information and those dimensions shown on the tender drawings are intended for tendering purposes only. The *Contractor* is required to take the actual measurements onsite before proceeding with design & manufacture of the HVAC Works as dimension accuracy remains the responsibility of the contractor.

The minimum general equipment design criterion that is to be met is as follows:

- a) The equipment is to be designed to facilitate efficient manufacture, inspection, transportation, installation, maintenance, cleaning and repairs.
- b) The equipment is to be designed to ensure safe and satisfactory operation for a life expectancy of at least 15 years for the HVAC equipment under the conditions prevailing at Duvha Power Station site. The life expectancy of the pipe work and associated fittings must suffice for the remaining life of the station
- c) The equipment is to be designed to prevent undue stresses being produced by expansion and contraction due to temperature change and other local natural and manmade conditions.
- d) The equipment is to be designed to keep maintenance costs to a minimum.
- e) The equipment is to be designed to comply with all the legal requirements in respect of safety and the prevention of environmental pollution.
- f) The equipment is to be designed to satisfy any specific requirements contained in the relevant statutory codes and standards.
- g) The equipment is to be designed for operation of 365 day per annum, 24hrs per day.
- h) The equipment is to be designed such that all material from which the equipment are manufactured from is compatible with the intended duty and service conditions. All equipment is suitable treated and protected from corrosion.
- i) After the design freeze, at the time of the award of the contract, the information stated in the data sheets are to be fully complied with through the installation, unless otherwise agreed upon by both Eskom & contractor in writing.
- j) All electrical equipment, forming part of the specified equipment are sealed against penetration by hose cleaning operations, and be also accessible for repair and maintenance.

The details of equipment and installation requirements are as follows as minimum, however not limited to:

### DX Air Conditioning units

The unit to be provided with the following as a minimum:

- An ON/OFF facility with the ability to select full air conditioning and Fan operation only.



- A fan speed selector with a HIGH/MEDIUM/LOW setting.

The controls are to be clearly marked and easy to operate.

The unit is to be provided with an adjustable temperature controller with an adjusting range of 20-25°C. The sensitivity of this temperature controller are to be such that it controls in a differential band of 2°C (adjustable 1 to 4°C, factory set at 2°C), 1°C on either side of the set points. The temperature controller is to be clearly marked in which way to adjust the room temperature. The temperature controller is to switch on the heater or compressor automatically in accordance with the load.

Install the control facilities within a suitable draw box recessed into the wall/partition, with the control cable reticulated within an enclosed conduit.

## **Operating range**

Fan delivery does not decrease more than 10% when filter dirty and the operation point are stable part of the curve.

Unit operate continuously without damage or malfunction for the following range of conditions at local altitude:

- a) Condensing Unit: Entering Air Temperature : 0°C - 52°C

A "low ambient" condensing control is to be incorporated in the unit if specified as such in the schedule.

Safety protection is to be provided for the fan motors as follows, unless otherwise specified:

- a) Single phase motors: Thermal overload protection.
- b) Three phase motors: Combined thermal overload and phase failure protection.

Fan motors are non-overloading at any operating point of their performance curves. Both indoor and outdoor units are to be fully protected and to fail safe. Minimum safety protection, caused by possible external abnormal conditions to be provided for the following, and require manual or automatic reset after fault occurrence:

- a) High discharge pressure.
- b) Low Suction pressure/anti-freeze protection.
- c) Crankcase heater.
- d) Thermal overload protection for all motors.
- e) Current overload protection on compressor.
- f) Re-starting time delay for compressor.
- g) Auto re-starts on power supply interruption.

## **Reliability and availability**

All components and casings to be designed for a service life of 15 years for local conditions based on a 24 hour daily operation.

All components which may come in contact with water (rain, condensate, sweating of compressor, etc.) are to be protected against corrosion in order to obtain the desired service life.

## **Technical restraints**

The unit coils are provided with the following minimum requirements:

- a) The AHU coil to be aluminium fins mechanically bonded to seamless copper tubes. The fin spacing to be greater than 2mm. Ensure no "water carry over" during any operation condition.

- b) The outdoor coil must be hail-proof.
- c) Coil and refrigerant piping to be protected from freezing in ambient temperatures down to -5°C.

Heating to be provided by a reverse cycle "heat pump feature" if specified as such in the schedule. Compressors may be either semi-hermetic, suitable for field servicing or hermetically sealed.

The unit electric heater must have the following minimum requirements:

- a) Manual reset thermal cut-out device set between 60 – 80 °C with reset button, labelled and operable without removing any terminal box cover.
- b) Elements to have an adequate resistance to earth, with due regard to the possible condensation of moisture during the cooling cycle.

The refrigerant piping system is provided with the following minimum requirements:

- a) Refrigerant pipe sizing calculations are to be submitted where the length exceeds 15 metres.
- b) The necessary traps to be installed in the refrigerant lines to ensure oil return for applications where the outdoor unit is installed higher than indoor unit.
- c) Flare connections to be used at the indoor and outdoor unit.
- d) Three way valves with service port are to be installed at the outdoor unit for connection of standard refrigerant pressure gauges.
- e) Fit a filter in the liquid line with a sight glass and moisture indication thereafter.
- f) Provide facilities for charging the units with refrigerant and measuring the refrigerant pressures of the unit using standard refrigerant gauges.
- g) Units which are not pre-charged are to be evacuated to a vacuum of not less than 4mm Hg before charging.
- h) The insulation for the refrigerant piping to be of the "ultra-violet resistant" type. Insulation exposed to outside weather to be finished off with ultra-violet resistant plastic tape or paint.

Drainage of condensate from the units to be collected by the following means:

- a) A pan of sufficient size to catch all condensate which may emanate from the unit.
- b) Drainage via gravity feed from this pan to a suitable connection; or booster pump assisted drainage where indicated on the relevant drawings or in the accompanying schedule.
- c) The drain pan to be fabricated from galvanised sheet steel and painted internally to prevent condensation on the external surface.
- d) Drain piping to be fixed and routed to the nearest suitable drain point to ensure positive drainage.
- e) Drain piping to be resistant or protected against weather elements or people traffic.

The electrics and controls must have the following minimum requirements:

- a) All electrically powered elements within the unit to have an adequate resistance to earth, with due regard to the possible condensation of moisture and comply with statutory requirements.
- b) Interconnecting wiring from the outdoor unit to the indoor unit is to be via conduits or suitable special cable.
- c) Power supply from the local isolator is to be protected against the elements by means of conduit or suitable cable.
- d) Confirm adequacy of the power supply at equipment submission stage.
- e) A manual override facility is to be provided on the indoor unit if a remote wireless

Temperature/control unit is offered.

### **Installation restraints**

Install units in accordance with manufacturer's recommendations and be capable of being fitted into the

spaces indicated.

The unit not to drum, vibrate or leak under any operating conditions. Noise level in the conditioned space through the operation of the unit at any operation point is not to exceed NC 40 with an 8dBA room attenuation factor in each octave band.

All penetrations through building structures are to be sealed against ingress of water and air.

All piping/conduits/wiring/supports are to be neatly and securely fixed to the building structure. Method of fixing is to be submitted to *Employer* prior to installation.

### **Measurement to confirm equipment compliance with specification**

*Contractor* is to submit with the tender certified performance tests of capacity and power consumption at either local conditions by the SANS or a similar organisation.

Performance to be based on the actual mounting details and location where installed.

Performance testing of each unit to be done in a certified "on line" test facility. The minimum tests are to include compressor running amps, entering and leaving temperatures, a leak test, the heater amperage, all controls for function and calibration of thermostat. All results to be properly recorded against the serial number of the unit and signed off by the responsible person for quality.

## **Fans**

### **Operating range**

The operation point is to be in the stable part of the curve.

Safety protection is to be provided for the motors as follows, unless otherwise specified:

- a) Single phase motors: Thermal overload protection.
- b) Three phase motors: Combined thermal overload and phase failure protection.

### **Reliability and availability**

The allowable maximum downtime for fans are to be so installed that replacement are not to take longer than 2 hours when executed by qualified building maintenance staff. *Contractor* is to submit service-, maintenance, troubleshooting- and testing instructions in order to obtain acceptance. Documentation is indexed in accordance with the equipment part of the Operating & Maintenance Manuals.

### **Technical restraints**

The Fan is to be complete with standard flanges. Bearings are to be of the permanently lubricated type.

Air flow arrow indicators to be installed for each fan unit. Fan is direct driven or belt drive as required by equipment schedules, suitable for mounting at any angle and mounted on vibration areolation mountings. Motor rating is not to be less than the maximum power required by the fan at any operating point between zero and break off capacity.

Fan casing are to be insulated with high density acoustic insulation to limit break out noise to the occupied space. The fan motors are to be provided with manually adjustable speed controller to deliver the specified air quantity where required.

## **Installation restraints**

Install fan assembly in accordance with manufacturer's recommendations.

## **Measurement to confirm equipment compliance with specification**

*Contractor* is to supply the necessary field testing instruments and detailed description of field testing arrangement to prove a capacity/performance measurement accuracy of  $\pm 5\%$  for the Fan Acceptance Testing.

