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Compiled by	Functional Responsibility	Authorized by
H Khorommbi	**T Mbulawa**	**G Olukune**
Auxiliary Engineer	**Auxiliary Engineering Manager**	**Engineering Manager**
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1. INTRODUCTION

This document specifies and describes the supplies, services and engineering, and construction *Works* which are to be provided and any other requirements and constraints relating to the manner in which the Kusile Power Station Unit 1 to 6 Condensate Extraction Pump (CEP) Variable Speed Drives (VSD) room modification contract is to be performed.

Unit 1 to 6 CEP VSD rooms are identical and situated adjacent the condensate pump auxiliary rooms and mostly covered in shade by the surrounding buildings and the overhead air-cooled water condensation system. Each CEP VSD room has a floor area of approximately 28.29m^2, and 4.75m high. Each building consists of a grille with a filter on the inside, a roller-shutter door, and a steel personnel door. Each CEP VSD room is constructed on a concrete slab, with face brick walls and are covered with a concrete slab on the roof.

The CEP VSD installed on each room is an ABB variable speed drive unit that is rated at 2500 kVA, with a typical efficiency of 97%. The anticipated heat loads to be generated by a 2500 kVA VSD is estimated to be 75 kW.

The current Unit 1 to 6 CEP VSD room ventilation (extraction/exhaust) system is not adequate to keep the room temperatures below 40°C when ambient exceed 35°C and this has resulted to VSD failures due to high room temperatures. High ash content prevalence onsite causes filter to be often clogged resulting limited room air flow, which increases room temperatures above 40°C.

The CEP VSD rooms are to be modified to meet the VSD room temperature to 25ºC (± 5ºC) as detailed by requirements of Medium Voltage AC Variable Frequency Drives Standard (240-50237146).

2. SUPPORTING CLAUSES

2.1 SCOPE

The project scope of work focuses on the modification/upgrade of the existing infrastructure and the relevant engineering activities for the services required. The CEP VSD room modification project is limited to Unit 1 to 6 Condensate Extraction Pump (CEP) Variable Speed Drives (VSD) rooms.

2.1.1 Purpose

The purpose of this document is to describe the minimum requirements for engineering, drawings, procurement, manufacture, quality control & assurance, supply, delivery, installation, commissioning, testing, training, and maintenance and handing over of Kusile Power Station Unit 1 to 6 Condensate Extraction Pump (CEP) Variable Speed Drives (VSD) room modification.

2.1.2 Applicability

This document shall apply to Kusile Power Station Unit 1 to 6 Condensate Extraction Pump (CEP) Variable Speed Drives (VSD) room modification.

2.1.3 Effective date

This document will be effective from the date of its authorization.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

2.2.1 Normative

[1] 240-50237146: Medium Voltage AC Variable Frequency Drives Standard

[2] 240-102547991: General Technical Specification for HVAC Systems

[3] 240-70164623: Eskom Heating Ventilation and Air Conditioning (HVAC) Design Guideline

[4] 240-143112846: Heating Ventilation and Air Conditioning System Design Work Instruction

2.2.2 Informative

[5] 240-53665024: Engineering Quality Manual

[6] 240-53114026: Project Engineering Change Management Procedure

[7] 240-53113685: Design Review Procedure

[8] ISO 9001 Quality Management Systems.

[9] 240-53114002 Engineering Change Management Procedure

[10] 240-511486 Documents and Record Management

2.3 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*.
Contractor	Refers to the corporation appointed to perform the engineering, procurement, and construction Works required for the project.
Contractor's Designer	A registered Professional Engineer or Professional Engineering Technologist specialising in and having experience and qualified in the field of applicable engineering appointed by the Contractor
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
Engineering	Refers to the Eskom Engineering team who will perform the reviews and provide technical assistance for the work performed by the appointed *Contractor.*
Heating, Ventilating, and Air Conditioning (HVAC)	Relates to Systems that perform processes designed to regulate the air conditions within buildings for the comfort and safety of occupants. HVAC Systems condition and move air to desired areas of an indoor environment to create and maintain desirable temperature, humidity, ventilation and air purity.

Definition	Description
Interface	Interface in these document means either to hard wired or software interaction between the *Contractor*s 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.
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
System	A set of things working together as parts of a mechanism or network in an organised manner or method such that the requirements of the System are achieved.
The Client	The end user will be Eskom who will be represented by Kusile Power Station throughout the duration of the Project.
Unequipped spare	A functional unit that does not house any electrical components but is intended to be used in future by retrofitting/modifying the functional unit.

2.3.1 Disclosure Classification

Public domain: published in any public forum without constraints (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
ACC	Air Cooled Condenser
AHU	Air Handling Unit
AFS	Air Flow Schematic
ASHRAE	American Society of Heating Refrigeration Air Conditioning Engineers
BMS	Building Management System
BS	British Standard
CA	Corrective Action
CAV	Constant Air Volume Terminals
CBMS	Consolidated Building Management System

Abbreviation	Description
CEP	Condensate Extraction Pump
CIBSE	Chartered Institution of Building Services Engineers
C&I	Control and Instrumentation
CM	Corrective Maintenance
CoE	Centre of Excellence
COP	Coefficient of Performance
CPP	Condensate Polishing Plant
DC	Direct Current
DCS	Distributed Control System
DGN	MicroStation CAD drawing, vector format
DWG	AutoCAD drawing, vector format
DX	Direct Expansion
EFP	Electric Feed Pump
ELL	Equipment Label Lists
FAT	Factory Acceptance Testing
FDCP	Fire Detection Control Panel
FDS	Fire Detection System
FRA	Failure Report Analysis
GA	General Arrangement
HCFC	Hydro chlorofluorocarbon
HBS	Hardware Breakdown Structure
HMI	Human Machine Interface
HVAC	Heating Ventilation and Air Conditioning
ISO	International Organisation for Standardisation
LCC	Life Cycle Cost
LPS	Low Pressure Services
LV	Low Voltage
MCC	Motor Control Centres
MTTF	Mean Time To Failure
MTTR	Mean Time To Repair
MV	Medium Voltage
NKP	National Key Points
O&M	Operating and Maintenance
OEM	Original Equipment Manufacture
OH&S	Occupational Health and Safety
PBS	Plant Break Down Structure
PEC	Professional Engineering Certificate

Abbreviation	Description
PFD	Process Flow Diagram
P&ID	Process & Instrumentation Diagram
PM	Planned Maintenance/Project Manager
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Procedure
RAM	Reliability, Availability and Maintainability
RCM	Reliable Centre Maintenance
RCC	Regional Control Centre
RH	Relative Humidity
SANS	South African National Standards
SAT	Site Acceptance Testing
SLA	Service Level Agreement
SLD	Single Line Diagrams
TBC	To be Confirmed
TBF	Time between failures
V	Voltage
VSD	Variable Speed Drive
WB	Wet Bulb

2.5 ROLES AND RESPONSIBILITIES

Role	Responsibility
Compiler	The document compiler is responsible for ensuring that this document is up-to-date and that this document is not a duplication of an existing documentation, regarding the document's objectives and content
Functional Responsibility	The Functional Responsible Person shall determine if the document is fit for purpose, before the document is submitted for authorisation
Authoriser	The document authoriser is a duly delegated person with the responsibility to review the document for alignment to business strategy, policy, objectives and requirements. He/she shall authorise the release and application of the document
Lead Discipline Engineers and Stakeholders	Provide input and reviews to the document and associated engineering activities
Configuration Management Lead	Is accountable for ensuring that the engineering documentation, engineering systems and databases are correctly configured. As part of this role, the Configuration Practitioner is responsible for the development of the configuration management plan; configuration and management of the PBS and the management of plant item Tags.

2.6 PROCESS FOR MONITORING

The primary process for monitoring will be governed by the Design Review Procedure (240-53113685), this entails assuring that the design achieves the requirements set out in this document. Any changes to this document will be performed as per Project Engineering Change Management Procedure (240-53114026).

2.7 RELATED/SUPPORTING DOCUMENTS

Refer to Section 2.2.1 and 2.2.2.

3. DESCRIPTION OF THE *WORKS*

3.1 SCOPE OF *WORKS*

The HVAC scope of *Works*, as detailed in this specification document, activity schedule and accompanying drawings; comprise of the engineering, the provision of all labour including materials and *Contractor's* equipment, manufacturing, supply, delivery, off-loading, hoisting, erection, testing, balancing and commissioning to serve, guarantee and maintenance after final completion of the air conditioning and ventilation installation.

The engineering, quality control, inspections, plant and material selection, preparation of installation drawings, testing, balancing, commissioning and preparation of operating and maintenance manuals, are to be managed and executed by the *Contactor* in a systematic manner as follows:

a) Detailed Design.
b) Plant and material selection.
c) Installation drawings.
d) Plant installation.
e) Testing, balancing and commissioning Documentation.
f) Quality control.
g) Operating Instruction and Maintenance Manuals; and
h) Inspection Record Cards/Checklists and final hand-over

The Works include the following:

a) Each CEP VSD room is to be serviced by dedicated custom-built Direct Expansion (DX) industrial units and ducted air distribution system to control room temperatures to 25ºC (± 5ºC).
b) Associated Electrical *Works* for new HVAC system.
c) Associated controls and accessories for new HVAC system.
d) Associated Building, Civil and Structural *Works* for HVAC system.
e) Decommissioning and removal of all old equipment to allocated space at Kusile Power Station and make good where required for complete HVAC Works.
f) Re-testing, re-balancing and re-commissioning of the complete HVAC *Works.*
g) Provision of painting and corrosion protection for complete HVAC *Works*
h) Updating of the existing operation & maintenance manuals and provision of new where required
i) Update the plant codification & labelling and provide new where required for the complete *Works*
j) The Contractor makes provision for spares and maintenance support as per the requirements set out in this document.

k) Quality assurance.
l) The Contractor is to execute maintenance and maintenance management under the supervision of Employer for a period of 12 (twelve) months from the date of Taking over of the *Works*. The minimum intervals for the Contractor to be onsite for inspection and maintenance after taking-over of *Works* are to be 3, 6, 9 and 12 months respectively.

The construction of the *Works* will be undertaken while Kusile Power Station remains live during the complete duration of the execution of works. Hence, the installation of new Works is to be carried out in a systematic manner to ensure no loss of services in essential areas can be accommodated at any stage.

3.2 *EMPLOYER*'S OBJECTIVES AND PURPOSE OF THE *WORKS*

The HVAC system is to be upgraded and refurbished to satisfy (need in terms of the functions the system must perform) the following:

a) The HVAC system is to be equipped with air-conditioning systems that will be able to control the ambient conditions according to 25ºC (± 5ºC).
b) The relative humidity is to be controlled at 75% max, with no condensation
c) All rooms are to be maintained under a positive pressure, so as to minimise dust ingress (minimum positive pressure of 5Pa with all doors closed).

The purpose of the *Works* includes the following:

a) To ensure that Power Station 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 building.
g) To interface closely with the Fire Protection/Detection Systems to ensure integrity of fire compartments and fire zones.

4. ENGINEERING AND *CONTRACTOR'S* DESIGN

The complete HVAC system is to be designed in accordance with the requirements of Eskom Heating Ventilation and Air Conditioning (HVAC) Design Guideline (240-70164623) and Heating Ventilation and Air Conditioning System Design Work Instruction (240-143112846).

4.1 EMPLOYER'S FUNCTIONAL SPECIFICATION REQUIREMENTS

The design of the following related HVAC Works is to be provided as follows:

Table 1: Division of Work Schedule

Description of work	Responsible Discipline				
	HVAC *Works* (Excluding Electrical, controls and Building related *Works*)	**HVAC standalone equipment controls**	**Fire Detection Interface**	**HVAC Power Supply and distribution**	**Related Building *Works***
1. Functional Specification	*Employer's* HVAC discipline	*Employer's* HVAC discipline	*Employer's* C&I discipline	*Employer's* Electrical discipline	*Employer's* Civil/Structural discipline
2. Detailed Design	*Contractor's* HVAC discipline	*Contractor's* HVAC discipline	*Contractor's* Electronic/Fire discipline	*Contractor's* Electrical discipline	*Contractor's* Civil/Structural/ Builder's discipline
3. Plant and material selection; installation and as built drawings; Testing, balancing and commissioning Documentation; Operating Instruction and Maintenance Manuals; and Inspection Record Cards/Checklists	*Contractor's* HVAC discipline	*Contractor's* HVAC discipline	*Contractor's* Electronic/Fire discipline	*Contractor's* Electrical discipline	*Contractor's* Civil/Builder's discipline

The details of the *Employer's* designs are provided under plant and material standards and workmanship section below.

The *Employer* provides the following interfaces:

a) Existing HVAC system plant locations and new plant locations
b) Existing HVAC electrical panels. New electrical termination points for new HVAC electrical panels.
c) Existing and new ducting routes
d) Existing fire detection panels

4.2 DESCRIPTION OF EXISTING HVAC SYSTEM

4.2.1 Existing Electrical Equipment Installed

The CEP VSD installed on each room is an ABB variable speed drive unit that is rated at 2500 kVA, with a typical efficiency of 97%. The anticipated heat loads to be generated by a 2500 kVA VSD is estimated to be 75 kW.

4.2.2 Existing Ventilation System

Each CEP VSD room is equipped with 4-off 25% rated ducted exhaust fans which are activated by a thermostat device to start the fans at 36°C & above and switch them off at 28°C & below. Filtered fresh air drawn into each room via wall mounted louvres that are equipped with primary filters.

The ventilation system is designed to maintain the indoor temperature within the specified areas below 40°C, however the system has not been able to control the room temperatures to the desired temperatures and has resulted to high temperatures when ambient exceed 35°C.

