Eskom	Specification	Technology

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…………………………………..	…………………………………..	…………………………………..
[redacted]	[redacted]	[redacted]
EDWL	**Electrical Engineering Manager (Acting)**	**Engineering Manager**
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EXECUTIVE SUMMARY

Emission legislation as issued by the Department of Environmental Affairs (DEA) to Eskom Generation Power Stations (Air Quality Act, 2004 [Act 39/2004], Notice 248; 31 March 2010: Minimum Emission Standards) implies that all existing Power Stations should conform to a 100 mg/Nm^3 (N = Normalized cubic meter, 101.325 kPa, 0°C, normalised to 10% reference O_2, on a dry basis) particulate emission level. It further states that all operating plant shall conform to the new plant particulate emission limit of 50 mg/Nm^3 by 2020.

Tutuka Power Station's license however differs a bit from this general requirement. The table below is an extract of the existing license.

Point Source Code	Pollutant Name	Maximum Release Rate			Duration of Emissions
		(mg/Nm^3) *(mg/Nm^3)mg/Nm^3) expressed as on a daily average under normal conditions of 273K, 101,3-KPa , 10% Oxygen and dry gas	Date to be Achieved By	Average Period	
Stack 1 & 2 [U1 – 6]	PM	350	1 April 2015 to 31 December 2018	Daily	Continuous
		200	1 January 2019 to 31 December 2019	Daily	Continuous
		100	1 January 2020 to 31 December 2020	Daily	Continuous
	SO_2	3400	1 April 2020 to 31 December 2025	Daily	Continuous
	NOx	1200	1 April 2015 to 31 March 2020	Daily	Continuous

At the moment Tutuka Power Station is not able to operate sustainably within their particulate emissions license limit. The objective of this project is to pilot a solution to test the sustainability of Tutuka's ESP performance with the aim of reducing particulate emissions.

A pilot project for High Frequency power Supply (HFPS) done at Lethabo and Duvha Power Station (currently being implemented) proved to be a successful enhancement solution to improve ESP efficiency and reliability with a reduction in particulate emissions. Even without SO_3 conditioning the performance tends to be better than conventional units without conditioning.

The objective of this project is to install and test HFPS's at Tutuka Power Station to determine to what extent the ESP performance can be improved.

A new interlocking system will be installed on all the fields due to the deteriorated condition of the existing system.

The scope of work at Tutuka Power Station will include the design, manufacturing, installation, commissioning and performance testing of the HFPS units, PPMS and interlocking system and upstream supply transformers. The PPMS upgrade scope of work is described in detail in the C&I section. The station needs to advise how to best optimise the DHP availability.

The document is applicable to 3 off Tutuka Units for the replacement of HF power supplies and 6 off Tutuka Units for the replacement of upstream supply transformers.

1. INTRODUCTION

High frequency power supply technology was selected as an ESP enhancement technology. The project will be executed on the next available ESP unit opportunity.

The aim for the project is to install HFPS technology which can improve the ESP performance at Tutuka Power Station to a point where the ESP can operate sustainably within the particulate emission limit. To prove the capability of the technology on Tutuka Power Station, it is a requirement that the internals of the ESP be according to design specification and the DHP must be able to operate at its design capability. It must be noted that maximum performance will only be seen when HFPS technology is used in conjunction with flue gas conditioning.

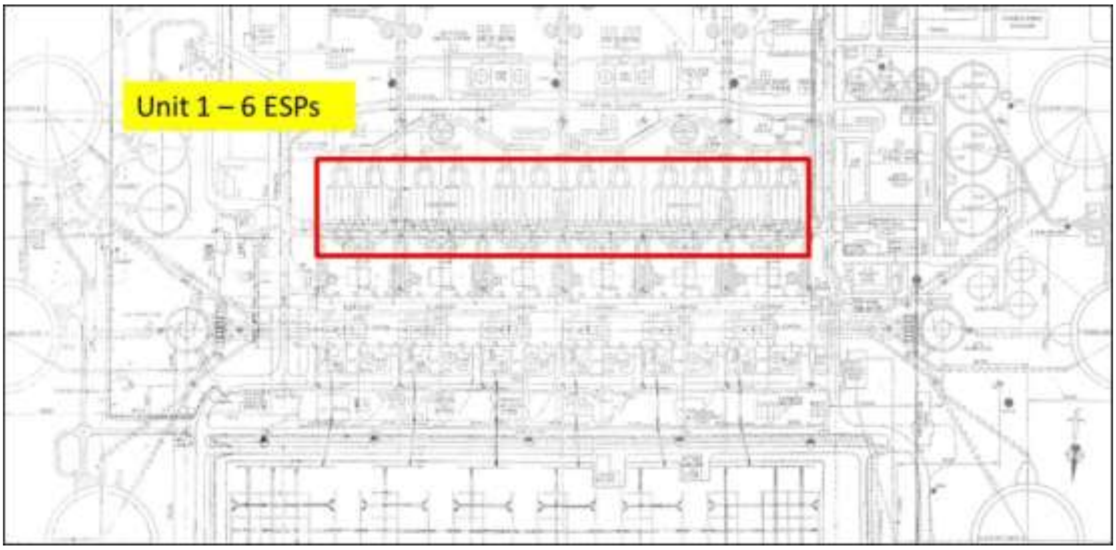

Figure 1-1: Tutuka Power Station plan view

The scope for this project for each identified unit will involve the removal of the 20 conventional transformers and replace them with 20 HFPS units as well replacement of 2 upstream supply transformers. The HFPS's will be installed on the footprint of the existing conventional transformers with the possible exception of the second and fifth field which might get a new platform due to space limitations. This is dependent on the successful supplier's product size and design.