Certified test results are to be plotted on the official published and certified equipment performance graph/table to confirm that claimed performance is achieved.

The various tests as required by the Quality Management System are demonstrated and accessible to the Employer at all times for monitoring.

## **Low pressure air distribution system**

### **Operating range**

Maximum allowable variation between actual air flow and specified air flow is not to exceed 5%.

Leakage is not to exceed 4% under operating conditions.

Ducting system is to attenuate the total sound power fed into the system by the fan to provide the specified noise levels in the spaces supplied by the ducting system either directly or indirectly (duct break out and noise or air outlet noise).

All isolating, fire, smoke and balancing dampers are to have external easy accessible position indicators, with locking and sealing means when required, and means of resetting after tripping. Inspection doors are to be provided to inspect damper and/or equipment operation for which external indication is impossible or impractical.

### **Reliability and availability**

Duct system control and safety equipment such as automatic dampers, booster fans, etc., requiring service and possible removal/replacement are to be installed in such a way that the downtime of the duct system does not exceed 1 hour when either service/repair or removal and re installation are required.

Duct system control and safety equipment requiring service, maintenance, trouble shooting and periodic replacement etc., are to be documented in accordance with the equipment part of the Operating & Maintenance Manuals.

## **Technical restraints**

The ducting system is to comply in all respects with:

- a) SANS 1238 1979 "Standard Specification for Air Conditioning Ductwork
- b) SANS 0173 1980 "Code of Practice for the Installation, Testing and Balancing of Air Conditioning Ductwork".
- c) Low Velocity Duct Construction Standards-SMACNA.
- d) SANS 10400 Section TT 43.2.

Additional sound attenuating elbows, attenuators, internal acoustic material are to be installed if a sound analysis - in accordance with Chapter 32 Sound and Vibration Control of ASHRAE 1984 System's Volume - for the actual sound power generation of the selected fan, selected fittings and duct construction details indicate that this are required to maintain the specified noise level in the space.

Flexible ducting complete with insulation are to be constructed of non-combustible material as required in terms of the building regulations provided that:

Approved combustible flexible connections are to be used where the length of such connection does not exceed 1.5m and such connection does not pass through any wall or floor which is required to have a specified fire resistance.

Approved combustible flexible joints of not more than 250mm in length may be used in any system room where such system room are protected by a smoke detection system.

#### **4.7.1.1**

### **Installation restraints**

Ducting systems are to be isolated from actual or potential vibration generating equipment and building components to eliminate transmission of vibrations.

### **Pressure testing**

Duct work is to be pressure tested as follows:

- a) The duct pressure is to be at least 2 times maximum operating pressure, or 150 Pa, whichever is the greater.
- b) Smoke is introduced into the duct section under test.
- c) All leaks letting out visible smoke are to be closed up with approved duct sealing compound.
- d) A further pressure test are to be performed at the above specified duct pressure and leaks sealed until a maximum allowable leakage rate of 4% are reached, suitably de-rated for the volume handled by the duct section being tested.
- e) Pressure testing are to be performed with the spigots installed, temporarily capped, but before the application of the external insulation.

### **Measurement to confirm equipment compliance with specification**

The testing and balancing of the ducting system are to be executed under the control and supervision of an *Employer*. The method instrumentation, procedure, recording are to be documented in a Testing, Balancing, Adjusting Procedure Book.

Minimum requirement for procedure are to be submitted for acceptance in accordance with contract conditions, SANS Code of Practice 0173 1980 and/or Procedural Standards National Environmental Balancing Bureau and/or C.I.B.S. Code of Practice.

On completion of testing and balancing of the ducting system a signed report are to be submitted by the *Contractor* listing all the results to prove that the system are balanced as specified. *Contractor* is to submit proven and necessary calibration certificates that measurements have a 5% accuracy.

### **Refrigerant piping system**

The refrigerant piping system is to be designed and engineered in detail in accordance with the design criteria laid down in:

- a) Trane Reciprocating Refrigeration Manual 1977, and/or
- b) Carrier Systems Design Manual Piping Design Chapter 3, Refrigerant Piping.

The refrigerant accessories are to be fully catalogued products and the documentation to include performance curves or selection tables, for the expected range of operational conditions. Submit certified detailed selection shown on these performance tables or curves. Submit full documentation and calculations for acceptance of equipment submission, showing all detailed pressure loss and velocity calculations for the entire refrigerant piping system and accessories under full load and minimum load conditions, including the temperature/pressure curves and balance points for evaporator, compressor and condenser.

Where reduction in pipe size are necessary to provide sufficient gas velocity to entrain oil upwards in vertical risers at part load, and at full load the pressure drop exceeds specified design limits, a double riser incorporating an oil trap are necessary.

The system is to be designed:

- a) To minimise loss of lubricating oil from compressor at all times.
- b) To ensure lubricating oil return to compressor, at the same rate at which it leaves under all load conditions
- c) To prevent lubricating oil being trapped in system.
- d) To prevent liquid refrigerant from entering the compressor during operation and shutdown.
- e) For minimum pressure drop and noise generation. The suction, discharge and liquid lines are to be sized so that the pressure drops do not cause a change in saturation temperature of refrigerant greater than 1,1 degrees C in each respective line.
- f) For handling the specified capacities from 100% down to minimum load at specified suction and discharge/condensing temperature.

Refrigerant piping accessories and connections are to be selected to ensure no leakage from refrigerant piping system during its operational life. Refrigerant piping system is to be complete with all necessary isolating valves to enable repairs and maintenance to be carried out on any one section of the system.

The refrigerant accessories are to be so connected and installed into the refrigerant piping system that either a sub component replacement or total removal or reinstallation of the accessory does not take longer than 2 hours by qualified refrigeration mechanics.

Piping system, including accessories, thermal insulation, hangers, supports and vibration isolators are selected and installed to give a minimum working life of 15 years under normal building service conditions. The entire refrigerant system is to be subjected to a leak pressure test with a suitable gas, e.g. clean dry air or nitrogen. It is permissible to add system refrigerant to enable leakages to be more easily detected. Prior to carrying out this test, the *Contractor* verifies by examination of the various parts of the components of the system that the test pressure to which they were subjected at the manufacturer's works, are adequate for the required duties.

Incorporate a safety valve or rupture disc in the piping system. Rupture discs are to have a specified and certified bursting pressure at a specified temperature and marked accordingly on the disc. The system is to comply with the Safety Code for Refrigerant Piping ASA B31.35-1962, with the requirements of ASME, with Occupational Health and Safety Act as amended, and with local authority's by laws. Piping to be stored and handled on site to prevent dirt from entering piping system. Open ends are to be plugged.

Tubing is to be protected against oxidation during silver soldering by use of dry nitrogen flowing through tubing. Solder to be silver solder. Where required for connection to gauges and control devices, tubing not larger than nominal 10mm may be type K soft (annealed) with flared tube fittings suitable for high pressure. Accessories connected to copper tubing are to have solder type ends or flanged ends and soldered flange adaptors.

Piping is to be installed so as to allow for expansion and contraction. Suction and discharge lines are to be installed so that the first point of support is 6 pipe diameters in each of three directions from the unit.

System vibration areolation are in accordance with Sound and Vibration Control requirements.

Thermal insulation of suction line is to be in accordance with insulation requirements. Piping is to be installed parallel or perpendicular to building construction, while maintaining the required gradients.

Refrigerant piping between indoor and outdoor units are to be supported along its entire length by a galvanised perforated cable tray of sufficient size to allow pipe work to be neatly laid out and insulated. The cable trays are to be supported clear of fixing surface by galvanized brackets allowing air space between cable tray and mounting surface.

Where piping and insulation are exposed to damage or located externally to the building, a galvanized sheet metal cover having a minimum thickness of 0.8mm are neatly formed and secured to the cable tray brackets. Joints are to be lapped by a minimum of 30mm and to have a minimum clearance of 10mm over insulation.

All necessary pressure gauges are to be installed in refrigerant lines to check pressures and temperatures for load monitoring function of various accessories and possible blockages of strainers. Isolate accessories requiring regular inspection, cleaning and removal by shut off valves to enable this without pump down of the entire refrigeration system.

## **Accessories**

### **4.5.9.1.1. Liquid receivers**

Liquid receivers are offered with the following minimum requirements:

- a) Each receiver is to have sufficient capacity to hold all refrigerant in the system to which it are connected, except that in systems having two or more separate refrigerant circuits, cross connected by pump out piping.
- b) The receiver is to have sufficient capacity to hold all refrigerant in the largest circuit. Receiver capacity is to be based on not over 85% of its internal volume being occupied by liquid. Receiver is to be complete with liquid level indication.

### **4.5.9.1.2. Liquid suction interchanger**

Liquid Suction Interchanger must have the following minimum requirements:

- a) Heat exchangers for field assembled systems are to be the standard products of a reputable manufacturer. Field fabrication of heat exchangers is not permitted.
- b) Heat exchangers for field assembled systems are to be of the shell and tube, shell and coil or double tube type. Tubes are to be seamless copper, plain or with integrally formed fins. Shells are to be welded steel, conforming to the requirements of the latest edition of the Mines and Works Act or the Occupational Health and safety Act and Regulations (85 of 1993), covering pressure vessels. Gas passages are to be arranged so as to prevent trapping of oil.