4.3 PARTS OF THE *WORKS* WHICH THE *CONTRACTOR* IS TO DESIGN

The CEP VSD room modification project is limited to Unit 1 to 6 Condensate Extraction Pump (CEP) Variable Speed Drives (VSD) rooms. The impacted systems/areas include the following, however not limited to:

a) Heating, Ventilation and Air Conditioning system (HVAC) upgrade/modification.
b) Electrical system modification.
c) Building/Civil and Structural infrastructure modification.
d) C&I system modification.

The plant and material are to be designed and selected with due regard to the installation site conditions, particularly with respect to altitude, ambient temperatures, and atmospheric conditions. The plant and material are to be selected to operate within the limits recommended by the manufacturers and where equipment will be required to operate at conditions deviating from the manufacturer's standard selection tables; re-rating is to be done strictly in accordance with the manufacturer's selection procedures.

The contractor's design is to comprise detailed design package (detailing the selection of the equipment) which will be reviewed and approved in accordance with Employer's design review procedure 240-53113685. The *Contractor's* designer is to issue Professional Engineering Certificate (PEC) in terms of the Construction Regulations, Occupational Health and Safety Act, 1993 for the complete HVAC *Works,* stating that the installation has been carried out in accordance with applicable standards.

The design data specified in this specification 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 complete *Works* as dimension accuracy remains the responsibility of the *Contractor*.

The *Contractor* is to design, produce required drawings and select plant & material which satisfies:

a) The overall plant performance and efficiency specification.
b) The specified reliability; and keep maintenance costs to a minimum.
c) Local and statutory authorities and construction requirements.
d) Space constraints; and
e) Local content

Contractor produces self-explanatory operating and maintenance manuals suitable for staff training. The Operating and maintenance manuals are to include the following however not limited to:

a) Description of the complete HVAC system
b) Operating, control and maintenance philosophies
c) As Built drawings & Commissioning Results

The *Contractor* is to execute the following:

a) Detailed design

b) Plant and material acceptance testing
c) Testing and commissioning
d) Training of operators
e) Training of maintenance personal
f) Training of engineering personal
g) Troubleshooting
h) Implementation of an overall quality assurance plan

The *Contractor* is responsible for the detailed design of the *Works* below and that such designs are submitted to the *Employer* for approval prior to procurement and manufacture of any plant and material.

The complete HVAC design is to be flexible to future growth and allow modular growth. 10% future growth has been built into the heat loads and selection of the equipment.

The complete HVAC system is to be designed and configured to allow ease of access for service and maintenance. Sufficient access space has to be allowed for, between the HVAC equipment for operation and maintenance purposes.

4.3.1 Investigation, Survey and Site Clearance

The design data specified in this specification 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 *Works* as dimension accuracy remains the responsibility of the *Contractor*.

4.3.2 Outdoor Design Conditions

The outdoor design conditions for HVAC are based on the Weather Bureau data. The mean maximum temperature (DB) for summer and mean minimum temperature for winter is taken as a design condition. The Weather Bureau does not list temperature and associated relative humidity (RH) as one set of data. The Kusile Power Station in the Mpumalanga climate conditions are as follows:

a) Summer: Ambient Temperature = 33ºC DB 20ºC WB.
b) Winter: Ambient Temperature = 0ºC DB -2ºC WB.
c) Site elevation: 1545 m above sea level.

4.3.3 Indoor Design Conditions

The HVAC system is to maintain indoor conditions as detailed by the table below 24hours, 7 days a week, and 365 days per year.

Table 2: Indoor conditions

Description	Indoor Temperatures	Relative Humidity	Pressurisation Requirements
1. Variable Speed Drives (VSDs)/Variable Frequency Drives (VFDs)	25ºC ± 5ºC	75% max, no condensation	Positive pressure (minimum positive pressure of 5Pa with all doors closed)

4.3.4 HVAC System Design Requirements

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 of the complete HVAC Works.

The *Contractor* is to submit the detail design for the HVAC scope for acceptance. Employer's HVAC department to review the designs submitted by the *Contractor* and sign it off for acceptance.

The complete HVAC performance figures obtained during testing and commissioning must be within a range of ±5% of the specified figures given during *Contractor* design, plant and material selection phase.

The *Contractor* is to issue HVAC Certificates of Compliance (COCs).

The system is to consist of DX industrial air conditioning units that are to service the various areas. The system configuration is envisaged to be as follows:

Table 3: Direct Expansion (DX) Industrial Units Configuration

HVAC System component	Running Units Only	Running + Standby Units
1. Air Cooled Condensers		✓
2. AHU's equipped with pressurisation		✓
3. Ducted distribution system	✓	
4. Controls		✓
5. Power supply (Essential and Normal Supply)		✓

Proposed HVAC System description as follow:

a) **Air Cooled Condensers:** Heat rejection (condensing) will be accomplished by dedicated air-cooled condensers that shall service the AHUs through refrigerant pipework.
Design: Air Cooled Condenser configuration is designed as running + standby system. The system however has a single point of failure in terms of refrigerant pipework.

b) **Air handling units with pressurisation:** The room is to be served by a ducted AHUs to provide the required cooling in each substation.
Design: AHU units are designed as running + standby system.

c) **Ducted distribution system:** All substations are to be served by externally insulated supply air ductwork complete with air terminals and fire dampers where required.
Design: The complete ductwork is designed as running service.

d) **Power supplies:** The complete HVAC system is to be provided with 1 x power distribution board/switchgear panel fed by 1 x set of power cables (single feed). The power distribution board/switchgear panel is to be serviced by essential and normal power supplies with source selected upstream at the mains power supply.
Design: Power distribution board and power supplies are designed running + standby system.

e) **Controls:** Purpose made central control or monitoring system will be installed in the building. Each air-cooled condenser and AHU can also be manually overridden if a controller fails. Independent controls provide a better reliability, and by default do not have a single point of failure.
Design: Controls are designed as running + standby system.

The 2-off exhaust fans located on the northern side of the room are to be replaced with 2-off custom built DX industrial air conditioning units (duty & standby) on each CEP VSD Room. The other 2-off exhaust fans are to be retained and be utilised for smoke extraction purposes. The fresh air intake louvres are to be removed and bricked-up, section of the opening to be used for ducted return purposes back to the new air conditioning units.

Each custom-built DX industrial air conditioning unit is to be equipped with post evaporator primary washable and secondary bag filters; as well as pre condenser section primary washable filters.

The main HVAC equipment details for each CEP VSD Room have been selected as follows:

Table 4: Ducted Type Direct Expansion (DX) Built-up Units

Area	Unit Nominal Cooling Capacity each (kW)	Number Required (duty & standby)	Power Source (50Hz)	Estimated Weight of equipment (kg)
1. Unit 1 CEP VSD Room	105	2	380V/3ph/60kW (each)	1500
2. Unit 2 CEP VSD Room	105	2	380V/3ph/60kW (each)	1500
3. Unit 3 CEP VSD Room	105	2	380V/3ph/60kW (each)	1500
4. Unit 4 CEP VSD Room	105	2	380V/3ph/60kW (each)	1500
5. Unit 5 CEP VSD Room	105	2	380V/3ph/60kW (each)	1500
6. Unit 6 CEP VSD Room	105	2	380V/3ph/60kW (each)	1500

4.3.4.1 DX System Cooling Plant

Each CEP VSD room is to be equipped with running and standby DX ducted type Air Handling Units (AHUs) together with matching air-cooled outdoor units. The HVAC equipment is to be configured to operate on running and standby mode for redundancy, including automatic change over between the units in case of failure of any one unit and at pre-set intervals to allow equal running time between the units.

The units are to have a cooling only mode of operation and are to provide cooling 24 hours a day, seven day a week throughout the year.

Each Air Handling Unit (AHU) is to comprise of the following:

a) Fresh air and return air dampers
b) Axial return air fan
c) Mixing plenum
d) Washable primary air filters
e) Disposable secondary (bag type) air filters (to 85% Dust Spot Efficiency - EU7)
f) Differential pressure gauges for filtration System
g) Belt driven centrifugal supply air fan.
h) Sound attenuators (external to AHU's)
i) Externally insulated supply air ducting
j) Drainpipe to a suitable drain point

The condenser section is to be equipped with direct driven centrifugal condenser fans to enable heat rejection exhaust to outside the HVAC plant rooms. The refrigerant circuit is to be equipped with compressors, high and pressure switch, access valves, 4-way valves, filter drier, electronic expansion valve, strainer, accumulator, solenoid valve, bypass capillary tube, evaporator and condenser coils, check vales, compensator and capillary tube.

4.3.4.2 DX System Fresh Air and Air Distribution Ducting Network

Filtered and conditioned air is to be supplied from the AHUs to the different spaces via externally insulated ducting and matching air terminals. The air is to be returned to the unit via return air ductwork.

Fresh air is to be provided to various rooms via the fresh air intake of the custom-built DX unit, supplying 10% fresh air to the return air side. The custom-built DX unit fresh air intake side is to be equipped unit and be fitted with washable primary air filters and disposable secondary (bag type) air filters (to 85% Dust Spot Efficiency - EU7).

4.3.4.3 Extraction Ventilation System

2-off existing ducted exhaust fans are to be retained and be utilised for smoke extraction purposes. In the event of a fire break out, the fire detection system is to send a signal to the HVAC system controllers to indicate that there is a fire in a specific zone; the HVAC controllers are to automatically stop the HVAC system supply serving the respective areas; and start the smoke extraction fans to exhaust the smoke out.

4.3.4.4 HVAC system controls

The HVAC equipment in each CEP VSD room is to be configured to operate on running and standby mode for redundancy including automatic change over between the units in case of failure of any one unit and at pre-set intervals to allow equal running time between the units. The provision of standby units will allow hot maintenance to be carried out on the main plant whenever required and manual override switch will also be installed to have any HVAC equipment switched on/off by maintenance when required.

The 2-off DX industrial air conditioning units in each room is to be programmed to provide cooling when the CEP VSD room temperatures rise above 25°C and cool down the room until a room set point of 22°C & below is reached. The two units in each room is to be linked to a common controller and are to be further programmed such that should the switchgear room temperatures rise above 28°C or should a fault occur on the running unit, the controller will automatically start the standby unit.

The complete HVAC system is to be interfaced to the fire detection system. In the event of a fire break out, the fire detection system is to send a signal to the HVAC system controllers to indicate that there is a fire in a specific zone; the HVAC controllers are to automatically stop the HVAC system supply serving the respective areas; and start the smoke extraction fans to exhaust the smoke out. The HVAC system is to automatically return to normal operation once the fire alarm signal to the ventilation system switchboard is cleared.

The control system will be able to generate alarms that will be routed to future Central Building Management System (CBMS) for monitoring purposes.

4.3.5 Electrical System Design Requirements

The *Contractor* is to specify the power requirements for the HVAC to provided and installed. The load schedule template (240-56227927) provided is to be utilized to specify the power requirement.

The *Contractor* is to size, supply, pull, terminate and safety clear the cables from source to destination (primary cabling). Furthermore, verify the adequacy of the supply switchgear as per the drawings issued by *Employer*.

The *Contractor* is to design, supply, pull and terminate any secondary cabling, that is all interfacing cabling between the *Contractor's* provided equipment.

The *Contractor* is to be responsible for any additional primary racking as well as all the secondary racking associated with the *Works*. The *Contractor* is to comply with the Eskom Cabling and Racking Standard 240-56227443. for all *Works* associated with cabling and racking.

The *Contractor* is to be responsible for all connections to the earth mat. The connection points to the earth mat shall be advised by the *Employer*. The *Contractor* is to comply with Eskom Earthing and Lightning Standard 240-56356396 for all *Works* associated with earthing. The *Contractor* is to supply all consumable materials associated with the electrical *Works*, including all the cabling, and earthing material.

The *Contractor* is to design, supply, install and safety clear any required secondary LV switchgear and control gear. Supply to the HVAC Units is to be redundant (running and standby).

The *Works* are to fully comply to Eskom standard specification 240-56227516 (LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V), SANS 10142-1 (The wiring of premises Part 1: Low-voltage installations) and IEC 60947-4-1 — Low voltage switchgear and control gear — Part 4-1: Contactors and motor-starters — Electromechanical contactors and motor-starters.

The *Contractor* is to issue electrical Certificates of Compliance (COCs).

The available boards to supply the new HVAC system are the unitised CPP Board 1 and the unitised Air Conditioning Board. The 400V CPP Board 1 is fed from the 400V Unit Turbine Board 1, and the Air Conditioning Board is fed from the 15kV Unit Board 1 via 15/0.4kV, 2 MVA transformer. See drawing number 0.90/13, sheet 7, rev 1: Unit 1 MV and LV Single Line Diagram. Both electrical board panels from the CPP and Aircon Board are to supply both HVAC DX Units simultaneously.

The currently used power supplies for two of the CEP rooms northern side fans are to be decommissioned and kept as spares whilst the two southern side fans are to be kept operational for smoke extraction purposes as detailed by HVAC system design section above.

The new CEP VSD Room HVAC electrical panel in each area is to feed power to each Direct Expansion (DX) HVAC Units supplies via two cables. The electrical panel is to be fed from the 400V CPP Board and to the 400V Air Conditioning using cables capable of supplying the power requirements for one Direct Expansion HVAC Units at a time as well as the control requirements as indicated by typical figure below.