Liquid gas heat exchangers for Refrigerant 12 are to have sufficient surface to ensure heating the gas to not less than 18.5 degrees C at the outlet. Liquid pressure drop are not to exceed 21 kPa and gas pressure drop not to exceed 3.5 kPa.

The vessels and equipment are to comply with the pressure equipment regulation as per SANS 347 standard

### **4.5.9.1.3. Refrigerant driers**

Refrigerant Driers have the following minimum requirements:

- a) Refrigerant driers for field assembled systems are to be of the angle type with removable cartridges that can be renewed without disturbing pipe connections. Driers are to have brass or steel bodies and solder joint connections. Bonnets are to be flanged and bolted. Cartridges are to be charged with dry silica gel or activated alumina, held securely in place without restraining normal expansion, and provided with suitable means for distributing the refrigerant evenly through the charge. Unless otherwise indicated driers are to be installed in liquid lines close to the receiver outlets and be provided with valves on the inlet and outlet connections. Valved by-passes are also to be provided unless the driers are of a type guaranteed by the manufacturer

to operate indefinitely without dusting of the desiccant or appreciable increase in pressure drop. Install a liquid sight glass and moisture indicator of the colour change type in the liquid line, close to each drier.

- b) Select each drier so that the pressure drop through the drier does not exceed 14 kPa when operating at full connected evaporator capacity.
- c) Drier cartridges are not to be installed until after pressure and vacuum tests have been completed but immediately prior to charging

#### 4.5.9.1.4. Thermostatic expansion valves

Thermostatic Expansion Valves have the following minimum requirements:

- a) In field assembled systems, each evaporator circuit are to be provided with a thermal expansion valve of the gas charged type.
- b) Valves are to have external equalizer connections, external superheat adjustments with seal caps and solder joints or flanged pipe connections.
- c) Valves are to move from fully open to fully close with not more than 3 degrees C superheat change. Superheat setting is to be 6 °C at full load. Each valve is to be provided with an external strainer, regardless of any internal strainer that may be incorporated in the construction. Strainers are to be as specified under "Refrigerant Strainers".

#### 4.5.9.1.5. Oil separators

Oil Separators have the following minimum requirements:

- a) Each reciprocating compressor having suction and/or liquid mains more than 15 m long is to be equipped with a discharge line oil separator.
- b) Separators are to be made of welded steel and have an effective impingement type separating element, an oil sump and a float operated return trap connected to them to return oil to the compressor automatically.

#### 4.5.9.1.6. Refrigerant Stop and Shut-off Valves

Refrigerant Stop and Shut-off Valves have the following minimum requirements:

- a) Refrigerant stop valves generally are to be of the back seating key operated, sealed cap type. Valves which are opened and closed in regular operation are to have packless type hand wheels.

#### 4.5.9.1.7. Refrigerant strainers

Refrigerant strainers have the following minimum requirements:

- a) Refrigerant strainers are to be of the angle type, cleanable without disturbing pipe connections. 40 mm N.B. strainers and smaller are to have brass bodies and solder joint connections. 50mm N.B. strainers and larger are to have brass or rust proofed steel or iron bodies and flanged connections. Connections are to be flanged and bolted.
- b) Screens are to be bronze metal with perforations not larger than 0.25 mm for liquid lines and 0.5mm for gas lines. The free area of each screen is not to be less than 5 times the area of the strainer inlet pipe.

Charging valves are to be located in the liquid line between the receiver shut-off valve and expansion valve.

Provide external gauge connections at inlet and outlet of condenser, evaporator coil and compressor to enable evaluation of system pressures at commissioning and for normal maintenance inspections.

All gauges are to be connected to the refrigerant piping system through isolating shut off valves.

Liquid indicators are to be of sight glass - double port with seal cap type - of full size in the main liquid line before the thermostatic expansion valve.

The solenoid valves are to have manual override to enable the system to continue to operate in case of solenoid coil failure.

#### 4.5.9.1.8. Vibration isolators

Vibration Isolators (Flexible Connectors) have the following minimum requirements:



- a) Suction and discharge lines from the compressor are to be fitted with flexible connectors of the bronze braided hose type, having sweat-ends, to fit over copper tubing having the same size as the line in which they are installed.
- b) Locate flexible connector as close as possible to the compressor and parallel to the compressor shaft. It must not be subjected to compression or extensions.
- c) For refrigeration installation utilising a remote air cooled or evaporative condenser, hot gas mufflers are used to remove pulsations from the hot gas discharge and thereby reduce noise and vibration from the piping system. The hot gas muffler must be installed to prevent accumulation of oil.

## Testing, charging and evacuation

Complete system to be pressure tested with dry nitrogen and leak test carried out. Test pressure to be maintained for 24 hours with no loss in pressure. Complete system to be evacuated and proved to be free of moisture. The system is able to stand for a minimum of 12 hours with no change in Vacuum. System to be liquid charged on high side following purging of connections to the estimated total charge. Minor adjustment to charge is to be carried out during the 12 hour test run.

The following method is recommended for pressure leak testing:

- a) Use a mixture of nitrogen & trace refrigerant in conjunction with one of the following suitable leak detection methods: Acceptable leak test methods include, Liquid submersion testing, soap bubble leak detection, fluorescent leak detection & electronic leak testing or any acceptable standard.
- b) Pressurise the complete system with dry nitrogen & leak test using any acceptable method.
- c) Having ensured there are no leaks using A or B above, the system must be pressurised to a safe test pressure. Observe over a period of time, relative to the size of the system that no pressure drop occurs, having due regard to temperature variation throughout the system.
- d) After determining that there are no refrigerant leaks when the system is pressurised, the system must be evacuated to remove moisture & air. Evacuation must be deep evacuation method, or triple evacuation using dry nitrogen only as the moisture absorber. To be witnessed by Employer's representative.
- e) DEEP VACUUM METHOD: Pull a deep vacuum to a pressure of less than 13 Pa absolute (100 microns of mercury). After isolation the vacuum pump, allow the system to stand for 60 minutes to ensure the vacuum are maintained at or below 16 Pa absolute (120 microns of mercury), OR
- f) TRIPLE EVACUATION METHOD: Use a vacuum pump to pull a vacuum to a pressure of at least 260 Pa absolute (2,000 microns of mercury). Break the vacuum with dry nitrogen & allow the system to stand. Re-evacuate the system & repeat the procedure twice more, breaking the vacuum each time with dry nitrogen.
- g) The final evacuation should be held for twelve hours with no loss of vacuum. After the system has been evacuated the vacuum pump should be isolated from the system and as guide, with constant ambient conditions the vacuum should not rise more than 13 Pa absolute (100 microns of mercury) in one hour. A greater rate of rise may indicate a leak. Absolute vacuums should be measured using accurate measuring equipment selected for the specific application.

Expansion valves and solenoids are to be stripped before welding refrigerant pipes so as to avoid overheating and associated damage to seals, or they are to be kept at constant temperature by means of damp rags.

Should the refrigerant piping run longer than normal, the amount of refrigerant oil is to be increased in the pipe system as per the manufacture's specification.

## 3.7 Electrical works

### Background

The HMI server and equipment rooms are currently being air conditioned at a capacity of 255 L/s and 4kW. The new cabinets and servers require an estimated cooling capacity 1050L/s and 22kW. The capacity of the existing is insufficient to achieve temperature control in the HMI server and equipment rooms, and shall be upgraded.

The rooms shall be air conditioned with a dedicated air conditioning system, comprising of 2 x 100% package cooling units, air distribution ductwork including fittings and a return air fan for economic cycle purposes. One package unit shall be on standby while the other package shall be operational. The package cooling units shall be positioned at the north side of the Water Treatment Plant building

### New HVAC power requirements

The power requirements for the package cooling units are 11kW, 20.1A for working package unit, 11kW, 20.1A for standby package unit and 0.55kW, 1.45A for a return air fan). The total power requirement for the running unit including the return air fan is estimated at 11.55kW, 23.1A.

### Electrical point of supply

The HVAC cooling units shall be installed approximately 200 meters away from the South Water Plant Substation, hence the appropriate point of supply is from this Substation. Spare circuits of 63A with a fuse rating (100A) and spare circuit 40A with a fuse rating (100A) were identified on both the 380V Water Treatment Plant Board 1A and 380V Water Treatment Plant Board 1B respectively. The stated spare circuits on the 380V WTP Boards shall be utilised and modified to power the 400/380V AC HVAC Electrical Distribution Panel.

### Requirements for the AC Switchgear

The design for the 400/380V AC HVAC Electrical Distribution Panel shall be in accordance with 240-56227516. The panel shall consist of two incomers, a bus coupler, two feeders for cooling units and two direct online motor control circuits. The panel shall be installed in an open area, thus the Contractor shall ensure that the IP rating for the panel is sufficient for all weather conditions.

### Electrical Contractor responsibilities

The Electrical Contractor shall be responsible for the detailed design; manufacturing, construction, factory testing, transportation, offloading, installation, site testing and commissioning of the 400/380V AC HVAC Electrical Distribution Panel. The *Contractor* shall provide and terminate the power cable (s) from the existing 380V WTP Boards on the available spares circuits to supply the HVAC cooling units. The *Contractor* shall also provide and terminate the power cable (s) from the new 400/380V AC HVAC Electrical Distribution Panel to supply the HVAC field equipment. The Contractor shall ensure the electrical works is properly earthed and protected against any lightning strikes. The Contractor shall provide all the necessary documentation for the complete HVAC related electrical works. The *Contractor* shall submit the detail design to the Employer for review and acceptance.

The responsibility matrix between the Electrical Contractor and HVAC Contractor is as depicted in following Table:

**Table 1: HVAC Related Electrical Works Schedule**

Description of work	Responsible Discipline		
	Employer	Electrical Contractor	HVAC Contractor
1. Detailed Design of HVAC related electrical works		X	
2. Plant and material selection; installation and as built drawings; Testing, balancing and commissioning Documentation; Operating Instruction and Maintenance Manuals; and Inspection Record Cards/Checklists.		X	
2.1. Supply and install 400/380V AC HVAC Electrical Distribution Panels with circuit breakers, contactors, isolators, indication lamps, pushbuttons, door interlocking handles, ammeters, selector switch, auto/manual etc.		X	
2.2. Supply, install and terminate power cables on the new 400/380V AC HVAC Electrical Distribution Panels.		X	
2.3. Allocate the spare circuits on the selected boards to supply the new 400/380V HVAC Electrical Distribution Panels. Modify existing circuit if necessary.	X		
2.4. Terminate the power cables on the allocated spare circuits on the selected boards to supply the new 400/380V AC HVAC Electrical Distribution Panels.	X		
2.5. Electrical cable / wiring, Cable ladders and trays, power and control cabling and racking, joint kits, earthing, hangers and mounting arms, risers and droppers measured as elbows etc. and isolators ending within to HVAC equipment and its controls.		X	
2.6. Testing and commissioning HVAC related electrical works	X	X	X

## Cable, Racking and Routing

For the cabling and cable racking *Works*, the *Contractor* shall:

- Design, manufacture/procurement, transport, supply, install, test and commission the new cables.
- Ensure interfacing with all the other system requirements of the plant/installation.
- Ensure that the *works* are implemented as prescribed in the corresponding standards
- Test all cables and provided certificate.
- Develop, finalise and implement the optimised cable routing.
- Produce exact cable routing designs of all the cables.
- Cater for cable servitudes and cable racking.
- Implement all cable routing designs as approved.
- Implement all cable terminations.
- Produce all documentation and drawings

## Earthing and Lightning protection

For the earthing and lightning protection *Works*, the *Contractor* shall:

- Perform earth resistance and earth continuity tests of the existing earthing system to determine the status of the earthing point used.
- Construct new earthing tied into the existing earth mat
- Propose and implement lightning protection interventions.
- Perform detailed designs, manufacture/procure, transport, supply, install, test and commission the earthing and lightning protection system and its components, in line with the relevant standards.
- Provide all equipment and components required.
- Ensure that interfacing with all the other system requirements of the plant/installation.
- Produce all documentation and drawings.

### Applicable Electrical Standards

The design of the electrical systems shall be applicable to the following Standards as a minimum:

- The design for the 400/380V AC HVAC Electrical Distribution Panel shall be in accordance with 240-56227516: LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard.
- Cabling, cable racks and cable routing shall be design in accordance with 240-56227443: Requirements for Control and Power Cables for Power Stations Standard.
- Earthing and lightning protection design shall be in accordance with 240-56356396: Earthing and Lightning Protection Standard.

Refer to section to section 5 for a detailed list of Applicable Standards

## 3.8 C&I Works

### Control and Instrumentation System Design

The Contractor's HVAC discipline is responsible for the detailed design; plant and material selection; installation and as built drawings; testing, and commissioning documentation; operating instruction and maintenance manuals; and inspection record cards/checklists of the complete HVAC standalone equipment controls which are capable of interfacing with Building Management System (BMS).

The HVAC controllers are to be designed to utilise standard sensors, transducers and actuators for the industry which has been field tested for the last two years.

The HVAC controllers is to have a capability to communicate with the standard equipment supplied such as fans to enable monitoring of performance of the components and allow for subsystems to be tested, logged and commanded at the central operator's terminal.

Field controllers are to operate independently of the BMS and each redundant plant is to have dedicated sensors and actuators. The communication bus is to be BACnet, LonMark or Modbus.

Each HVAC system is to be provided with centralized controller capable (HVAC controller) interfacing to with Building Management System (BMS).

The HVAC related controls and fire detection Works responsibility matrix between Contractor's Electronic/Fire discipline and HVAC discipline is as detailed by table below.

**Table 2: Division of HVAC Related Controls and Fire Detection Works Schedule**

Description of work	Responsible Discipline		
	Contractor's Electronic/Fire discipline	Contractor's Electrical discipline	Contractor's HVAC discipline
1. Detailed Design of HVAC standalone equipment controls including plant and material selection; installation and as built drawings; Testing, balancing and commissioning Documentation; Operating Instruction and Maintenance Manuals; and Inspection Record Cards/Checklists.			X
2. Fire signal within 2.0m of HVAC equipment and electrical boards	X		
3. Provision and connection of fire relay in HVAC equipment and electrical boards		X	X
4. Testing and commissioning of HVAC related fire detection works	X	X	X

### Stand-alone control system

The stand-alone control system is to be of the direct digital control type and be configured with the following functions. The stand-alone micro-processor based plug-in modules typically control peripheral devices, elements and components in a subsystem and must:

- a) Provide means to change set-points, integrating and derivative time, and proportional bands through portable plug-in operator terminal.
- b) Transmit relevant data to other stand-alone controllers installed if required to do so. The control system is to be Employed and arranged in such a way that staged start-up at sub-system level is provided for staged commissioning.
- c) All the programming units or equipments must be formally handed over to the *Employer* after commissioning, for future tuning of the controllers

### Operating range

Sensitivity, speed of response and throttling range of the individual items of the control system is adjustable so that the controllers maintain steady conditions without hunting or drifting within the specified control values.

### Safety and alarm

In case of any control system malfunctioning or function interruption, an alarm signal is given by field adjustable, programmable, audible and visual alarms and the control device must remain in its last controlled position prior to the failure.

Points in alarm are accessed on the stand-alone controller by using menu on screen. The list of signals is as follows:

#### a) Controls

- Dx. package unit automatic/manual selection switch
- Room return air temperature thermostat controlling 3 way valve at close control
- Heater stop/start per step

- Return air fan motors start/stop
- Fire dampers re – opening

## **b) Indications**

- Fan running/stop/tripped indications
- Duty selection position
- Change over to standby plant activated/not activated
- Individual Dx. Package cooling unit air flow failed/normal
- Filters clean/dirty
- Fire dampers open/close signals

## **c) Alarms at (Visual at WTP HMI in future)**

- High and low air conditioned zone temperatures.
- Dx. Package cooling unit trip
- Fans trip
- No airflow (priority alarm for operator 's investigation)

## **Reliability and availability**

The equipment are so constructed and components installed, connected and documented so that with required spares available and diagnosis methods used, the maximum breakdown interference for any card or board replacement will be limited to one hour. The *Contractor* demonstrates at tendering stage how the "Mean Time To Return" the system to its operational status is achieved with the aid of trouble shooting flow charts to diagnose and repair the sub system.

During pre-handover (commissioning and testing) "Downtime" of the control system and/or during actual "Downtime" during the period that the Comprehensive Service and Maintenance Contract is in force, the *Contractor* must operate the entire system for as long a period as may be required to provide satisfactory performance at all times in the occupied spaces served by that system for up to 24 hours a day continuously.

The *Contractor* provides the operator(s) and equipment required for testing and operating the system. The *Employer* may assign operating personnel as observers but such observation time must not be counted as instruction time. The *Contractor's* operator(s) are fully conversant with the system operation and experienced in running similar installations.

The Mean Time between failure of the overall system or parts of the system is offered at a minimum of 7.5 years. Not more than 5% of the system components fail in any one year. At tender stage the *Contractor* submits the interpretation of the point list, major qualifications and brief summary of the proposed system offered.

The *Contractor* submits at equipment submission stage full details of the proposed:

- a) Fault detection and identification methods
- b) Fault correction methods
- c) Spare parts availability
- d) Documentation
- e) Operators and Maintenance training.

During construction, prior to handover full Operating, Trouble Diagnosis, Service and Maintenance Manuals, together with training aids and procedures are submitted.

The *Contractor* submits full details how and what integrity checks are continuously performed concurrent with normal operation and the subsequent actions are fully described and the influence of these procedures on achieving the claimed "Mean Time to Return" to normal operation.

## Technical restraints

The equipment requirements is such that the control system hardware is readily accessible, modular, plug-in connected, to allow for easy fault diagnosis and ease of maintenance on a remove and replace basis to limit downtime to minimum. Adequate space is provided around all items for easy removal of parts. The system has self-diagnostic characteristics to determine fault conditions.