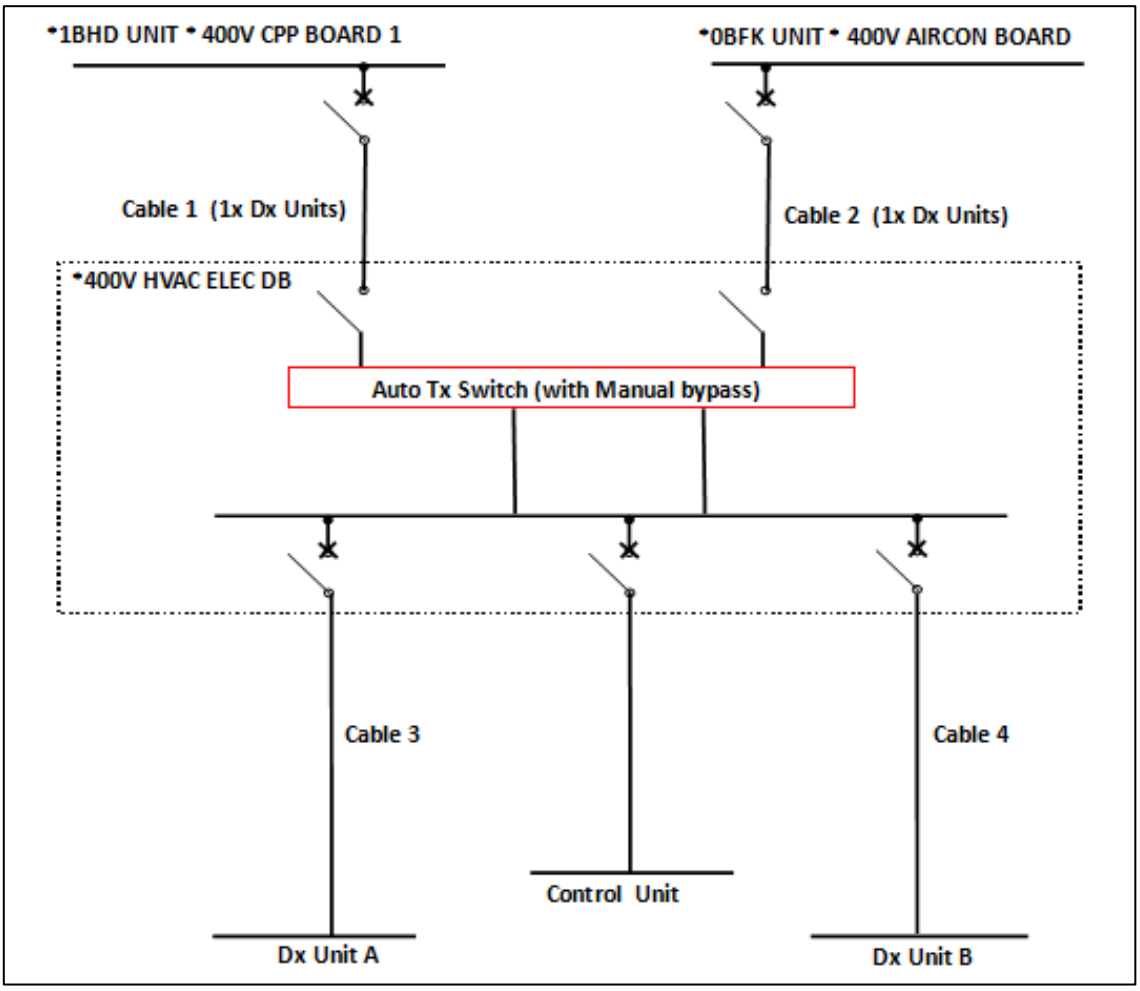

Figure 1: 400V Power Supply Concept for HVAC System

4.3.6 Control and Instrumentation Design Requirements

The new HVAC system is to be interfaced to the fire detection system. In the event of a fire break out, the fire detection system is to send a signal to the HVAC controllers to indicate that there is a fire in a specific zone; the HVAC controllers are to automatically stop the HVAC system serving the respective areas and close all fire dampers to that specific area. After the fire has been extinguished, smoke evacuates by a manually operated switch in a break glass box positioned on each zone which re-opens fire dampers, re-starts extraction fans and over-ride damper control, closing return air dampers and opening exhaust dampers in the air conditioning plant rooms. The HVAC system is to automatically return to normal operation once the fire alarm signal to the air conditioning switchboard is cleared.

The interface between the fire detection and HVAC systems is to be implemented at the controller level between the Fire Detection Control Panel (FDCP) and the HVAC Controllers. The HVAC controller interface with the fire system is to be via potential free normally closed contacts, receiving signal from fire panels via hard wired links. The HVAC control system should have capability to communicate with the standard HVAC equipment supplied, so that the sub-system can be tested, logged, stopped, started, load-shed, reset temperature and commanded at the central operator's terminal and locally, so as to manage the relevant sub-systems in terms of operation, energy and maintenance.

The HVAC controllers and associated instruments, if not contained within temperature and humidity-controlled environments, will be suitable for the environmental conditions prevailing at Kusile Power Station, without any negative impact on the performance, reliability, availability or life expectancy of the equipment. All equipment will also be provided with the appropriate level of ingress protection for the environment in which they are installed.

The HVAC controller is to be able to provide the following status, measurements, and control locally and from the CBMS system:

a) Power supply status and measurements and alarming
b) Fire damper test control
c) Fire damper position
d) HVAC system mode status and control
e) Air flow monitoring
f) Room temperature measurement and alarming
g) Room humidity measurement and alarming
h) Room pressure measurement and alarming
i) Air filter differential pressure measurement and alarming

The HVAC controller is to be ready to transfer status and measurement data to CBMS and DCS systems interfaces. The controller is to be configurable from a personal computer interface for potential future expansions or control philosophy changes. All process information operator actions and alarms are to be archived in the HVAC historian. All interfaces to fire detection and CBMS are on existing interfaces of the Kusile Power station fire detection and CBMS systems.

The *Contractor* is to be responsible to interface the HVAC Controllers to the CBMS which is supplied by others. The *Contractor* is to use approved P&ID and AFS drawings to complete 5 x C&I schedules per building as follows:

a) Alarm list
b) Cable schedules
c) Driver and actuator schedule
d) Virtual signal list
e) Instrument schedule

All HVAC Controller related documents, drawings and schedules are required to be fully KKS coded to Level 3. This 3rd level coding of the HVAC Controller is required to complete the 5 x C&I schedules noted above. *Contractor* to ensure that the Single Line Diagrams (SLD's) are updated to reflect the as-built panels in accordance with the specification before being sent to *Employer's* Configuration for KKS coding. Once documents are approved it is the *Contractor's* responsibility to physically label (KKS code) the HVAC Controller internal components.

The *Contractor* is to apply for *Employer* to inspect and sign off all labelling. The completed 5 x C&I schedules per building must be submitted to *Employer's* Configuration Team for KKS coding of the soft signals and alarms.

4.3.6.1 Alarm Schedule

Alarm rationalisation will be the combined responsibility of *Eskom* Engineering and the *Contractor's* designer. The *Contractor's* designer will review the Alarm and Virtual Signal Schedule submissions primarily for completeness of alarms, alarm priorities and rationalisation.

4.3.6.2 Cable Schedule

Cables are all must be coded as cable schedules contains connection details.

4.3.6.3 Driver and Actuator Schedule

Driver and actuator schedules are to include the following, however not limited to:

a) Fan motors
b) Actuated Dampers

4.3.6.4 Virtual Signal List

All monitoring and control signals must be listed.

4.3.6.5 Instrument Schedule

All instruments on AFS and P&IDs are to be listed.

4.3.7 Civil, Structural and Building Works Design Requirements

The *Works* include the design, supply and construction of all Building, Civil and Structural scope described in this specification. The Building, Civil and Structural related scope is detailed below:

a) Design and install a single tier High Security Mesh Fence around the perimeter of the DX plant yards. The fence panels are to be at least 3000mm wide and 2400mm high (above ground level), with 4mm diameter high tensile wires and aperture size, 76.2mm x 12.7mm (centres). The fence posts are to be supported on reinforced concrete footings. A manual lockable swing access gate is to be provided at the entry point to the plant. The gate is to have aperture size: 76.2mm x 12.7mm (centres).

b) Design and construct support plinths for the DX industrial air conditioning units.

c) Provide 2-off supply (1000 x 800mm) and 1-off return (600x1200mm) air openings for each area on CEP room walls at all units to accommodate HVAC ducting.

d) 1-off 600x1200 mm opening is to be provided in each area on the wall separating the CEP and VSD area for pressure relief purposes.

e) Modify two installed single push bar doors to auto-close to maintain positive pressure within the room areas. Seal around roller shutter door.

f) Remove installed fresh air grille/steel louver and seal wall openings at each of the room areas.

g) Seal the CEP VSD room in order to prevent dust ingress and air losses (to preserve positive pressure within the room), this includes but not limited to the access doors, piping and ducting entry points and drain points within the VSD room.

h) Issue a Professional Engineering Certificate (PEC) in terms of the Construction Regulations, 2014, Occupational Health and Safety Act, 1993, for the completed Works.

4.4 HVAC PLANT AND MATERIAL SELECTION

The complete HVAC system is to be procured, manufactured, supplied, delivered, installed, commissioned, and tested in accordance with the requirements of Eskom General Technical Specification for HVAC Systems (240-102547991).

4.5 PROCEDURE FOR SUBMISSION AND ACCEPTANCE OF *CONTACTOR'S* DESIGN

The procedure for submission and acceptance of *Contractor's* Design is detailed under section 7.5 of the specification.

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

a) Detailed design report, including detailed calculations such as hydraulic and pipe stress analysis (where required), pipe supports, plinths, handers and racks.
b) Documents including equipment data sheets and specification for selected equipment, electrical cabling and other associated equipment.
c) 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 drawings are to have at least a plan and two different elevations or sections giving overall dimensions.
d) Dimensioned shop drawings showing proposed method of fixing of all the plant and equipment
e) Detailed electrical wiring diagrams including schematic 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 specification and literature for all items of equipment that forms part of the complete installation
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 *Works* for complete *Works* including detailed design calculations and construction drawings. All building works calculations and analysis models to be submitted in native format as wall is in doc/pdf format as part of the detailed design report.
l) Detailed maintenance, reliability, control and operating philosophies
m) Testing, balancing and commissioning procedures
n) Plant and material acceptance testing
o) Detailed operation & maintenance manuals with As-Built drawings & Commissioning Results
p) Plant codification lists for each section of the *Works*
q) Construction competition reviews
r) Acceptance testing reviews
s) Quality assurance reports
t) Close out reports

4.6 OTHER REQUIREMENTS OF THE *CONTRACTOR'S* DESIGN

The *Contractor* is to comply with all legislated safety requirements as well as *Employer's* health and safety standards.

The decommissioning, removal of all redundant equipment and making good where required is to include the following, however not limited to:

a) The *Contractor* is responsible for decommissioning, dismantling, removal, lifting, transport and storing (including making good thereof) of existing redundant or retired equipment to the allocated space provided by the *Employer.*

b) The scrapping of the existing equipment to the nearest scrapyard outside of Kusile Power Station will be the responsibility of the *Employer*. The responsibility of the *Contractor* is the removal of existing equipment, storing it and making good thereof.

The term "making good" refers to the following, however not limited to:

a) All areas where old plant or material is removed on the plant are made neat by means of closing of holes, grinding of old anchor points and welding, repainting and resurfacing.

b) The interface point between the new system and existing plant or material is made neat and functional to prevent weak points in the final delivered product e.g., the fixing of brackets and supports of interface boxes, covers, locking nuts etc.

The *Contractor* provides all scaffolding, crane, transport, etc necessary for decommissioning, dismantling, removal, lifting, transport and storing of existing redundant or retired equipment to the allocated space provided by the Employer; and scraping thereof.

The *Contractor* provides dust sheets and everything necessary for clearing and removal of all rubble due to the work, for the protection of the work from damage due to the operations. Contractor is to take adequate precautions to the satisfaction of the Employer to prevent damage to existing apparatus during erection operations.

The retired HVAC equipment is to be decommissioned and dismantled according to the manufactures' instructions and the relevant codes & standards. The retired HVAC equipment containing a refrigerant is to be pumped down of both refrigerant & oil and should be labelled as containing no refrigerant as soon as it's been decommissioned, dismantled and stored away.

Items to be removed are marked clearly before decommissioning start in order to avoid the removal of incorrect plant or material.

All existing plant that is removed is deemed re-usable and remains the property of the *Employer*.

Decommissioning and dismantling of retired HVAC equipment that maybe required for future use should include the following however not limited to:

a) Disconnection of power supply and making safe thereof.

b) Safe dismantling of the existing machines and the safe removal from site to the allocated storage area provided by *Employer*.

4.7 DESIGN OF EQUIPMENT

The minimum general HVAC 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 at least 15 years for DX Systems; under the conditions prevailing at Kusile Power Station, in Mpumalanga.
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 is 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, the information stated in the data sheets is to be fully complied with through the installation, unless otherwise agreed upon by both *Eskom* & *Contractor* in writing.

4.8 EQUIPMENT REQUIRED TO BE INCLUDED IN THE WORKS

The *Contractor* is required to provide lifting facilities and other equipment required for the execution of the complete *Works.*

4.9 AS-BUILT DRAWINGS, OPERATING MANUALS AND MAINTENANCE SCHEDULES

The importance of managing the "as-built", “operate-to” and the “maintain-to” operation and maintenance manuals including maintenance schedules for each piece of equipment is critical to the life of the plant. The operating & maintenance manuals are to be detailed enough to operate, maintain, dismantle, reassemble, adjust, and repair plant & equipment.

4.9.1 As-built Drawings

The *Contractor* is to provide “As Built” drawings based on the shop drawings embodying all modifications made during construction. The “As Built” drawings are to include general arrangement and sections of all plant and equipment including isometrics and P&ID’s or PFD’s. Safety, instrumentation, control and operation drawings are to also be included “As Built” drawings indicating the intended functioning, capacity data and control functioning of all Systems.

The As Built drawing is to indicate all relevant plant coding and labelling. The determination of these codes and labels are to be done in accordance with the documents listed in this Technical Specification.

Two hard copies and one soft copy (submitted in native format DGN) of “As Built” drawings are to be submitted to the Employer for approval.

4.9.2 Operating Manuals and Maintenance schedules

The Operating & Maintenance Manual must describe how the facility is to be operated and by whom, as well as the desired level of training and orientation required for the building occupants.