The stand-alone controller level and interface is designed as follows:

- a) The system is designed to utilise only standard sensors, controllers transducers, servo actuators, for the industry which have been field tested for at least 2 years. The control system does not only incorporate its own sensors and controllers where applicable, but also use the standard instrumentation, sensors and control equipment supplied as "standard" on equipment such as air cooled condensing units, in order that the performance of all the components of a subsystem can be test logged and commanded at the central operator's terminal.
- b) All actuators, operating valves, dampers, etc., controlling the capacity of components and/or subsystems are equipped with manual operators to maintain control during power failure or interruption. It is impossible to use the manual operator when the power is switched on. If the actuator is switched back to automatic control the manual operator knob must automatically disengage.
- c) All interface between sensors, components, relay boards, capacity controllers, etc., is via plug in terminal factory pre tested connector strips in the MCC's or interface panels.
- d) The accuracy of the sensors, controllers, outstations and management level is of such a standard that the discrepancy (measuring error) between actual and measured value never exceed 2% of the operating rang.
- e) All the field instruments positioned in the battery room are Exn rated

## Installation restraints

Every care is taken to protect material, either fixed or unfixed, from damage, ingress of dust, water and moisture. The entire installation is in "as new" condition at handover. All panels are totally enclosed, dust, damp and vermin proof.

The system is designed for location in mechanical system rooms with maximum indoor temperature of 40°C. The system is designed to provide continuity and correct operation during abnormal conditions caused by over voltages, electromagnetic induction, spiking input/output and any other "normal" interference found in commercial buildings through switching of fluorescent lights, operation of other control equipment, operation of welding machines, somewhere in the building, etc.

The installation in its entirety must comply with regard to electrical safety, supply interference and suppression requirements, with SANS regulations.

## Measurement to confirm equipment compliance with specification

After successful demonstration of control operation of each sub system including accuracy of sensors, a total system demonstration is performed. This demonstration, having satisfactorily met previously approved submittals, must with the Employer's written acceptance, allow commissioning of the system for on line operation.

The *Employer* takes over the control system upon successful completion of the following by the *Contractor*:

- a) Training of the system's operator and demonstration that the operator is fully conversant with the system trouble diagnosis and corrective actions.

- b) The proper functioning of the entire stand-alone control system is documented in a formal handover/test report written and signed by the control system's responsible *Employer* representative and accepted and countersigned by *Contractor*.
- c) The control system tenderer must submit the pro forma test/handover report at tendering stage.
- d) No handover of system will take place without submission to and acceptance by the *Employer* of this formal handover report.



### 3.9 Building works, Civil engineering and structural works

#### Civil and Building Works Design

The *Contractor's* is responsible for the detailed design; plant and material selection; installation and as built drawings; testing, and commissioning documentation; operating instruction and maintenance manuals; and inspection record cards/checklists of the complete HVAC related building works. The HVAC building related work requirements are as detailed by attached HVAC floor layout plans.

#### 4.7.1.2 4.8.1.1. Structural Scope

The design process shall follow the Structural Design and Engineering Standard (240-56364545), the steps below outline the deliverables required by the contractor:

1. The Contractor picks a suitable plinth location near the building as shown in appendix 10.7. The selected location must not interfere with any existing services (i.e The plinth must not be in front of the existing air conditioners).
2. Two plinths are designed to support the HVAC equipment and HVAC distribution board.
3. The Fencing and access gate around the HVAC distribution board and control panel
4. HVAC distribution board and control panel is sheltered to protect the electrical equipment

#### Design requirements

1. The Plinths are designed to support the total mass of the HVAC equipment/Electrical panel, and to accommodate all of the forces that are exerted onto them
2. Drainage is considered in the sizing of the plinth and determining the height above final Terrence level.
3. Contractor positions the plinth in a location that has sufficient space for the maintenance of the equipment to be supported and also for the existing pipes next to the building.
4. All designs shall comply with the Eskom Standard 240-56364545 "Structural Design & Engineering Standard and relevant SANS standards
5. The Contractor submits all designs to the *Project Manager* for review and acceptance.
6. The contractor submits the final layout of the plinth with fence to the station for approval and acceptance

## Documentation control and configuration management Information Requirements

All documents and records management are performed according to Technical Document and Record Management Work Instruction (240-76992014) and the Employer ensures that the *Contractor* is provided with latest revisions. Any uncertainty regarding the work instruction should be clarified with the Employer and clarification updates should be reflected in updated versions of the works instruction. The Contractor complies with all minimum document metadata as specified in Technical Documentation Classification and Designation Standard (240-54179170).

Transmittal letters are provided with each document submittal. The transmittal letter must include the *Contractor's* drawing number, revision number, and title for each drawing attached. Each drawing title must be unique and must be descriptive of the specific drawing content.

In addition, the Contractor is provided with the following standards which must be adhered to:

- Documentation Management Review and Handover Procedure for Gx Coal Projects (240-66920003).
- Project Documentation Deliverable Requirement Specification (240-65459834).
- Technical Document and Record Management Work Instruction (240-76992014)

### Configuration Management

The *Contractor* supplies a comprehensive configuration management program according to ISO 10007 (2<sup>nd</sup> Edition) 'Guideline for Configuration Management' to ensure that plant structures, components and computer software conform to approved design requirements. The *Contractor* develops a project specific Configuration Management Plan document which is aligned to ISO 10007. In addition, the Works as-built physically and functional characteristics must be accurately reflected in selected documents and databases, including those for design, procurement, construction, operation, testing and training. The configuration program must be applicable for use throughout all phases of the project life cycle, including management of spare parts, replacement parts and product upgrades, and forms part of deliverables for hand-over to the *Employer* for use during the operation and maintenance phases of the plant.

### Change Management

Design change management is performed in accordance to the latest revision of the Eskom Project Change Management Procedure (240-53114026) and the Employer ensures that the *Contractor* is provided with latest revisions of this procedure. Any uncertainty regarding this procedure should be clarified with the *Employer* and clarification updates are reflected in updated versions of this procedure.

### AKZ Classification System

#### Plant Codification

The AKZ Keypart is used by the *Contractor* for classifying and designating both Plant and their associated documents. The rules for applying the AKZ codes are contained in the AKZ Standards that is provided by the *Employer*.

The *Contractor* codes all Plant within scope of supply according to the AKZ classification system to component level. The *Employer* provides the Plant Breakdown Structure with plant, systems and equipment coded up to the level of design. The relevant AKZ codes allocated appear on all Plant related documentation, drawings, lists and correspondence.

The *Contractor* is responsible for plant codification of all new systems, equipment and components that form part of the design. In order to codify the plant and its documentation, the *Contractor* makes use of the relevant codification standard provided by the *Employer*. Unless otherwise stated, the codification is limited to the lowest component level of coding and applies to all systems included in the *works*.

The *Contractor* is responsible for ensuring the accuracy, completeness and consistency of the designations in all documents. This applies both to designations within documents (Plant designations) and of documents (document designations). The *Contractor* submits these for the *Employer's* acceptance.

The *Contractor* provides the *Employer* with outline drawings or diagrams showing the *Contractor's* reference coding for materials as per schedule of submittals.

## **Plant Labelling**

The *Contractor* manufactures and installs labels according to the Duvha AKZ Plant Location Coding ENS0002 that will be provided. Detailed nameplate or label lists with the service legends, including the AKZ code are prepared by the *Contractor*, submitted to the *Employer* for review and comment before commencing with the manufacturing of the labels.

## **Document Submittal Program**

The Vendor Document Submittal Schedule (VDSS) provides a list of the documents to be provided and their due dates.

The *Contractor's* engineering program allows a minimum of 5 working days for mailing, processing, and review of drawings and data by *Employer*.

If *Contractor* makes further changes to the equipment and materials shown on submittals that have been reviewed by the *Employer*, the changes are clearly marked on the submittal by the *Contractor* and the submittal process is repeated. If changes are made by *Contractor* after delivery to the Plant, as-built drawings indicating the changes are prepared by the *Contractor* and submitted to the *Employer* for review. Any resubmittal of information clearly identifies the revisions by footnote or by a form of back-circle, with revision block update, as appropriate.

## **Minimum Requirements**

The Drawings to be provided must be in accordance with the Engineering Drawing Standard – Common Requirement (240-86973501)

## **Procedure for Submission of Documents**

The *Contractor* completes the design change [report/request] within 10 working days or such other time period that the *Project Manager* and *Contractor* agree is reasonable in the circumstances, of the *Project Manager's* instruction changing the Works Information.