The operation and maintenance manuals are to consist of the following as the minimum:

a) List of Contents (Index)

b) Introduction

c) General description of the functions of each of the Systems including detailed description of each element of each System, how it functions, how it operates and how to maintain it and what attic stock or tools to carry.

d) Full as-built drawings and detailed drawings, brochures and catalogues for each System and each element of each System.

e) The format of the O&M documentation is to be A4 and is to be a specially bound document with hard cover and with metal ring binding. (All drawings folded into A4 format.)

f) The names, addresses and telephone/fax numbers/email addresses of all responsible persons and manufacturers/suppliers are to be listed in the O&M document.

g) A full list with reference numbers are to be included to enable the *Employers* O&M staff to order materials and equipment.

h) Colour diagrams are be provided to illustrate the operation and function of each System with reference to the relevant as-built drawings or brochures of equipment. These diagrammatic drawings are to also indicate the locations of valves with their numbers.

5. PROCUREMENT

5.1 PLANT AND MATERIAL

5.1.1 Quality

The *Contractor* is not use Plant or Materials which are generally recognised as being unsuitable or otherwise to be avoided for the purpose for which they are intended.

Only components of high reliability are to be utilised, with a proven operating history, to enable the Plant to achieve required reliability and availability. Plant and Material design, engineering and manufacture to accord with the best modern practice applicable to high-grade products of the type to be furnished, so as to ensure the efficiency and reliability of the *Works* and the strength and suitability of the various parts for the *Works*.

Plant and Materials withstands ambient conditions and the variations of temperature arising under working conditions without distortion, deterioration or undue strains in any part.

All parts are made accurately, and where practicable, to standard gauges so as to facilitate replacement and repairs. Like parts are interchangeable.

No repair of defective Plant and/or Materials are to be permitted without the *Employer's* approval and any such repair, if approved, are to be carried out to the satisfaction of the *Employer*.

The *Employer* is free to specify hold and witness points during the installation and on-site testing stages of the project. The *Contractor* issues preliminary notification of such hold and witness points as per agreed schedule to the *Employer* and confirms such hold and witness points at least seven working days prior to the activity.

Typical hold points are listed below:

a) Design Review
b) Factory Acceptance Test
c) Delivery to Site

d) Erection
e) Site Acceptance Test
f) All manuals and drawings (in the specified format)
g) Commissioning

In addition to maintaining appropriate inspection and test records to substantiate conformance to requirements, the following records are safely stored for a minimum period of seven (7) years following the final completion of the *Works*:

a) Construction, layout and component approvals
b) Type and routine test certificates
c) Construction drawings and approvals

After this period, the *Contractor* offers these records to the *Employer* (in writing) and obtains a disposal instruction.

Documentation regarding quality procedures is submitted as per agreed schedule after Contract Award. The *Employer* is review and comment on the acceptability of these documents in a time frame as per the requirements of the contract for contractual correspondence. If controlled copies of these documents have been submitted to the *Employer*, then the controlled copy numbers may be quoted in the submission.

5.1.2 Plant & Materials Provided "free issue" by the *Employer*

None.

5.1.3 *Contractor's* Procurement of Plant and Materials

The *Contractor* is to take all necessary steps to ensure that all Plants and Materials are adequately protected against damage during shipping, transport and storage.

5.1.4 Spares and Consumables

The *Contractor* provides as part of the operating & maintenance manual, a recommended parts list as well as a proposal for the execution thereof:

a) The *Employer* is responsible for procurement of recommended spares.
b) The *Contractor* is responsible for ensuring that consignment spares are available in time of need.

Each recommended spare part is to be uniquely identified with a part number, which can be cross referenced to a part list and associated drawing. The *Employer* prefers that support from the Original Equipment Manufacturer (OEM) is available locally in South Africa.

5.2 TESTS AND INSPECTION BEFORE DELIVERY

The *Employer* carries out quality inspections at own discretion. The *Employer* is to inspect and approve stages of manufacture of all equipment necessary to ensure the correct quality of equipment as prescribed in the approved project quality plan.

All inspections and testing to be performed in accordance with the Quality Control Procedure (QCP) developed by the *Contractor* after approval by the *Employer*.

The *Contractor* is to provide facilities for inspection of all items of equipment at the place of the manufacture and this requirement is to be extended to all *Sub-contractors* and suppliers. All material

labour or assistance, tools, gauges, articles or apparatus that the *Employer* may require for the purpose of testing, gauging and inspection, are to be provided by the *Contractor*. The *Contractor* is to provide all such facilities for testing and the contract price is to include for this.

The *Employer* reserves the right to reject items that do not conform to the *Employer's* requirements. When the plant has passed the test referred to in this specification, the *Employer* is to furnish to the *Contractor* a certificate or endorse the *Contractor's* test certificate to that effect. Examination by the *Employer* is not to relieve the *Contractor* from the responsibility of carrying out all tests which may be necessary to ensure the required standard of manufacture or from any obligations in terms of the contract.

The achievement of adequate standards during the tests at the place of manufacture, if performed, is only the first requirement. The final criterion is the performance onsite, and any of the requirements which prove defective due to bad workmanship or material are to be replaced forthwith by the *Contractor* at his/her own cost on the instruction of the *Employer*.

The following tests are conducted by the *Contractor* and are to be witnessed by the *Employer* at the manufacturer's *Works* or *Contractor's* premises as a minimum requirement:

a) Visual inspection of the equipment.
b) Review of the certification requirements.
c) Functional tests of the systems and controls including starting & stopping procedures.
d) Inspection of paint work and corrosion protection.
e) Verification that all components are delivered to the *Contractor's* premises.
f) Verification that all power plugs is correct.
g) Verification that components installed is correct.
h) Verification that all labels are correct.
i) Phase rotation.

5.3 MARKING PLANT AND MATERIAL OUTSIDE THE WORKING AREAS

All Plant and Material paid for by the *Employer* must be clearly labelled as being the *Employer's* property.

5.4 *CONTRACTOR'S* EQUIPMENT (INCLUDING TEMPORARY *WORKS*)

The *Contractor* provides the following in order to complete the *Works*:

a) All scaffolding required.
b) Any equipment necessary to complete the *Works.*
c) Lifting facilities.

The *Contractor* supplies, installs, maintains and removes all temporary construction facilities and utilities necessary to provide the *Works.*

6. CONSTRUCTION

6.1 CONSTRUCTION OF HVAC WORKS

The construction of the new HVAC system is to be undertaken while Kusile Power Station remains live during the complete duration of the execution of works. Hence, the installation of new HVAC system is to be carried out in a systematically manner to ensure no loss of ventilation in essential areas can be accommodated at any stage.

6.2 COMPLETION, TESTING, COMMISSIONING AND CORRECTION OF FAULTS

6.2.1 Work to be done by the Completion Date

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

a) The Plant is erected, and commissioned
b) Signed erection and safety clearance certificates.
c) The final as built drawings have been submitted.
d) 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.
e) The plant and all documentation, drawings are coded and labelled.
f) All special tools have been supplied.

6.2.2 Materials Facilities and Samples for Tests and Inspections

The *Contractor* provides all Materials, facilities and/or samples required for tests and inspections.

The *Employer* reserves the right to call for samples of equipment offered to inspect the workmanship as the work proceeds and either accept or reject the equipment or workmanship. The *Employer's* approval of the design, material and workmanship are to in no way reduce the *Contractor's* liability to provide a complete and proper working plant which is abreast with modern technology.

The *Contractor* must allow for control samples of the following which are to be approved by the *Employer* and are to be held in the site office to establish the quality standards:

a) Control sample of ducting to establish the ductwork quality standard.
b) Control sample of welded, insulated, and cladded piping to establish the pipework quality standard.
c) Air terminals

6.2.3 Commissioning

The complete HVAC system with interfaces are to be commissioned in accordance with the following SANS and Chartered Institution of Building Services Engineers (CIBSE) codes or such other recognized commissioning procedure or code approved by the client:

a) Air distribution systems
    i. SANS 10173: Code of Practice for the Installation, Testing and Balancing of Air Conditioning Ductwork, or
    ii. CIBSE Commissioning Code A: 2006 or latest revision
b) Automatic controls: CIBSE Commissioning Code C: 2001 or latest revision
c) Refrigerating Systems: CIBSE Commissioning Code R: 2002 or latest revision
d) Water Distribution Systems**:** CIBSE Commissioning Code W: 2002 or latest revision

The *Contractor* does comprehensive pre-commissioning, commissioning as well as quality monitoring on all the HVAC and its sub-systems and is to provide a report with the following details.

a) Demonstrate that the services were commissioned in compliance with SANS OR CIBSE Commissioning Codes or ASHRAE Commissioning Guideline for all mechanical services.

b) 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.

c) Include the outcomes and changes made to the building as a result of the commissioning process, accounting for all of the recommendations; and

d) Reference appended extracts of commissioning records for major plant and equipment.

e) Ensures that the correct performance of the equipment, safety of plant and personnel, and compliance with the Technical Information before commissioning of plant commences is achieved.

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 maintenance period commences. Items of equipment which are of a specialist nature e.g. automatic controls etc. are to be commissioned by the manufacturer's representative who instruct the *Employer* on the function and proper operation of the equipment.

6.2.4 Start-up Procedures required to put the Works into Operation

No alterations or adjustments are to be made to the *Works* after functional checks are done without the *Employer's* written permission.

At this stage the following is to be achieved:

a) Installation and pre-commissioning completed.
b) Testing report and the associated certificates received.
c) Signed erection and safety clearance certificates.
d) Final draft of the technical, operating, maintenance manuals delivered.
e) All Quality Control Plan (QCP) documentation received.

6.2.5 Take Over Procedures

The Employer takes over the Works on the date of safety clearance of the HVAC and its sub-systems in accordance with the sectional completion dates of the Accepted Program.

6.2.6 Performance Tests after Completion

All HVAC systems are to be subjected to performance tests under full working conditions as follows:

a) The *Contractor* is to supply the necessary field-testing instruments (thermometers and flow meters etc) and detailed description of field-testing arrangement to prove a capacity/performance measurement accuracy of ± 5% for equipment supplied.

6.2.7 Training and Technology Transfer

After completion of the contract, the *Contractor* is required to provide training and transfer system knowledge to the *Employer* 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 *Employer's* personnel to ensure that they have all the information and understanding needed to operate and maintain the features and systems in the various areas.

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 training is preferable to be offered during the commissioning and testing for a minimum of ten (10) personnel. The *Contractor* is to, prior to handing over of the *Works*, satisfy the *Employer* that maintenance, engineering 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:

a) Information provided in the design intent report (including energy/environmental features)

b) Review of controls set up, programming, alarms and troubleshooting

c) Review of O&M manuals

d) Building operation (start up, normal operation, unoccupied operation, seasonal changeover, shutdown)

e) Measures that can be taken to optimise energy efficiency

f) Occupational health and safety (OH&S) issues

g) Maintenance requirements and sourcing replacements

h) Obtaining and addressing occupant satisfaction feedback

i) Development and creation of HMI mimics, logic and parameters

Steps for conducting On-site Training are to include:

a) Preparation

b) Introduction

c) Explanation

d) Demonstration

e) Practice Under Supervision

f) Conclusion

The operating and maintenance manual are to be available during the training of *Employer's* personnel. *Employer's* personnel are to be made familiar with the contents of that manual.

6.2.8 Operational Maintenance after Completion

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 maintenance period commences. The *Contractor* is to execute maintenance and maintenance management under the supervision of *Employer* for a period of 12 (twelve) months from the date of Taking over of the *Works.*

The *Contractor* is to return to site following the issuing of the Taking over Certificate whenever is required or as defined by the detailed maintenance schedule submitted on Operating & Maintenance manuals. The minimum intervals for the *Contractor* to be onsite for inspection after taking-over of *Works* are to be 3, 6, 9 and 12 months respectively.

A report after each visit is to be submitted to the *Employer* in writing. The *Contractor* is to rectify such items in accordance with the requirements of the conditions of Contract. The *Contractor* is responsible for any faults that may arise during the guarantee and maintenance period and will be called out to repair such faults as required; therefore, it is important that a responsible/contact person and alternatives are to be provided as part of the Operating & Maintenance manual submissions.

The *Contractor* is to make all adjustments necessary for the correct operation of the plant and equipment for a period of 12 (twelve) months after the date of issue of taking-over certificate. The *Contractor* is to make good any faults due to inferior material or workmanship that may arise during this period. If during this period, the plant is not in working order for any reason for which the *Contractor* can be held responsible or if the plant develops faults, the *Contractor* will be notified, and immediate steps are to be taken by him to remedy the faults or to make any adjustments required. Should such faults occur so frequent as to become objectionable or should the equipment otherwise prove unsatisfactory during the above-mentioned period, the *Contractor*, if called upon by the *Employer*, is to replace at his/her own expense the whole or such parts thereof as the *Employer* may deem necessary, with apparatus to be specified by the *Employer*.

Final acceptance is to be taken once all the equipment has been replaced and the plant is in working order again. The *Contractor* is to confirm by means of instrumentation that the plant is delivering the same duty that it was at first acceptance. These readings and measurements are to be witnessed by the *Employer*.