- In completing the change report, the *Contractor* takes into account the impact of the *Project Manager's* instruction on the works, in accordance with the Works Information and the Contract;
- Provides the *Project Manager* with the impact on the *Contractor's* detailed design, programme,
- costs, Completion Date, Key Dates, execution and methodologies

The above information from the *Contractor* is sent to *Others* on the Project in order to integrate the system and ensure that the *Employer's* objectives in relation to the Project are achieved. Likewise, the *Contractor* may during the Contract receive such information, via the *Project Manager*, from *Others*. The *Contractor* assesses this information to:

- Assess the impact of changes on the *works*, in accordance with the Works Information
- and the Contract;

- Provide the *Project Manager* with the impact on the *Contractor's* detailed design, programme,
- costs, Completion Date, Key Dates, execution and methodologies

Within 5 working days or such *Other* time period that the *Project Manager* and *Contractor* agree is reasonable in the circumstances of the *Contractor* submitting (or receiving this information), the *Contractor* attends a meeting with the *Employer* and *Others* on the Project to align the *Employer*, *Contractor* and *Others' works* and ensure compatibility and integration of the Project.

The *Contractor* submits its revised programme within 5 working days or such *Other* time period that the *Project Manager* and *Contractor* agree is reasonable in the circumstances, taking into account all information received from the *Employer* and *Others*.

The *Contractor's* obligation to submit quotations within the times periods stipulated in clauses 62.3 is not negated by the procedures set out in this paragraph. If, however, the *Contractor's* quotation does not include the information required by this paragraph or take into account the impact of this information, the *Employer* rejects the quotation in accordance with clause 62.4.

Where the *Contractor* is unable to comply with the Contract or Works Information, the contractor promptly notifies the *Project Manager* of:

- Details of the non-compliance;
- Impact of non-compliance on *Others*;
- Remedial steps to be taken.

The *Project Manager* meets with the *Contractor* and *Others* to assess the non-compliance. The *Project Manager* assesses all the information provided to him by the *Contractor* and *Others* including the impact on *Others*. The *Project Manager* issues an instruction to the *Contractor* and *Others* on how to deal with the non-compliance. The *Contractor* bears the liability for effect of the Instruction including the remedial work and the work undertaken by the *Employer* and *Others* to deal with the non-compliance.

For all instances where the *Contractor* is required to submit a quotation, the contractor must provide the necessary supporting information (detailed in paragraph 2.12 below) in order for the *Project Manager* to assess the Actual Cost. If the *Contractor* fails to provide such information with the quotation, the *Project Manager* rejects this quotation. Notwithstanding the lack of a compliant quotation, the *Project Manager* is entitled to issue an instruction for the *Contractor* to start the work.

If there are any delays under the Contract, the *Contractor* must as part of the quotation show how it intends to mitigate its losses. This includes allocating resources, including key people to *Other* contracts, limiting accommodation, travel and catering expenses. The *Contractor* shows that in incurring these expenses the *Contractor* prepared for the possibility of delay and made all reasonable attempts to mitigate the losses prior to incurring these expenses.

The following process will be followed during submission of documents:

- The Contractor submits the documents/drawings to the Project Manager.
- The Employer's Document Controller registers the documents.
- The Employer's Document Controller will supply the documents/drawings to all relevant parties
- within the Employer's project team.
- The Employer's project team reviews the documents/drawings and will submit all comments or
- inputs to the Project Manager and the Project Manager submits to the Contractor for consideration.
- If the Employer finds major deficiencies in the submitted documents/drawings, the Contractor
- revises the documents/drawings and resubmits to the Project Manager.

- The Employer reviews the documents/drawings and if no major deficiencies are found, the
- Contractor organises a Design Review session.
- The Employer and the Contractor conduct a Design Review.
- If any fundamental errors were found in the designs or further actions are required, the
- Contractor record all concerns raised and revise the designs.
- The Contractor organises a Design Review session once all designs were revised according to
- The concerns raised by the Employer.
- If no fundamental errors were found in the designs during the Design Review session, the
- Contractor compiles the Design Review minutes or report and submits it to the Project Manager.
- The Employer's Document Controller registers the report.
- The Employer's project team reviews the Contractor's report/minutes. If the report/minutes are
- not acceptable, the Contractor revises the report/minutes and resubmits to the Project Manager.
- The Project Manager will accept the Contractor's design once the report/minutes are
- accepted by the Employer's project team.

#### **Installation, Operation, and Maintenance Manuals**

The Contractor must provide proof, final installation, operation and maintenance manuals for the unloading, storage, installation, operation, and maintenance of the plant materials.

#### **Design Review Documentation**

The *Contractor* conducts design reviews as per the *Contractors* official design review procedure. *Contractor* further takes note of the *Employers* Design Review Procedure (240-53113685) and participates in all design reviews as specified by the *Employer*. The *Employer* "Accepts" or "Rejects". The *Contractor* makes the necessary revisions on the documentation and ensures acceptance is obtained from *Employer*. The *Contractor* includes the design reviews in Table 3 below as part of the schedule.

The following design reviews as shown in Table 3, will be conducted, by the *Employer*, as per the design review procedure.

**Table 3 : Contractor Design Reviews**

Contract Award Review
Design Freeze Reviews (Detail Design)
System Integrated Design Review (Detail Design)
Pre-Commissioning Review
Acceptance Testing Review

Design Freeze reviews can be conducted as End-of-Phase Design Reviews or as a series of Interim Design Reviews with the aim to design freeze a system or subsystem/asset in order to enable subsequent designs to progress. The number of design freeze reviews is discussed with the *Employer* during the contract negotiations.

Documentation for design review is presented to the *Employer* at least ten working days prior to the start of the formal technical clarification discussion.

Where required the *Contractor* meets with the *Employers* for a technical meeting, before the final design review meeting. This meeting may be weekly and will facilitate discussion around interfacing between different designs.

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## 7 Applicable standards and codes

**Table 4: List of Applicable Standards and Codes**

Number	Title
SANS 10400	The Application of the National Building Regulations
SANS 10108	The Classification of Hazardous Locations and the Selection of Equipment for Use in Such Locations
SANS 10103	The measurement and rating of environmental noise with respect to annoyance and to speech communication
SANS 61800	Adjustable speed electrical power drive systems
SANS 10140-3	Identification color marking Part 3: Contents of pipelines
SANS 10142-1	The wiring of premises Part 1: Low-voltage installations
SANS 10147	Refrigerating systems including plants associated with air-conditioning systems
SANS 10173	The installation, testing, and balancing of air-conditioning duct work
SANS 193	Fire dampers
SANS 1238	Air-conditioning ductwork
SANS 1287-1	Ventilation brattices and ducting Part 1: Flexible ducting
SANS 1287-2	Ventilation brattices and ducting Part 2: Brattices, unsupported
SANS 1424	Filters for use in air-conditioning and general ventilation
SANS 1551-1	Check valves (flanged and wafer types) Part 1: PN series
SANS 1551-2	Check valves (flanged and wafer types) Part 2: Class series
SANS 1849	Butterfly valves for general purposes
ASHRAE 15	Safety Codes for mechanical refrigeration
ASHRAE 62	American Society of Heating Refrigeration and Air Conditioning Engineers. Ventilation for acceptable indoor air quality
ASHRAE 55	Thermal environmental condition for human occupancy
ASHRAE 52/76	Standard test method for filters
ASHRAE G1	Guideline for commissioning of air conditioning system
240-56355754	Field Instrumentation Installation Standard
240-56355815	Field Instrument Installation Standard - Junction Boxes and Cable Termination
240-56227443	Requirements for Control and Power Cables for Power Stations Standard
240-56356396	Earthing and Lightning Protection Standard
240-40643427	Coding and Labelling Standard
240-56227516	LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard
240-56177186	Design Guide for Power Station Battery Rooms
240-56176097	Electrical Cable Schedule Template
240-56227927	Electrical Load List Template

Number	Title
240-56356421	Electrical LV Switchgear Schedule Template
240-56356465	Electrical LV List of Switchboards Template
240-77302094	Cable Termination Schedules
NFPA 70	National Electrical Code

## 7.1 3.10 As-built drawings, operating manuals and maintenance schedules

- (1) 'As Built' documentation, as listed in Appendix 1 – list of documents required from the contractor is supplied by the Contractor to the Project Manager upon completions of works.
- (2) 3 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 Sectional Completion of the Plant Area concerned.
- (4) The documents are reviewed by the Project Manager for correctness and conformance to the accepted design.

### CONTRACTOR Requirements for the “AS BUILT” Documentation

- (1) The CONTRACTOR signs of on the completeness of the As Built documentation package

### EMPLOYERS Requirement for the Document

- (1) The contractor to supply Duvha with a complete data package.

## **8 4 Procurement**

### **8.1 4.1 People**

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

Only qualified and experienced people to be employed.

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.

- (1) 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.

The courses for this will be presented free of charge to contractors and bookings must be done via the Project Manager.

- i. N.B Access to the switchgear/equipment rooms the Contractor to comply to the following prior to access being granted:
  - a. 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.
  - b. Contractor to ensure that all personnel working in the room wear special overalls due to the nature of equipment in the rooms.

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.

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

The Employer formal Black Economic Empowerment (BEE) programme was first initiated in 1995 with the publication of its policy regarding procurement from Black Suppliers (ESKADAAT6). ESKADAAT6 has set the standard for BEE programmes within Eskom and across South Africa as a whole.

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.

Eskom will concentrate its development efforts on black suppliers in the manufacturing, construction and mining /extraction sector of the economy and provide support.

#### **Accelerated Shared Growth Initiative – South Africa (ASGI-SA)**

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

*[Insert the agreed ASGI-SA Compliance Schedule here]*

The *Contractor* shall keep accurate records and provide the *Project Manager* with reports on the *Contractor's* actual delivery against the above stated ASGI-SA criteria. [Elaborate on access to and format of records and frequency of submission etc.]

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



## **Subcontracting**

### **Preferred subcontractors**

The Contractor shall make use of any supplier for sourcing of equipment, tools and material whatever that the contractor will use to execute works shall comply with the SABS

### **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 not subcontract a contractor that has lower or higher level accreditation than his/her according to CIDB.

### **Visual Automation Interface Scope**

The contractor of The station Historian Visual Automation 4 (VA 4) is SAM. It is recommended that the contractor may consult SAM to obtain assistance for establishing a link between the WTP and VA.

### **Limitations on subcontracting**

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

### **Attendance on subcontractors**

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

## **8.2 4.2 Plant and Materials**

### **8.2.1 Quality**

Refer to Duvha quality manual - See Appendix 5

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

- a) The *Employer* will provide power supply, water and land for the storage of equipment and material.
- b) The *Contractor shall* supply all the necessary equipment and material required to execute the *Works*.
- c) Should the *Contractor* need to use of any of the *Employer's* Equipment, including compressed air, electricity, water supply and crane, it must be specified by the *Contractor*. The *Employer* does not guarantee continuity of supply of any of these items.

### **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.

### **Spares and consumables**

- (1) The *Contractor* shall provide any spares and consumables as they are required for this fault finding and solutions to the defective plant items

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

### **8.3 4.3 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.

## **5. Construction**

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

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

Refer to Access Control document - see Appendix 6

#### **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, 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

#### **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 informs the person in charge of the plant (ASS on the panel or Operating Supervisor) 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.

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

- (1) Refer to Health and Safety Specification document see attached Appendix 7

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

- (1) Refer to Environmental Policy See Appendix 7

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

- a) The Contractor has no title to an object of value or historical or other interest within the site
- b) 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.
- c) The Contractor does not move the object without instruction.
- d) The Contractor has title to material from excavation and demolishing only as stated in the works information.

#### **Cooperating with and obtaining acceptance of others**

The Contractor shall co-operate with others in obtaining and providing information which they need in connection with the works.

The Contractor shall share the working area with others in executing the works.

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

- a) Should publicity and/or progress photographs be required, an application shall be made via the Project Manager.

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

- a) The Contractor's attention is drawn to the applicable regulation framed under the Machinery and Occupational Safety Act, 1983 (Act No. 6 OF 1983)
- b) When working in built-in areas, the contractor shall provide and use suitable and effective silencing devices for pneumatic tools and other plant that would otherwise cause a noise level exceeding 85 Db(A) during excavation and other works.
- c) Alternatively the Contractor shall by means of barriers, effectively isolate the source of any such noise in order to comply with the said regulation.

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

- a) Should the Contractor require using any of the Employer's Equipment, including compressed air, electricity, water supply and crane, it must be specified by the Contractor during the kick off meeting. The Employer does not guarantee continuity of supply of any of these items.
- b) The Employer shall be entitled to withdraw use of the said Equipment, should proper maintenance and cleanliness not be ensured. In that event, the Contractor shall be obliged to provide the necessary Equipment at his own cost.
- c) 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.
- d) The Contractor 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. Arrangements for training courses can be made via Duvha Power Station Maintenance Training but the Contractor will absorb costs.
- e) A copy of this accredited and valid training certificate must be given to the Employer's Supervisor, who will then arrange access for usage.

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

##### **a) Potable Water Supply**

- Potable water is available at the existing points.

**b) Electrical Power Supply**

- Power is available at the existing points.
- The Contractor provides his own portable 380V electrical distribution boards, and supply cables to and from the boards, for all his power supply requirements to execute the works.
- Contractors' Electrical Distribution Boards complies with OHSA as referred to in the Electrical Installation Regulations and the Electrical Machinery Regulations.
- Each board brought onto site must have a Certificate of Compliance issued by an accredited person.
- The Contractors' electrical distribution boards are installed at the works on a time negotiated with the project manager, prior to the possession date.
- The Employer connects distribution boards to a 380V three-phase AC power supply, only after the Contractor has submitted the valid Certificate of Compliance.
- All Contractors' Electrical Distribution Boards are earthed to the steel structure of the plant.

**c) Toilet Facilities**

- The Employer provides the Contractor access to existing toilet facilities. The Contractor is to provide this facility should the existing facilities not be within reasonable distance from the working area.

**d) Catering Facilities**

- The Contractor are not 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).
- The Contractor may buy take away meals from the fast foods outlet on Site.

**e) Medical Facilities**

- The *Contractor* provides a First Aid service to his employees and subcontractors. 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.
- Outside the *Employer's* office hours, the *Employer's* First Aid Services are only available for serious injuries and life threatening situations.
- The *Employer* recovers the costs incurred, in the use of the above *Employer's* facilities, from the *Contractor*.

**Facilities provided by the Contractor**

- The contractor should provide facilities they deem necessary in executing the work. This must be discussed with the Project Manager prior to commencement of work.

**Survey control and setting out of the works**

- a) The Contractor shall properly deal with and disposal of water to ensure that the works are kept sufficiently dry for their proper execution.
- b) The contractor shall provide, operate and maintain in sufficient quantity such pumping equipment, well points, pipes and other equipment as may be necessary.
- c) The Contractor shall also provide temporally works as may be necessary to minimise damage, inconvenience or interference.

**Survey control and setting out of the works**

- a) The Contractor shall properly deal with and disposal of water to ensure that the works are kept sufficiently dry for their proper execution.
- b) The contractor shall provide, operate and maintain in sufficient quantity such pumping equipment, well points, pipes and other equipment as may be necessary.

- c) The Contractor shall also provide temporary works as may be necessary to minimise damage, inconvenience or interference.

#### **Excavations and associated water control**

- a) The contractor will be held responsible for any damage to known services (services that are within the site of the works and are known/shown on drawings or highlighted by employer) and he shall take all the necessary measure to protect them.
- b) All works or protective measure shall be subjected to approval.
- c) In the event of service being damaged the contractor shall immediately notify the authority concerned as well the project manager and the engineer.
- d) The contractor shall not repair any such service unless instructed to do so by the project manager.
- e) The contractor shall complete such an investigation well in advance, prior to the start of construction work in the said section and shall submit a report in good time to enable the engineer to make whatever arrangements that are necessary for the protection, removal or diversion of the service before any construction works commences.
- f) As soon as any underground service not shown in the in the drawing is discovered, it shall be deemed to be known service and the contractor will be held responsible that the contractor for any subsequent damage to it.
- g) If such service is damaged during the course of its discovery, the cost of rectifying the damage will be met by the employer unless it is established that the contractor did not exercise reasonable diligence and that the damage was avoidable.
- h) Where the authority concerned elects to carry out on site own account any alteration or protective measure, the contractor shall co-operate with and allow such authority reasonable access and sufficient space and time to carry out the required work.
- i) Permanent alteration or permanent diversion of service necessitated by the execution of the works and authorized will be paid for in terms of the conditions of contract, but no such work will be paid for if it has not been previously inspected and if no proper written instruction was given.

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

Where underground cables and pipes are present in the area, care must be exercised to ensure that they are not damaged. In the case of damage to existing components, the contractor will be held liable for replacement/repair thereof.

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

- a) The Contractor shall take all responsible measure to minimise any dust nuisance, pollution of stream and inconvenience to or interference with public as a result of the execution of the works.
- b) Remove all rubble and dispose to appropriate facility as according Duvha waste management procedure (EVP0005)

#### **Sequences of construction or installation**

All work must be inspected and approved as per QCP holding points by the system engineer and project manager. The contractor's supervisor is still entirely responsible for ensuring that the work is carried out as per the complete QCP

#### **Giving notice of work to be covered up**

All work must be inspected and approved by the system engineer and project manager before it may be covered up.

## **8.4**

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. 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.

Item of work	To be completed by
Performance testing of the <i>works</i> in use as specified in paragraph 1.1 of this Works Information.	Contractor in the presence of <i>Project Manager</i> and engineer

#### **8.4.1 5.1 Use of the *works* before Completion has been certified**

The *Employer* may use any part of the *works* before completion has been certified. If he does so, he takes over the part of the *works* when he begins to use it except if the use is:

- a) For a reason stated in the works information
- b) To suite The Contractors method of working

The *Project Manager* certifies the date upon which the *Employer* takes over any part of the *works* and its extension within one week of the date.

#### **8.4.2 5.2 Materials facilities and samples for tests and inspections**

The Contractor and the *Employer* provide material, facilities and samples for test and inspection as stated in the Works Information.

#### **8.4.3 5.3 Commissioning**

The *Contractor* supplies personnel to assist the *Employer* with commissioning of the *works*.

The plant is commissioned by running the system fully manual and testing each piece of Plant and Material for full functionality.