6.2.8.1 Principles of Effective Maintenance and Maintenance Management

The following principles are to prevail to ensure effective maintenance management and maintenance of the HVAC facilities/ equipment, namely:

a) The principle of disciplined configuration management/control is to be complied with during this period. The maintenance execution should apply strict control/discipline not to change/alter the configuration status of the equipment without either approval by or notification of the change. The importance of managing the “as-built”, “operate-to” and the “maintain-to” information data packs (operation and maintenance manuals including maintenance schedules for each piece of equipment) of the equipment. Any discrepancies between the actual configuration and the information data pack information could lead to cost-inefficient maintenance (wrong information on equipment leads to wrong maintenance execution and therefore the operation and maintenance manual will be 100% correct.

b) The principle of applying optimum maintenance management and the desire to continuous improvement, learning from lessons of the past and wanting to apply intelligent maintenance management principles, should be accommodated as the driving force for maintenance management. The *Contractor* will therefore start with the built of each HVAC Systems history for future continuous improvement.

c) The sound principle of the maintenance Contractor having an independent quality assurance (QA), quality control (QC) and even an inspectorate service of the maintenance execution, where the *Employer* should only execute quality assurance (check a % of the QA and QC of the *Contractor*). It is therefore the responsibility of the *Contractor* to provide

the *Employer* with maintenance QC lists and QA methods that are to be used during the one-year maintenance period.

d) Management information is of the utmost importance, especially in areas where huge sums of money are spent or where decisions are highly dependent on accurate information. Good performance measurement and management is highly dependent on accurate information (Maintenance report back information). The *Employer* will determine with the *Contractor* before *Works* completion, the maintenance information requirements and format that will be provided by the *Contractor* during the maintenance period.

e) Given the complexity/diversity of the HVAC equipment, it becomes obviously important to name and number the different System equipment to determine the exact maintenance history of each piece of equipment during the maintenance year and thereafter. The *Contractor* will therefore number each unit of each System in accordance the numbers that will be provided by the *Employer* before the *Works* commences.

f) Statutory regulations and Eskom standards should be adhered to in the maintenance execution period in conjunction with the normal preventative and corrective maintenance actions. Where facilities/equipment is found that do not comply are to be rectified to create a working environment that is safe and without risk to safety and health. The SANS 10147 is an OHS Act Regulation and should always be complied with during the maintenance period.

g) Although the initial focus of maintenance management should be on optimising/reducing the maintenance-cost, the focus should shift to incorporate optimising/reducing of the entire operating cost and ultimately optimising/reducing the life cycle cost (LCC). The *Contractor* will therefore incorporate measurements such as “Coefficient of Performance” (COP) measurements as part of the year’s PM maintenance program. Other energy saving methods will be provided by the *Employer* to the *Contractor* to be included in *Contractor*s PM schedule. Power consumption readings of each System provided with meters will be part of the *Contractor*’s monthly Planned Maintenance (PM) schedule.

h) Trade-off studies should continuously be analysed or conducted to ensure optimal use of preventative maintenance and corrective maintenance for each respective/individual situation (e.g. - more preventative, less corrective to increase item MTTF/MTTR).

i) Trade-offs regarding repair or replace decisions should continuously be made, as well as decisions on whether equipment/Systems should be phased out due to too high operating cost. Trade-offs involving decisions to purchase more reliable equipment with lower maintenance cost versus less reliable (also less costly) equipment with higher maintenance-cost will be executed.

j) A strategy will be developed by the *Contractor* regarding different standard levels of repair during the maintenance period to ensure focus/cost-effectively of the *Contractor*’s service (supplier cost versus *Contractor* cost).

k) Re-commissioning of equipment after System breakdowns will be implemented as part of the *Contractor*’s Corrective Maintenance (CM) procedure.

l) The *Contractor* will provide a maintenance service to the level defined in a quality plan (service level agreement standard). All the activities performed will comply with the required standard. The *Contractor* will supply procedures, documentation, and testing methods to support the committed level of service. The *Contractor* will have a documented process that verifies that all Kusile Power Station requirements (maintenance specification requirements and standards) are met. The PM and CM response times as required by *Employer* will be

applied by the *Contractor* during the year maintenance period. Refer to *Employer* maintenance response times in accordance with the Service Level Agreement (SLA) between *Contractors* and *Employer*.

6.2.8.2 Service Level Agreement

The *Employer* expects the *Contractor* to at least meet the following service requirements however not limited to:

a) Ensure a continuous supply of conditioned air to all the facilities requiring conditioned air and that are fitted out with HVAC equipment.
b) Restore any interruption to conditioned air supply within the agreed restoration times.
c) Maintain an accurate database of all assets maintained.

6.2.8.3 Maintenance Requirements after Completion of *Works*

The *Contractor* is to be responsible for any failures as a result of the installation during this period.

A maximum response time of 4 hours will be allowed for all failures from the time the notification had been delivered to the *Contractor*.

The planned maintenance is to be execution in 3-monthly maintenance service, except if the OEMs recommend a different service interval; the later are to take preference. The *Contracto*r will provide a PM schedule that will include the following:

a) Inspections time periods of applicable HVAC equipment/items including manufacturer's inspection requirements.
b) All HVAC equipment/items that require 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 and calibration during a specific period e.g. weekly, monthly, 3 or 6 monthly, yearly or when required such as dirty filters, evaporators, etc. This is to include the manufacturer's maintenance requirements.
c) The schedule will be associated with PM guides/instruction list indicating the function to be executed and the material to be used for each piece of HVAC equipment that will be used by the *Contractor* during the one-year maintenance period. Each guide/instruction list will include the General instructions, Special instructions, Tools and materials to be used, List of codes/standards that are applicable to the equipment being maintained and Maintenance check points & maintenance execution including manufacturers maintenance requirements.
d) The *Contractor* will indicate all materials to be used for each instruction e.g. "Replace or clean filters if required" – Material required = Three (3) panel filters (600mm X 600mm X 50mm).

A process used to determine maintenance requirements of any physical asset in its operating context is to make use of the "Reliable Centre Maintenance" (RCM) process (RCM by John Moubray – distributed by Butterworth-Heinemann) or similar. The RCM process entails asking seven questions about the asset or System under review, as follows:

a) What are the functions and associated performance standards of the asset in its present operating context?
b) In what ways does it fail to fulfil its functions?
c) What causes each functional failure?
d) What happens when each failure occurs?
e) In what way does each failure matter?
f) What can be done to predict or prevent each failure?

g) What should be done if suitable proactive task cannot be found?

To apply the above questions a table should be drawn up of each HVAC unit's component/item function, function failure, failure cause, failure consequences and proactive tasks. The *Contractor* will provide detail tables of each installed HVAC units items which will be discussed and agreed with the *Employer* before any maintenance tasks e.g. inspection period (e.g. daily inspections) or preventative maintenance tasks is taken up in the maintenance schedule (drawn up by the *Contractor*) that will be executed by the *Contractor* during the one year maintenance period.

6.2.8.4 Maintenance Information Requirements

The *Contractor* will provide maintenance information on each PM and CM executed during the one-year maintenance period. The report template to be used for providing the required reporting will be agreed upon between the *Employer* and *Contractor* before execution of the maintenance & servicing commences.

All PMs are to be executed by means of *Employer* request number which is to form part of the procedure.

Although maintenance is executed on a unit/System more detail is required of that unit/System and specific detail is required of the components/items of that unit/System as follows:

a) Time reported or request/order generated
b) Time in - Time *Contractor* arrived on site
c) Time out - Time *Contractor* finished breakdown/complain
d) Total time spend on breakdown maintenance
e) Components/item description maintained
f) Was component/maintenance item:
    i. Repaired
    ii. Replaced
    iii. Inspected
g) Remarks on repair, replace or inspection and quantity/number of materials used
h) Power measured
i) Cooling capacity measured
j) COP (if applicable)
k) Cost of maintenance or servicing

6.2.8.5 Maintenance Management

From information received on the PM`s and CM`s reports, logbook (produced by the *Contractor*) and *Employer* service requests, maintenance management will be executed by the *Contractor* in conjunction with the *Employer*. A maintenance meeting will be held once a month during the maintenance period where the *Contractor*, *Employer* will discuss all areas of the maintenance execution process, problems, maintenance information, and non-compliances and introduce maintenance management processes to be implemented by the *Contractor* during the maintenance period.

The following are some of the areas of maintenance on which maintenance management will be executed:

6.2.8.5.1 Improve Maintenance Cost-Effectiveness

The capability to improve maintenance cost-effectiveness will be developed by all parties at the monthly maintenance meeting, based on the data received from the *Contractor* and *Employer* requests. The following minimum capability will be developed:

a) Failure Report Analysis (FRA). FRA will be done for each specific piece of equipment and the following analysis will be carried out:
   i. Time between failures (TBF), draw a process control chart of the TBF showing the MTBF, each TBF as recorded in sequential order and TBF control limits.
   ii. Monthly preventative and corrective maintenance times/cost. Draw a process control chart of the monthly time/cost showing average monthly time/cost spend on PM`s and CM`s.
   iii. Draw a process control chart of the downtime showing the average downtime; each downtime as recorded in sequential order and downtime control limits.
   iv. Draw a process control chart of the average availability, availability as calculated in sequential order and availability control limits.
   v. Identify those entire specific pieces of equipment of which the most recent TBF, monthly cost, downtime or availability is outside the control limits of the specific of generic equipment type or downtime is not within specified/contracted levels.
   vi. List the following for each of the above identified pieces of equipment for the most recent failure, as well as all previous failures:
      - All of the failure descriptions
      - All of the failure causes

b) Corrective Action (CA). From the FRA, the activity report obtained from the maintenance contractor, as well as standardisation considerations, one of the following actions will be taken for each of those equipment identified in the previous section a).:
   i. Don’t do any corrective action and monitor the performance of the specific piece of equipment.
   ii. Replace the specific piece of equipment or phase the equipment out.
   iii. Updates the “maintain to” info data pack (improve preventative maintenance such as more frequent lubrication etc. or specify a more realistic downtime values).
   iv. Do maintenance concept trade-off studies and update the maintenance concept (i.e., improve the lines of repair, maintenance processes, inventory levels/contents (e.g., filters), etc.).
   v. Carry out an equipment design/application analysis and/or a LCC analysis to determine whether it is cost-effective to change the equipment configuration (i.e., a different model/producer in need of more/less reliability, performance, capacity, etc.).

6.2.8.5.2 Replace Identified Equipment As Soon As Possible

This task comprises that specific part of maintenance improvement whereby it is determined as soon as possible that the existing equipment should be replaced by other or new identical piece of equipment, mainly due to a result of an analysis showing that the existing equipment requires excessive maintenance and excessive costs. The disciplined replacement needs to be managed together with its configuration control regarding series number and warranty control. The equipment database needs to be updated and controlled.

6.2.8.6 Maintenance Guide for Three Monthly Service or As Required

"Maintenance" or “CHECK” in the guide are to mean the efficient and effective examination, inspection, service, repair and replacement of components and parts of an air conditioning unit or System so that the air conditioning unit or System complies to the manufacturers, design and commissioning operational specifications and statutory/company requirements. This includes the cleaning, removal of contaminants and waste, correct adjustment and setting, tightening, testing, fixing, refill, lubrication, balancing, rust prevention, touch up and refrigeration charge of the air conditioning unit or System.

The guide indicates maintenance check points, components and items that are all applicable to the different HVAC units and Systems of the company. When maintenance is executed in accordance with the guide the maintenance check points, components and items not applicable to the specific HVAC unit and System, are to be excluded from the service to be executed. The exclusion of any maintenance check points components and items are to be the responsibility of the *Contractor*. Any error exclusions are to be the responsibility of the *Contractor* and no considerations are to be given to claims made by the *Contractor* for the rectification thereof.

The following schedule is to be used for execution of maintenance and commissioning tests.

Table 5: Guide for execution of maintenance and commissioning tests

Check Points	Action
Compressor	Suction and discharge pressures, leaks, high- and low-pressure setting, mountings, current drawn
All coils	Finned surface area, coils fins, coils and plates, coil and plate mountings, leaks, temperature of refrigerant in, temperature of refrigerant out, air on coil temperature and air off coil temperature
Refrigeration circuits and accessories	Valves, piping, leaks and ice formation
All motors	Bearings, current drawn, speed, coupling, guards, shaft, protection, housing, mountings, belts, pulleys, gaskets, seals, nuts and bolts
All fans	Volume flow, bearings, seals, shaft, pulley, belts, protection, mounting, housing, blades, dampers, current drawn, bolt and nuts
Casing and frame	Openings, nuts, bolts, rust, paint, mounting brackets and covers
Filter(s)	Media condition, pressure difference, no bypass of air, seals, holding frame, catches and mountings
Louvers, dampers and grilles	Frames, blades, fixing, air throw, direction of discharge, mountings and supports
Heaters	Elements, protection, safety, heating steps and mountings
Electrical	Compliance with regulations, electrical supply, conduit, joints, thermal blocks, wiring, cables, insulation, trunking, switchgear and protection
Controls	Wiring, sensors, set points, indicators, alarms and signalling
Sound	Required NC level.

Check Points	Action
Drainage	Piping, leaks, connections, fittings, joints, water flow, trap and clamps
Ductwork and insulation	Sheet metal, material, joints, seals, fasteners, seams, hangers, supports and clamps
Alarms	Casing, controls, wiring, indicators, communication and faceplates
Other actions however not limited to.	Clean condenser, cooling coil fins, drain pan and fans. Slime or mould found on the coils or drain pan are to be cleaned with appropriate solution
	Inspect all coil fins. Straight with a fin comb as required
	Remove dirt or rust from parts, casing and frame. Touch up as necessary
	Replace or clean filter if required
	Inspect and adjust air damper
	Lubricate motor and fan bearings
	Inspect gaskets. Look for leaks between unit and frame. Caulk as necessary
	Check for refrigeration leaks with leak detector and correct. Refrigerant charge as required
	Drain and clean humidifier if applicable
	Start unit and observe operation including all controls and set properly
	Check all temperatures and record (see general checkpoints)
	Check frame of unit for proper electric ground
	Replace covers, clean casing and louvres
	Check ductwork and alarms if applicable (see general checkpoints)
	Clean-up work area
	Fill in and complete maintenance report

7. CONFIGURATION AND DOCUMENTATION MANAGEMENT

7.1 DOCUMENT MANAGEMENT

All documents supplied by the *Contractor* are to be subject to Eskom's approval. The language of all documentation is to be in English. All documentation is to be controlled and managed in accordance with Document and Records Management Procedure (32-6).

7.2 DOCUMENT IDENTIFICATION

The *Contractor* is required to submit the Vendor Document Submission Schedule (VDSS) as per agreed dates to the delegated *Employer's* Representative. *Employer* will allocate document numbers on the VDSS and send back to the *Contractor* through the delegated *Employer's* Representative. The VDSS is revisable, and changes must be discussed and agreed upon by all parties. Changes

in the VDSS can be additional documentation to be submitted, changes in submission dates or corrections in documentation descriptions, document numbers, etc. The *Contractor's* VDSS is to indicate the format of documents to be submitted.

7.3 DOCUMENT SUBMISSION

All project documents must be submitted to the delegated *Employer's* Representative with transmittal note according to Project / Plant Specific Technical Documents and Records Management Work Instruction (240-76992014). In order to portray a consistent image, it is important that all documents used within the project follow the same standards of layout, style and formatting as described in the Work Instruction. The *Contractor* is required to submit documents as electronic using SharePoint transmittal and hard copies and both copies must be delivered to the *Employer's* Representative.

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

- Project Plant Specific Technical Documents - Handover Works Instruction 240-124341168
- Project Documentation Deliverable Requirement Specification 240-65459834
- Technical Documentation Classification and Designation Standard 240-54179170
- Project/ Plant Specific Technical Documents and Records Management Work Instruction 240-76992014

The *Contractor* lists all project soft copies and hard copies for submittal on the transmittal with the following metadata fields, use *Employer's* transmittal template (240-71448626*)*:

a) Title of the document
b) Document unique identification number
c) Revision number
d) Name of discipline
e) Reason for issuing/submission
f) Sender's details
g) Sent date
h) Recipient's details
i) Date received
j) Quantity of documentation referenced on the transmittal
k) Number of copies
l) Format/medium submitted (e.g. paper, CD/USB Stick, etc)
m) Sender signature
n) Recipient signature, once submitted, to acknowledged receipt

The format of the final documentation handover will be specified in the Vendor Document Submittal Schedule. The Vendor Documentation Submittal Schedule (VDSS) specifies the following:

a) The limits of supply of the documentation, i.e., whether the documentation is provided / maintained by the *Contractor* or the *Employer*.
b) The type of documentation provided.
c) The software format (where applicable) in which the documentation is provided.
d) The stage in the project execution during which the documentation is provided as a deliverable.
e) The *Contractor* is to be responsible for planning the supply of the documentation during the various project stages and to provide the documentation in accordance with the Vendor Documentation Submittal Schedule (VDSS).

The documents are to be submitted to the Eskom Representative accompanied by the Transmittal Note. The *Contractor* submits all documentation to the Eskom Representative as well as the Project's Documentation Centre in the following media:

7.3.1 SharePoint Transmittal

Electronic copies will be submitted to Eskom Documentation Centre via the SharePoint Transmittal space that will be setup for the project.

7.3.2 Bulk Submission

Electronic copies large for transmitting via SharePoint (>700MB) will be delivered on CD/USB Stick, large file transfer protocol and/or hard drives to the Project Documentation Centre. For bulk document submission, the following link can be used https://zendto.eskom.co.za/

7.3.3 Emails and other submission methods

Where applicable and contractually agreed, e-mail submissions can be used, as well as other submission methods employed in the relevant project e.g. Box; Norman Secure, etc

7.3.4 Hard Copies

Two hard copies of documents are to be submitted to the Employer's Representative accompanied by the Transmittal Note.

7.4 DRAWINGS FORMAT AND LAYOUT

The creation, issuing and control of all Engineering Drawings will be in accordance to the latest revision of engineering drawing Standard 240-86973501. Drawings issued to Eskom will be a minimum of two hardcopies and an electronic copy that is editable. The *Contractor* is required to submit electronic drawings in Micro Station (DGN) format, and scanned drawings in pdf format. No drawings in TIFF, AUTOCAD or any other electronic format will be accepted. Drawings issued to Eskom may not be "Right Protected" or encrypted. The *Employer* reserves the right to use these drawings to meet other contractual obligations. The *Contractor* is to include the *Employer's* drawing number in the drawing title block. Drawing numbers will be assigned by the *Employer* as drawings are developed.

The *Contractor* submits all drawings in accordance with the requirements stipulated in the *Employers* Engineering Drawing Standard 240-8673501. Manufacturing of the equipment commences when drawings are accepted for construction, by the *Employer*. Two paper print, editable native CAD format (.dgn) and in .pdf format of each drawing are submitted to the *Employer* for acceptance as per agreed schedule before manufacturing of equipment commences, by the *Contractor*.

The *Contractor* submits a 3D Model in DGN format. The structure of the 3D model is to be according to the Plant Breakdown Structure. The 3D model is to clearly indicate all interfaces.

The *Contractor* submits all relevant drawings, documents and design information for approval before commencing any work. After the *Employer* accepts the drawings and design information, the *Contractor* is not allowed to depart from the accepted drawings in any way except when it is with the written consent of the *Employer*.

The *Contractor* is responsible for any error or deficiency in any drawings or documents supplied by him and for any loss, damage or expense arising out of such error or deficiency, notwithstanding that such drawing or document may have been accepted by the *Project Manager*.

Drawings are submitted to *Employer* in editable native CAD format (.dgn) and in .pdf format, after commissioning of the equipment. The drawings reflect any changes made during commissioning and are submitted as "As built" drawings.

The *Contractor* notes that all General Arrangement (GA) and detailed manufacturing and erection drawings become the property of the *Employer*. The *Employer* is permitted to purchase replacement parts off these drawings from the lowest cost suppliers.

7.5 CONFIGURATION MANAGEMENT

7.5.1 Plant Coding and Labelling

Coding and labelling of all Plant & Materials and documentation supplied is part of the *Works* and is the responsibility of the *Contractor*. The *Contractor* is to code the plant structures, systems, and components according to the KKS (Kraftwerk-Kenzeichnungs System) as developed by the VGB.

The *Contractor* is responsible for ensuring that he/she is fully familiar with the standard and concepts of KKS system. The *Contractor* is responsible for codification of plant, equipment and components which is under his/her supply.

The specific code for each item of the plant, equipment, measuring point, junction box, cable etc. is to appear on all documents, drawings, maintenance schedules etc.

A list of all KKS codes used by the *Contractor* is to be provided according to *Employer* standard documentation. The allocation of the codes is to be approved by *Employer*.

All designs, testing, commissioning, operating maintenance and training documentation and databases are to be suitably and comprehensively marked, cross-referenced, and indexed with the allocated KKS codes.

7.5.1.1 Functional Location of Components

The list of functional locations is to be arranged in Alfa-numeric order from 1st level KKS to 3rd level KKS number to show Hardware breakdown structure in specific plant area. The list as a minimum is to include all the maintenance significant items. It is assumed that items excluded, will automatically have a run-to-failure maintenance strategy and the impact of such failure would be insignificant. Where required, breakdown can be down to 4th level of KKS.

All equipment requires 3rd level KKS coding to comply with Eskom's specifications:

a) KKS Plant Labelling & Equipment Description Standard.

b) The Application of KKS Plant Coding

The *Contractor* is responsible for the following:

a) Generating coding and obtaining *Employer* approval prior to installation.

b) Produce drawings (MCC & HVAC Controller – GA & SLD, AFS & P&ID) to reflect approved codes and obtaining approval. (Note that QC inspections cannot proceed without these approved drawings).

c) Supplying and installing labels/mimic to specification (Aluminium, stainless steel, laminated PVC, or cable labels depending on application).

d) Applying for inspection by Employer.

e) Rectifying any incorrect labels.

f) Obtaining individual KKS certificates for mechanical, electrical and C&I.

The Contractor is to employ the services of an experienced KKS engineer for the purpose of plant coding and labelling.

7.5.1.2 KKS Coding

The plant codification system is to be uniform to entire project. The Kusile power station utilises KKS system, and this is to be applicable to HVAC system including all Mechanical, Electrical & C&I equipment that forms part of the works which needs to be coded. The codification is to be reflected on the relevant drawings and Equipment Label Lists (ELL)

The HVAC system is to be coded to at least up to 3rd level coding as follows:

7.5.1.2.1 Mechanical Plant

For the mechanical equipment 3rd level coding is to be implemented. For example, for an Air Handling Unit (AHU):

a) Level 1 – Equipment (AHU, etc.)
b) Level 2 – Components (Fan, etc.)
c) Level 3 – Subcomponents (Fan belts, pulley, motor, etc.)

7.5.1.2.2 Electrical Plant

The Motor Control Centres (MCC)/HVAC Electrical Panels and cabling are to be coded to 3rd level. For example, for an MCC is to be coded as follows:

a) Level 1 – HVAC controller panel – single code
b) Level 2 – Tiers & individual buckets – coded on outside of panel
c) Level 3 – Components inside MCC to be coded for example, (MCB's, contactors, terminals etc.)

Cables are all must be coded as cable schedules contains connection details.

7.5.1.2.3 C&I Installation

The HVAC controllers and cabling must be coded 3rd level. For example, for an HVAC controller is to be coded as follows:

a) Level 1 – Main board – single code
b) Level 2 – Tiers – coded on outside of panel
c) Level 3 – Components inside HVAC controller to be coded for example, (Controllers, relays, terminals etc.) A mimic table must be installed in panel door.

Cables are all must be coded as cable schedules contains connection details.

Once the MCC and HVAC controller 3rd level KKS codes are approved, labels or mimics will be produced and physically installed on the MCC or HVAC controller internal components. The *Contractor* is to update the MCC and HVAC controller document pack with the approved KKS signal codes as received on the 5 x C&I schedules.

The KKS signal codes must be implemented in the HVAC controller software and HMI graphics. HMI Graphics (HVAC controller touch screen) is to be configured as follows:

a) The approved AFS and P&ID drawings will be used to update the HMI homepage graphics.

b) All equipment on the HMI to have KKS codes. The approved equipment lists must be used.

c) The KKS codes on the HMI can be displayed either in the bottom corner of the HMI or to be displayed when hovered over with mouse. Last option is the preference of Eskom Generation.

d) All equipment descriptions as per the approved equipment lists. Descriptions can be shortened since the faceplate of the HMI will contain building/location name and system name.

e) A clear description is required for each alarm state especially for multi-state variables.

f) Legend to be generated on HMI with the following:

   i. Green: On or Running

   ii. Red: Alarm

   iii. Grey: Off

   iv. Purple: Override

   v. Orange: Offline

Interface to CBMS and the HVAC panel controllers will be via BACnet/IP communication protocol. The KKS signal code must be transmitted to the CBMS.

7.5.2 Change Management

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

7.5.3 Design Review Documentation

The *Contractor* conducts design reviews as per the *Contractor*s 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* may “Accept”; “Accept with Comments” or “Reject”. If required, the *Contractor* makes the necessary revisions on the documentation and ensures acceptance is obtained from *Employer*. The *Contractor* includes these design reviews as part of the schedule and suggests appropriate timing for such reviews.

7.5.4 Procedure for Submission and Acceptance of Contractor’s Design

The *Contractor* ensures the following:

a) The design is prepared, supervised, and managed in accordance with the *Employer*’s principles and quality procedures.

b) The design is prepared, reviewed, and verified by individuals who are competent and are registered with ECSA or other international recognised bodies.

c) The design of the *Works* complies with the Contract Specification, generic specifications, standards, drawings, the *Project Manager*'s instructions, and other documents.
d) The design is accurately recorded in the design submissions including calculations, verifications, detailed construction drawings, specifications, test and commissioning plans and operation and maintenance manuals.
e) The design is reviewed and endorsed as compliant by an internal Reviewer prior to sending it for verification by the *Employer*.
f) The design is developed and submitted for review in accordance with the Contract Specification and agreed schedule.
g) All design information, data, drawings, and other documentation is produced for the *Works* in accordance with the Contract.
h) The Detail design report is to be according to the *Employer*'s Detail Design Report Template, 240-49910707.

7.5.5 Design Review Procedure

The *Contractor* is the Design Authority for HVAC System, Controls, Electrical, Civil, Structural and Building related *Works* of the contract as defined in the *Employer's* Design Review Procedure 240-53113685. The *Contractor* is responsible for following this design procedure and conducts all the design reviews as specified in this procedure. The *Contractor* is responsible for conducting the following reviews:

a) Design Freeze Review (Detail Design)
b) Pre-Commissioning Review
c) Acceptance Testing Review
d) Handover Review

For design review purposes the designs will be reviewed per part of the *Works* as well as an integrated design where all interface issues between the various parts are addressed as follows:

a) The interim design stage will be an iterative process between the *Employer* and the designer with regular progress meetings.
b) The interim design stage will culminate with the submission of a report.
c) After receipt of the design report, the *Employer* will have ten (10) working days to review and submit comments to the designer.
d) The designer will then have five (5) working days to submit the updated final design report.
e) The submission will then constitute the End of Phase review and the *Employer* will accept the final design report with comments by the *Employer* and updates by the designer within five (5) working days.

7.5.6 Process for Submission of Documents

The *Contractor* submits all documents according to the templates that are referenced on the list of Standards. The process for the submission of documents is described below:

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

f) The *Employer* reviews the documents/drawings and if no major deficiencies are found, the *Contractor* organises a Design Review session.
g) The *Employer* and the *Contractor* conduct a Design Review.
h) If any fundamental errors were found in the designs or further actions are required, the *Contractor* record all concerns raised and revises the designs.
i) The *Contractor* organises a Design Review session once all designs were revised according to the concerns raised by the *Employer*.
j) 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 *Employer*.
k) The *Employer's* Document Controller registers the report.
l) 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*.
m) The *Project Manager* accepts the *Contractor's* design once the report/minutes are accepted by the *Employer's* project team.