#### **8.4.4 5.4 Start-up procedures required to put the *works* into operation**

The Contractor shall carry out sufficient checks to satisfy himself that the materials used and the workmanship comply consistently with the specified requirements and the results of those checks shall, if so ordered, be made available to the Engineer.

The Engineer may carry out such check as he deems necessary at any point or any depth or any layer, as the result of the Engineer's check shall be made available to the contractor.

#### **8.4.5 5.5 Take over procedures**

Take over will be on or before the Completion Date the *Contractor* shall have done everything required to provide the *works* and the Engineer has done all the necessary inspection and the approval of the *works* done

#### **8.4.6 5.6 Access given by the *Employer* for correction of Defects**

The Supervisor issues the Defect certificate at the later defect date and the end of the last defect correction period. The *Employer's* right in respect of the defect which the supervisor has not found and notified are not affected by the issue of the defect certificate

The Contractor contacts the *Project Manager* to gain access to the site to correct defects.

#### **8.4.7 5.7 Performance tests after Completion**

The Contactor shall conduct performance test after installation in the presence of the *Project Manager* and the Engineer according to the QCP, the end user and functional requirements.

#### **8.4.8 5.8 Training and technology transfer**

The *Contractor* shall provide any associated transfer of technology and knowledge to the *Employer*.

## 9 5.9 Plant and Materials standards and workmanship

All materials to be new and to comply to all the requirements as laid down in the applicable SANS or other standards.

### 9.1 5.10 Investigation, survey and Site clearance

The Contractor shall make arrangement with the *Project Manager* should he want to perform investigations or survey.

### 9.2 5.11 Electrical & mechanical engineering works

#### Wiring and cabling installation

- (1) All cables shall be sized according to the design of the system. This must take into account all electrical and mechanical characteristics, such as voltage drops, current carrying capacity, impedance and mechanical protection. This is often dependant on the type and make of the equipment, as well as the specific environments in which they are installed. This shall be the responsibility of the contractor.
- (2) Cables with "standard" fire resistance shall be used for general use. These cables shall have a rating of PH30 when tested according to BS EN 50200 [23]. The competent fire system engineer needs to specify the required cables to be provided to the risk areas.
- (3) Cables with "enhanced" fire resistance shall be used where certain systems are required to operate for longer than normally required. These cables shall have a rating of PH120 when tested according to BS EN 50200 [23].
- (4) Mixture of cable types is not permitted. Cables shall only be supplied from one manufacturer for the entire system to avoid known impedance problems caused by mixing different manufacturers cables.
- (5) Fibre optic cable is recommended for the communications medium between fire panels because it is immune to electromagnetic interference, can pass through hazardous areas without the risk of spark and provides high speed network connectivity.
- (6) Alternatives to hardwiring of systems may be considered, but only if necessary. These shall comply with the EN 54 standard.
- (7) Cables only enter panels from the bottom, never from the top.
- (8) Where the wiring enters control panels, etc., the wires of each conduit / cable are neatly and carefully bunched together and secured by means of plastic cable straps.
- (9) Saddles are positioned at intervals no greater than 1000 mm. All cables are armoured when not running inside conduit.
- (10) All cables are colour coded or numbered consistently and continuously throughout the work.
- (11) Painting of conductors is not acceptable under any circumstances.
- (12) Cable spacing is maintained by cable ties accepted by the *Project Manager*, every 300 mm in horizontal and vertical runs of trays.
- (13) Single cables run from a tray follow the building or structure members and are supported every 300 mm. Where necessary additional steel angles or channels are installed to support the cables.
- (14) Cables are installed with radii of bends not less than the minimum recommended by the cable manufacturer or eight times the outer diameter, whichever is the larger.
- (15) Trailing cables may be installed with radii of bends not less than eight times the outer diameter of the cables.
- (16) When cables are installed in positions exposed to areas with pedestrian traffic, vehicle traffic or maintenance activities, and could be subject to damage, they are provided with mechanical protection in the zone from floor or ground level to three metres above the floor.
- (17) All cables are installed in locations remote from sources of heat. Where, out of necessity, cables are installed in the vicinity of radiated heat source, they are adequately protected by a heat resistant barrier and are of a heat resistant type approved by the *Project Manager*.
- (18) All debris and foreign matter is removed from the cable trays and trenches prior to installation of the cables, and on completion of the work, the Contractor thoroughly checks all cable trays and trenches and again removes all accumulated dirt and debris. On completion of the cable



- installation, the Contractor ensures that all covers are in place on the trenches and trays where applicable.
- (19) During installation of the cables, extreme care is exercised to avoid kinking or bending which may damage the cable insulation or sheath. Cables that are accidentally damaged during installation are repaired or replaced to the satisfaction of the *Project Manager*. In no case is a cable, on which the outer sheath has been punctured, installed.
  - (20) Signal and control cables are not laid until the cables are safe from damage that may be caused by construction operations.
  - (21) All conductors on vertical runs of cable tray are supported independently of the terminal connections.
  - (22) Cables are installed in the trays in logical order such that they will lie flat on the tray with no crossovers.
  - (23) Cables entering or leaving a tray are routed to prevent possible mechanical damage due to abrasion.
  - (24) The Contractor is responsible for storage of all cables and suitably protects it from weather and damage during storage and handling.
  - (25)
  - (26) Wiring is multi-core and conforms to SABS 1411 (1996) and SABS 1574 (1992)
  - (27) Use can be made from the existing cabling. Any additional cabling required is included in the prices.
  - (28) The number of cables in any one conduit does not exceed the number permitted by the SABS Code of Practice 0142.
  - (29) Where the wiring enters control panels, etc., the wires of each conduit / cable are neatly and carefully bunched together and secured by means of plastic cable straps.
  - (30) All cables are colour coded or numbered consistently and continuously throughout the work.
  - (31) Painting of conductors is not acceptable under any circumstances.
  - (32) Cable spacing is maintained by cable ties accepted by the *Project Manager*, every 300 mm in horizontal and vertical runs of trays.
  - (33) Single cables run from a tray follow the building or structure members and are supported every 300 mm. Where necessary additional steel angles or channels are installed to support the cables.
  - (34) When cables are installed in positions exposed to areas with pedestrian traffic, vehicle traffic or maintenance activities, and could be subject to damage, they are provided with mechanical protection in the zone from floor or ground level to three metres above the floor.
  - (35) And again removes all accumulated dirt and debris. On completion of the cable installation, the Contractor ensures that all covers are in place on the trenches and trays where applicable.
  - (36) During installation of the cables, extreme care is exercised to avoid kinking or bending which may damage the cable insulation or sheath. Cables that are accidentally damaged during installation are repaired or replaced to the satisfaction of the *Project Manager*. In no case is a cable, on which the outer sheath has been punctured, installed.
  - (37) Signal and control cables are not laid until the cables are safe from damage that may be caused by construction operations.
  - (38) All conductors on vertical runs of cable tray are supported independently of the terminal connections.
  - (39) Cables are installed in the trays in logical order such that they will lie flat on the tray with no crossovers.
  - (40) Cables entering or leaving a tray are routed to prevent possible mechanical damage due to abrasion.
  - (41) The Contractor is responsible for storage of all cables and suitably protects it from weather and damage during storage and handling.

## **Cable Routing**

- (1) Low voltage cables (less than 50 V) in conduits are separated from circuits of higher voltages. These are not run in the same conduit.
- (2) Signal cables parallel to any power cables are routed at least 1000 mm from such power cables in the plant and cross the power cables at right angles where necessary.

## **Cable Termination**

- (1) Cable ends are properly crimped with pin lugs and securely connected in terminal blocks.
- (2) Solder less crimping lugs are used.
- (3) The terminals used in junction boxes are of non-brittle plastic,
- (4) Only compression glands to suit the cable and boxes are used. Termination of armoured cable in all power and control equipment is made in IP21 armoured cable glands.

## **Panel Wiring**

- (1) Crimping connector size is determined by the wire size.
- (2) Every wire is identified by numbered at each end.
- (3) All panel wiring is neatly laid in trucking to a maximum capacity of 80% of trimming capacity.
- (4) All exposed wiring is neatly looped in accordance with accepted practice.
- (5) Terminals are of the Clip-on polyamide feed through type or equivalent approved by the *Project Manager*.
- (6) Each terminal has a space for numbering.
- (7) Connection is made to terminal strips on one side only, leaving the other side clear for field connections.
- (8) Not more than one wire is connected to one side of any terminal.
- (9) Wiring passing through a terminal carries a terminal number on both ends.

## 10 List of drawings

### 10.1 6.1 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

## 7 Appendices

### 7.1 Appendix A Environmental Management Policy

### 7.2 Appendix B ENV0005- Procedure for waste management



Microsoft Word  
Document

### 7.3 Appendix C Supplier Contract Quality Requirement



QM-58 Supplier  
Contract Quality Requi

### 7.4 Appendix D Access Control Visitors Appointment



Access Control  
Visitors Appointment (

### 7.5 Appendix E AKZ Plant labelling standard



Microsoft Word  
97-2003 Document

### 7.6 Appendix F SHE Requirements



32-726 (0) SHE  
Requirements for the