The *Contractor* is to implement the following activities for approval:

a) The *Contractor* reviews, stamps, dates and signs to signify his/her approval and submit in the manner required by the *Employer* in orderly sequence so as to cause no delay in the work, all *Contractor's* drawings, equipment selections and/or samples required by the *Works* or subsequently by the *Employer*. *Contractor's* drawings, equipment selections and samples are to be properly identified as specified or as the *Employer* may require.
b) At the time of submission, the *Contractor* informs the *Employer* in writing of any deviation in the *Contractor's* drawings, equipment selection or samples from the requirements of the *Works*.
c) Each individual plant & material selection submission is to be accompanied by a copy of the applicable detailed technical specification. Each clause of this specification to be marked "Complies" or "Does not comply", complete with reason stated, alternative offered and countersigned by the *Contractor*.
d) Plant & material selection submissions are to be indexed similar to the index for plant & material part of the "Operating Instructions and Maintenance Manual".
e) The *Contractor* is to submit two copies of drawings and plant & material selections along the channels agreed.
f) By submitting drawings, plant & material selections and/or samples, the *Contractor* represents that he/she has determined and verified all site measurements, site instruction criteria, materials, catalogue numbers and similar data, and that he/she has checked and co-ordinated each services drawing and sample with the requirements of the *Works*.
g) The *Employer* reviews *Contractor's* drawings, plant & material selections, and samples to cause no delay, but only for conformance with the design of the *Works*. The *Employer's* approval of a separate item does not indicate approval of an assembly in which the item functions.
h) The Contractor makes any corrections required by the Employer and re-submits the required number of corrected copies of the Contractor's drawings, plant & material selections, or new samples until approved. The Contractor directs specific attention in writing on resubmitted drawings to revisions other than the corrections required by the Employer on previous submissions.

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

a) Documents, including detailed calculations such as hydraulic and pipe stress analysis (where required), pipe supports, handers and racks,

b) Documents including equipment data sheets and specification for selected equipment, electrical cabling, and other associated equipment.
c) 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 drawings are to have at least a plan and two different elevations or sections giving overall dimensions.
d) Dimensioned shop drawings showing proposed method of fixing of all the plant and equipment
e) Detailed electrical wiring diagrams including schematic and control circuits.
f) Compliance and Electrical Certificates
g) Detailed sequencing manner for installation procedure of *Works*
h) 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*
i) Technical specification and literature for all items of equipment that forms part of the complete installation
j) Proposed corrosion protection systems, including data sheets for coating proposed of equipment
k) List of recommended spares and technical specifications for the spares, part numbers and the stock levels required
l) Detailed building *Works* for complete *Works*
m) Detailed maintenance, reliability, control, and operating philosophies
n) Testing, balancing, and commissioning procedures
o) Plant and material acceptance testing
p) Detailed operation & maintenance manuals with As-Built drawings & Commissioning Results
q) Plant codification lists for each section of the *Works*
r) Construction competition reviews
s) Acceptance testing reviews
t) Quality assurance reports
u) Close out reports

7.6 TIME REQUIRED FOR ACCEPTANCE OF DESIGNS

The *Project Manager* will return one copy of the drawing marked "Accepted"; "Accepted with Comments" or "Rejected". as may be appropriate.

The notations "Accepted" and "Accepted with Comments" authorize the *Contractor* to proceed with the manufacture of the Plant covered by such drawings subject to the corrections, if any, indicated thereon.

Where prints or drawings have been "Rejected" or "Accepted with Comments" the *Contractor* makes the necessary revisions on the drawings and submit further copies for acceptance in the same procedure as for the original submission of drawings.

Every revision shows by number, date and subject in the revision block on the drawing.

The *Contractor* is to allow for 10 calendar days for review of documentation by the *Project Manager.*

8. APPLICABLE STANDARDS AND CODES

Table 6: List of Applicable Standards and Codes

Number	Title
ISO 9001	Quality Management Systems
OHSACT	Occupational Health and Safety Act 85 of 1993
240-50237146	Medium Voltage AC Variable Frequency Drives Standard
240-102547991	General Technical Specification for HVAC Systems
240-70164623	Eskom Heating Ventilation and Air Conditioning (HVAC) Design Guideline
240-143112846	Heating Ventilation and Air Conditioning System Design Work Instruction
240-53665024	Engineering Quality Manual
240-53114026	Project Engineering Change Management Procedure
240-53113685	Design Review Procedure
240-53114002	Engineering Change Management Procedure
240-511486	Documents and Record Management
240-56227443	Requirements for Control and Power Cables for Power Stations Standard
240-61379718	Instrument Schedule Template
240-61379755	Drive and Actuator Schedule
240-72344339	C&I Virtual Signal List for External Signal Exchange Template
240-72350241	C&I Hardwired Signal List for External Signal Exchange Template
	Alarm Schedule Template
240-56356396	Earthing and Lightning Protection Standard
240-56227516	LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard
240-57617975	Procurement of Power Station Low Voltage Electric Motors Specification Standard
240-56227443	Cabling and Racking Standard
240-56356396	Earthing and Lightning Protection Standard
240-56176097	Electrical Cable Schedule Template
240-56227927	Electrical Load List Template
240-77301384	Electrical LV Load Schedule Template
240-56356421	Electrical LV Switchgear Schedule Template
240-56356465	Electrical LV List of Switchboards Template
240-77302094	Electrical Termination Schedule Template
240-56364545	Structural Design and Engineering Standard
240-56737448	Fire Detection and Life Safety Design Standard

Number	Title
240-54937439	Fire Protection - Detection Assessment Standard
240-54937450	Fire Protection & Life Safety Design Standard
240-56737654	Inspection Testing and Maintenance of Fire Detection Systems Standard
240-76992014	Project / Plant Specific Technical Documents and Records Management Work Instruction
240-124341168	Project Plant Specific Technical Documents - Handover Works Instruction
240-65459834	Project Documentation Deliverable Requirement Specification
240-54179170	Technical Documentation Classification and Designation Standard
240-71448626	Transmittal template
240-86973501	Engineering Drawing Standard
240-61227631	Piping and Instrumentation Diagram (P&ID) Standard
240-7143250	Plant Labelling Standards
240-58552870	Smart Plant for Owner Operators (SPO) Documentation Metadata Standard
240-109607736	Eskom KKS Key Part Standard
240-109607332	Eskom Plant labelling and Abbreviation Standard
240-93576498	KKS Coding Standard
200-4190	The application of KKS plant coding (NMP 45-7)
200-18202	KKS Key Part-Fossil Power Station (NPSZ 45-45)
200-94660	Issuing of KKS certificate
200-46362	Site Inspections Procedure
32-6	Document and Records Management Procedure
36-681	Generation Plant Safety Regulations
32-95	Occupational Health and Safety Incident Management Procedure
32-727	Safety, Health, Environment and Quality (SHEQ) Policy
SANS 10142-1	The wiring of premises Part 1: Low-voltage installations)

9. LIST OF DRAWINGS ISSUED BY THE EMPLOYER

The drawings prepared by the *Employer* show general layout of all equipment and distribution systems, complete with schematic arrangements. These, together with the specification, give sufficient information to enable the *Contractor* to estimate the cost and to determine how the System must be installed, tested, balanced, inspected, operated, serviced, and maintained. These drawings are not dimensioned shop drawings and cannot be used as shop drawings. Location dimensions shown are only indicative of the routes and zones in which the service must be installed.

The following drawings are applicable to the contract and issued with this tender documentation for tendering purposes only:

Table 7: Existing Floor Layouts

Drawing No.	Sheet No.	Revision	Title
0.90/13	7	1	Unit 1 MV and LV Single Line Diagram
0.90/2295			Air Cooled Condenser Auxiliary building ventilation Piping and Instrumentation Diagram
0.90/1323			Air Cooled Condenser General Arrangement Unit 1,2,3
			Auxiliary Building Units 1-6 Condensate Pumps and VRD Area
0.90/5473			400V Air Conditioning Board Single Line Diagram
0.90/54739			Unit 1 400V Air Conditioning Board Single Line Diagram
0.90/54744			Single Line Diagram Unit 1 400V CPP Board 1
0.90/54745			Single Line Diagram Unit 1 400V CPP Board 2
0.90/40159			MCC General Arrangement 400V AC CPP Board 1 Unit 1
0.90/40160			MCC General Arrangement 400V AC CPP Board 2 Unit 1
0.90/40165			MCC General Arrangement 400V AC Air Condition Board Unit 1
0.90/5473			400V Air Conditioning Board Single Line Diagram
0.90/1599			ACC Unit 1 to 6 – Auxiliary Building Foundation Plan and Sections
0.90/1614			ACC Unit 1 to 6 – Auxiliary Building Architectural Plans
0.90/1613			ACC Unit 1 to 6 – Auxiliary Building Architectural Doors Schedule
0.90/1615			ACC Unit 1 to 6 – Auxiliary Building Architectural Sections and Details
0.90/1616			ACC Unit 1 to 6 – Auxiliary Building Architectural Views
0.90/101483			ACC Auxiliary Building Piping and Equipment Arrangement
0.90/57590			Site Finishing – Site Key Plan, General Notes & Legend
0.90/57595			Site Finishing – Site Plan Area 16A
0.90/71672			Site Finishing – Site Plan Area 16B
0.90/71681			Site Finishing – Site Plan Area 17B

10. CONTRACTOR'S TECHNICAL TENDER RETURNABLES

The *Contractor* must complete the *Contractor*'s technical tender returnable (proposed specifications and schedules for items of Plant and Materials and workmanship). The *Contractor* ensures that all information in the *Contractor*'s Works Information complies with the *Employer*'s Works Information and the Contract.

Any ambiguity or gap in the *Contractor*'s Works Information is the *Contractor*'s responsibility. The *Employer* accepts no responsibility for any change to the Prices, Key Dates or Completion Date as a result of above.

10.1 GENERAL

The following information is required in the tender stage:

a) Documents including equipment data sheets and specification for selected equipment, electrical cabling, and other associated equipment.
b) Electrical wiring diagrams including schematic and control circuits.
c) Detailed sequencing manner for installation procedure of *Works*.
d) Detailed programme for the *Works*
e) 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.
f) Proposed corrosion protection Systems, including data sheets for coating of proposed equipment

All major equipment and devices offered by the tenderer must be of proven technology. The reference list of identical equipment as offered should indicate the projects on which the technology was implemented, including the names of the clients, the country, and the year in which the technology was utilised. The referenced projects must have a minimum duration of five years since installation.

All major equipment and devices offered must be supplied by the Original Equipment Manufacturers (OEMs). If the equipment concerned is manufactured under licence, the tenderer is to provide a proof of licence agreement made with the OEM. The distributors or agents provide a copy of the contract agreement made with the OEM for the distribution of their equipment and the duration of the agreement should match that of the Contract.

The tenderer must have a track record of five completed projects as a minimum: construction, commissioning and testing of HVAC Systems. In case the tenderer intends to subcontract or form a joint venture, a letter of agreement, together with a track record for all parties involved must be provided. The detailed design (where required) in terms of this Contract is to be executed by a qualified professional for each discipline (Mechanical, Electrical C&I, Civil and Structural) who is a member of Engineering Council of South Africa (ECSA) or equivalent international acknowledgement.

The tenderer must have a proposed work plan indicating intent to undertake full scope of work whilst the Kusile Power Station remain live, activities divided up realistically in schedule and timelines realistic for execution of activity.

The tenderer is to a letter of indicating intent to full scope of work, and compliance to standards and specifications.

CVs of proposed employees are to contain all relevant qualification certificates.

The Tenderer is to provide proof of Construction industry Development Board (CIDB) certification.

10.2 HVAC SYSTEM TECHNICAL DATA SHEETS

The *Contractor* provides the plant components with minimum technical specification required by the *Employer*, presented in this section. If the *Contractor* considers any additional information (than presented in this section) that provides more clear understanding on requirement, the *Contractor* is allowed to provide such information. The *Contractor* lists the additional information clearly and provides to the *Employer* along with the bidding documents.

The HVAC equipment is to be located on the 0-meter level of auxiliary bays, unit 1 to 6 CEP VSD Rooms.

Table 8: 105 kW Ducted Type Direct Expansion (DX) Built-up Units or Similar Units

Description	Unit	Number Required	Specified	Tendered
1. DX Unit Design Conditions				
1.1. Direct Expansion (DX) Built-up Units or Similar Units Manufacturer	-	12	To be specified by the *Contractor*	
1.2. Location	-	-	Outdoors	
1.3. Site Altitude	m	-	1545	
1.4. Summer Ambient Design Temperature DB	ºC		40ºC	
1.5. Nominal Cooling Capacity	kW	-	105 (each)	
1.6. Constant or Variable Air Volume	-	-	Variable Volume	
1.7. Supply Air Discharge Direction	-	-	Front	
1.8. SA Fan Type	-	-	EC Plug	
1.9. Fan Static Pressure at Site Altitude	Pa		750	
1.10. ESP Required, at Site Altitude	Pa		200.0	
1.11. Supply Air Quantity	m^3/s	-	9.200	
1.12. Return Air Quantity	m^3/s	-	8.28	
1.13. Fresh Air Quantity	m^3/s	-	0.92	
1.14. Heating - Reverse Cycle	-	-	None	
1.15. Heating - With Electric Heaters	-	-	None	
1.16. Refrigerant	-	-	R410A or similar	
1.17. Housing (Internal / External)	-	-	Chromadek / Chromadek	
1.18. Insulation	-	-	Polyurethane	
1.19. Framing	-	-	Sealed tongue-and-groove	
1.20. Drip Tray of Stainless Steel	-	-	Yes	
1.21. Damper Filter/s	-	-	Yes	
1.22. Carel pCo Controller	-	-	Yes	
1.23. Remote Control - PGD Display	-	-	Yes	
1.24. Compressors	-	-	Scroll	

Description	Unit	Number Required	Specified	Tendered
1.25. Lead Compressor Starting	-	-	DOL	
1.26. Lag Compressor Starting	-	-	DOL	
2. Indoor Coils / Evaporator Cooling Cycle				
2.1. No. of Coils	-	-	To be specified by the *Contractor*	
2.2. Make & Model of Indoor Coil	-	-	To be specified by the *Contractor*	
2.3. Total Cooling Capacity	kW	-	105 (each)	
2.4. Total Air Flow	m^3/s	-	9.200	
2.5. On-Coil Conditions	ºC	-	24.0 / 16.0	
2.6. Off-Coil Conditions	ºC	-	15.2 / 13.1	
2.7. Size of each Coil - Height x Length	mm	-	To be specified by the *Contractor*	
2.8. No of Rows & Fin Spacing	-	-	To be specified by the *Contractor*	
2.9. Face Velocity / Air Pressure Drop	m/s / Pa.	-	To be specified by the Contractor	
2.10. Tube / Fin / Frame Materials of Construction	-	-	Cu Tube / Al Fins / Galv. Casing	
3. Primary Filters				
3.1. Type of Filters	-	-	Washable Panel Filter - 50mm Thk. / Aluminium Frames	
3.2. Number & Size (W x H x D)	-	-	To be specified by the *Contractor*	
3.3. Filter Face Area	m^2	-	To be specified by the *Contractor*	
3.4. Face Velocity				
4. Secondary Filters				
4.1. Type of Filters	-	-	Bag Filter 95% efficiency - 300mm Deep	
4.2. Number & Size (W x H x D)	-	-	To be specified by the *Contractor*	
4.3. Filter Face Area	m^2	-	To be specified by the *Contractor*	
4.4. Face Velocity				

Description	Unit	Number Required	Specified	Tendered
5. Outdoor Coils / Condenser Cooling Cycle				
5.1. No. of Coils	-	-	2	
5.2. Make & Model of Outdoor Coil	-	-	To be specified by the *Contractor*	
5.3. Total Condensing Capacity	kW	-	To be specified by the *Contractor*	
5.4. Head Pressure Control System	-	-	Condenser AC Fans - Speed Controller	
5.5. On-Coil Conditions Temperature DB	ºC	-	40	
5.6. Condensing Temperature DB	ºC	-	55	
5.7. Tube / Fin / Frame Materials of Construction	-	-	Cu Rifle Bore Tube / Al (Epoxy) Fins / Galv. Casing	
5.8. Condenser Panels	-	-	Galvanised (Powder Coated)	
6. Electrical				
6.1. Power Supply	V/Hz/ph.	-	400V / 50Hz / 3ph	
6.2. Power Input	kW	-	To be specified by the *Contractor*	
6.3. Running Amps	Amps	-	To be specified by the *Contractor*	
6.4. Full load Amps	Amps	-	To be specified by the *Contractor*	
7. Unit Details				
7.1. Overall Length	mm	-	To be specified by the *Contractor*	
7.2. Overall Width	mm	-	To be specified by the *Contractor*	
7.3. Overall, Height	mm	-	To be specified by the *Contractor*	
7.4. Approximate Rigging Weight	kg	-	To be specified by the *Contractor*	
7.5. Rigging Lugs	-	-	Permanently Attached	
7.6. Panel Thickness	mm	-	50mm	
7.7. Base Profile and Finish	-	-	Steel Channel 178 x 54 + Black Enamel Finish	

Description	Unit	Number Required	Specified	Tendered
7.8. Unit Drain	mm	-	Ø40	
7.9. Lights	-	-	Lights and switch	
7.10. Wiring Termination	-	-	Wiring to switchboard	
7.11. Access Panels / Doors	-	-	Light Weight Doors - Galvanised	
7.12. Unit Trim	-	-	Inner: 50mm x 50mm Al + Outer: 50mm x 50mm Al	

10.3 HVAC ASSOCIATED ELECTRICAL WORKS

Table 9: LV AC Cabling, Electrical Panel and Motor Circuits Components

Item No.	Description	Unit	Required	Tendered
1	**General requirements**			
1.1	Cable Manufacture	-	To be provided by Tenderer	
1.2	Cable Type	-	To be provided by Tenderer	
1.3	Cables rated for interior and outdoor condition, and suitable for working environment	Yes/No	Yes	
1.4	Name of Panel ASSEMBLY Manufacturer	-	To be provided by Tenderer	
1.5	KKS or Plant Coding required	Yes/No	Yes	
1.6	Expected period of use	years	≥ 25	
2	**Dimensions of Distribution Board ASSEMBLIES**			
2.1	Maximum overall length	mm	To be provided by Tenderer	
2.3	Maximum overall height mm	mm	To be provided by Tenderer	
2.4	Maximum overall dept mm	mm	To be provided by Tenderer	
2.5	Degree of Protection	IP	To be provided by Tenderer	
3	**Technical requirements**			
3.1	Cable's Cross Sectional Area (Size)	mm^2	To be provided by Tenderer	
3.2	Conductor material	-	Copper	

Item No.	Description	Unit	Required	Tendered
3.3	Maximum operating temperature range	°C	Max. +90	
3.4	Rated AC Voltage	V	400	
3.4.1	Rated short-duration power-frequency withstand voltage	V	2.5 kV	
3.4.2	Rated lightning impulse withstand voltage (common value)	V	5 kV	
3.5	Insulation	-	Halogen free	
3.6	Trademark and Code designation on cable	Yes/No	Yes	
3.7	Fire resistant	Yes/No	Yes	
3.8	Installation method	-	All outdoor cables are to be installed using metal conduits. All installations according to SANS 10142-1 requirements and Eskom Standard 240-56227443.	
3.9	Ground conditions	-	To be provided by Tenderer	
3.10	Number of conductors per cable	-	To be provided by Tenderer	
4	**Switches, disconnectors, switch-disconnectors and fuse-combination units for HVAC Panel and Unequipped circuits**			
4.1	**General**			
4.1.1	Manufacturer	-	To be provided by Tenderer	
4.1.2	Type	-	To be provided by Tenderer	
4.1.3	Number of poles	-	To be provided by Tenderer	
4.1.4	Neutral pole type	-	To be provided by Tenderer	
4.1.5	Utilization category (IEC 60947-3)	-	AC-23B	
4.1.6	Heat dissipation from the breaker	W	To be provided by Tenderer	
4.2	**Rated Voltages**			
4.2.1	Rated operating voltage (Ue)	V	To be provided by Tenderer	
4.2.2	Rated insulation voltage (Ui)	V	1000	

Item No.	Description	Unit	Required	Tendered
4.2.3	Rated impulse voltage Withstand (Uimp)	kV	To be provided by Tenderer	
4.2.4	Control voltage	V	To be provided by Tenderer	
4.3	**Rated currents**			
4.3.1	Rated operational current (Ie)	A	To be provided by Tenderer	
4.3.2	Conventional free-air thermal current (Ith)	A	To be provided by Tenderer	
4.3.3	Conventional enclosed thermal current (Ithe)	A	To be provided by Tenderer	
4.3.4	Rated uninterrupted current (Iu)	A	To be provided by Tenderer	
4.4	**Rated frequency**	**Hz**	**50**	
4.5	**Rated duty**	**-**	**Uninterrupted**	
4.6	**Rated making capacity**	A	To be provided by Tenderer	
4.7	**Rated breaking capacity @ rated voltage**	**kA @ Ue**	**To be provided by Tenderer**	
4.8	**Rated conditional short-circuit current (to SANS 1973-1)**	**kA**	**To be provided by Tenderer**	
4.9	**Operating device (Closing & opening)**	Yes/No	Yes	
5	**Contactors**			
5.1	**General**		**To be provided by Tenderer**	
5.1.1	Manufacturer	-	To be provided by Tenderer	
5.1.2	Manufacturer's type (provide rating and type for each load current)	-	To be provided by Tenderer	
5.1.3	Utilisation category (to IEC 60947-4-1)	-	AC3	
5.1.4	Type	-	Held-in	
5.1.5	Recovery voltage	%	To be provided by Tenderer	
5.1.6	On-load operations	-	1 000 000 for Ie <17A 300 000 for Ie >17A	
5.1.7	Type of contact and contact material (e.g., butt/silver)	-	To be provided by Tenderer	

Item No.	Description	Unit	Required	Tendered
5.2	**Operating coil (for held-in contactors) or closing coil (for latched contactors) s**			
5.2.1	Rated burden	VA	To be provided by Tenderer	
5.2.2	Control supply voltage (Us)	V	230	
5.2.3	Maximum continuous voltage	V	253	
5.2.4	Minimum closing voltage as percentage of Us	%	85	
5.2.5	Maximum drop-out voltage as percentage of Us (held-in contactors only)	%	75	
5.2.6	Minimum drop-out voltage as percentage of Us (held - in contactors only)	%	To be provided by Tenderer	
5.3	**Contactor rated voltages**			
5.3.1	-rated operational voltage (U_e)	V	To be provided by Tenderer	
5.3.2	-rated insulation voltage (U_i)	V	1000	
5.3.3	-rated impulse withstand voltage (U_{imp})	kV	2	
5.4	**Contactor rated current**			
5.4.1	Conventional enclosed thermal current (I_{the})	A	To be provided by Tenderer	
5.4.2	Rated operational current (I_e)	A	To be provided by Tenderer	
5.5	**Rated making capacity**	**A**	To be provided by Tenderer	
5.6	**Rated breaking capacity**	**A**	To be provided by Tenderer	
5.7	**Rated frequency**	**Hz**	**50**	
5.8	**Auxiliary contacts (utilisation category AC 14 or DC 13 to IEC 60947-5-1)**			
5.8.1	Number of auxiliary contacts (N/O & N/C) – according to standard schematic diagrams including Spares	-	See schematic diagrams	
5.9	**Maximum rating capacity of auxiliary contacts (AC)**			
5.9.1	Make	A	To be provided by Tenderer	

Item No.	Description	Unit	Required	Tendered
5.9.2	Break	A	To be provided by Tenderer	
5.9.3	Continuous	A	To be provided by Tenderer	
5.10	**Maximum rating capacity of auxiliary contacts (DC)**			
5.10.1	Make	A	To be provided by Tenderer	
5.10.2	Break	A	To be provided by Tenderer	
5.10.3	Continuous	A	To be provided by Tenderer	
6	**Motor starters**			
6.1	General			
6.1.1	Switching device / contactor / overload relay combination	Yes/No	Yes	
6.1.2	Heat dissipation from motor starters	W	To be provided by Tenderer	
6.2.1	Manufacturer	-	To be provided by Tenderer	
6.2.2	Type.	-	To be provided by Tenderer	
6.2.3	Tripping current as percentage of set value	%	To be provided by Tenderer	
6.2.4	Operating time at 105 % of set value (hot)	S	To be provided by Tenderer	
6.2.5	Operating time at 600 % of set value(hot)	S	To be provided by Tenderer	
6.2.6	Tripping characteristic curve to be provided	-	Yes	
6.2.7	Condition monitoring functionalities	-	Yes	
6.2.8	Data communication functionalities	-	Yes	
7	**Certifications of compliance**			
7.1	Type Test Certificate	Yes/No	Yes	
7.2	CE label or equivalent	Yes/No	Yes	
8	**Supportive Documents**			
8.1	General Physical information	Yes/No	Yes	
8.2	Electrical Properties data sheet	Yes/No	Yes	
9	**Additional Information – To be listed by the Tenderer**			

Item No.	Description	Unit	Required	Tendered
9.1	To be defined by the Tenderer	-		
9.2	To be defined by the Tenderer	-		
9.3	To be defined by the Tenderer	-		
9.4	To be defined by the Tenderer	-		
9.5	To be defined by the Tenderer	-		

10.4 SPARE PARTS

The *Contractor* includes in his offer all the proposed spare parts for operation and maintenance of the Project. The *Employer*, at its option, may decide to purchase such additional spare parts subject to schedule of delivery to be agreed with the *Contractor.*

11. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Nkosi Ndika	Chief Technologist – Gx Engineering, Asset management, Mechanical Engineering
Thando Mbulawa	Auxiliary Engineering Manager
Terrance Mavunda	Manager Projects
Alfred Phatlha	PTM Manager
Lelethu Thipa	Civil Engineer
Zanele Kubheka	Project co-ordinator
Sibusiso Gazu	Configuration Management
Gomotso Phokojoe	Electrical Engineering
Harold Marobane	C&I Engineering
Mauritz Van Der Bank	Manager Engineering

12. REVISIONS

Date	Rev.	Compiler	Remarks
August 2022	0.1	HP Khorommbi	First Draft for review and input by other disciplines
August 2022	0.2	HP Khorommbi	Second Draft for Multi-disciplinary Review.
October 2022	1.0	HP Khorommbi	Final Document for Authorisation and Publication.

13. DEVELOPMENT TEAM

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

- Nkosi Ndika
- Hlawulani Khorommbi
- Lelethu Thipa
- Gomotso Phokojoe
- Harold Marobane

14. ACKNOWLEDGEMENTS

We would like acknowledge Site Engineering as well as Kusile Power Station operating and maintenance departments for their support during data gathering and plant walk downs.

Appendix A: LIMITS OF SERVICE AND SUPPLY (LOSS)

The Limit of Service and Supply (LOSS) requirements are issued to the *Contractor* in excel format

Appendix B: VENDOR DOCUMENT SUBMITTAL SCHEDULE (VDSS)

The Vendor Document Submittal Schedule (VDSS) requirements are issued to the *Contractor* in excel format. The *Contractor's* submission is not limited to the documentation as listed in a spread sheet, but as a minimum per system the listed documentation needs to be included.

Where the required submission requirements cannot be met, the *Contractor* may suggest different option to be accepted by the *Employer.* The content of the VDSS is revisable at any stage during the Project, Changes must be agreed by upon by both *Employer* and *Contractor* before submission of the new revision.