The Contractor will have to interface with *Others* during outage work. ESP internal maintenance will be performed by *Others* during the outages.

The Contractor is responsible for carrying out all activities and supplying everything necessary to provide the *Works* in accordance with the requirements of this Technical Specification. It is the responsibility of the *Contractor* throughout the execution of the different contract activities to bring to the attention of the *Employer* any potential risks that could impact the completion of the *Works* and recommends cost effective changes and obtains acceptance from the *Employer*.

The scope of work includes the engineering, design, manufacturing, factory acceptance testing, site delivery, installation, commissioning, optimisation and performance testing. All *Work* shall conform to the *Employers* Standards listed in section 3.9 of this document.

The *Contractor* shall be responsible to optimise all 5 fields in each of the 2 casings within the ESP. As a minimum the optimisation shall include:

- Electrical optimisation of the controllers.
- Optimisation of the rapping system (full power rapping, power off rapping, reduce power rapping, clean system rapping, incremental rapping, automatic rapper test rapping, start-up and shutdown rapping).
- Optimisation using pulsing/intermittent energisation.

2. SUPPORTING CLAUSES

2.1 SCOPE

The scope is applicable to 3 Units at Tutuka Power Station of which the requirements are set out in this document includes the following but not limited to:

- Design, Supply, replace, installation and commissioning 12, 2MVA Upstream supply transformers
- Design, Supply, replace, installation and commissioning 60 HFPS units for ESP fields on the selected Units.
- Design of new platforms if required.
- Design and install a new interlocking system for safe isolation of the ESP.
- Modifications to electrical panels to meet the requirements of the HFPS units.
- Design, supply, installation and commissioning of new PPMS and replacement of the SixNet I/O modules with the latest technology.

The *Contractor* is responsible to hand over a fully functional HFPS units installed and controlled from the PPMS.

2.1.1 Purpose

This scope of work is developed to:

- Improve ESP electrical power performance and subsequently lower the particulate emission.
- In order to meet the Emission License Limit set out by the Department of Environmental Affairs (DEA).
- To improve control and optimisation of the ESP.

It should be noted that the maximum effect on particulate emissions will be noticed when HFPS is used in conjunction with Flue Gas Conditioning and refurbishment of the ESP.

2.1.2 Applicability

This document is applicable to various engineering disciplines: Electrical, C&I, Civil & Structural, Boiler Auxiliary, Bulk materials handling, Integration, and functional areas interfacing with Engineering on the project: Project development, Finance, Sustainability, Risk and Tutuka Generation.

2.2 NORMATIVE / INFORMATIVE REFERENCES

2.2.1 Normative

[1] 23901367 – Tutuka High Frequency Precip Transformer Retrofit

[2] 360-TUT-AABZ28-D00017-4 SRD Tutuka High Frequency Power Supply Project

[3] 360-TUT-BDDD-D00185-16 - Tutuka High Frequency Power Supply Project Basic Design Report Rev1

[4] Memorandum – Coal and Ash Flowrates for the fleet based on Boiler Mass and Energy Balance. 2016/11/30

2.2.2 Informative

[5] 240-53114002: Engineering Change Management Procedure

[6] 240-53113685: Design Review Procedure

[7] 240-53114026: Project Engineering Change Management

2.3 DEFINITIONS

High Frequency Power Supply	The HFPS unit takes a three phase input and rectifies it to DC which is then converted to high frequency through the IGBTs. The voltage gets transformed to high voltage and then rectified to DC.
Conventional TR	Takes a single phase input and steps up to high voltage which is then rectified to a DC before being fed into the ESP fields. This uses a SCR based controls.
Pilot Project	A pilot project in this document refers to the first unit on the station being retrofitted with HFPS.

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
C&I	Control and Instrumentation
CoE	Centre of Excellence
DC	Direct Current
DEA	Department of Environmental Affairs
DHP	Dust Handling Plant
EDWL	Engineering Design Work Lead
ERA	Execution Readiness Assessment
ESP	Electrostatic Precipitator
GO	General Overhaul
HFPS	High Frequency Power Supply
HT	High Tension
HV	High Voltage
ID	Induced Draft
IGBT	Insulated Gate Bipolar Transistor
IO	Input/ Output
IR	Interim Repair
MFPS	Medium Frequency Power Supply
PLC	Programmable Logic Controller
PLCM	Project Life Cycle Model
PPMS	Precipitator Plant Management System
QA/QC	Quality Assurance/ Quality Control
SCADA	Supervisory Control And Data Acquisition
SCR	Silicone Controlled Rectifier
SMPS	Switch Mode Power Supply
TR	Transformer Rectifier
UPS	Uninterruptible Power Supply

3. TECHNICAL SPECIFICATION

The purpose of this *Technical Specification* is to state the *Employer's* requirements and provide the *Contractor* with the necessary information to submit a comprehensive tender in order to replace the conventional transformers with HFPS units and upgrade the PPMS and replace the obsolete SixNet I/O modules for control and optimisation.

3.1 EMPLOYER'S DESIGN

3.1.1 Tutuka ESP Operating and Current design data

The existing particulate emission control plants at Tutuka Power Station units 1 to 6 are of the Lurgi design without flue gas conditioning.

The ESP's are located outside the boiler house between the air heaters and ID fans. The ESP plant for each unit consists of 2 parallel casings, each having two gas passes without any division wall. Each pass has five electrical fields in series. The ESP's were originally designed with a collection efficiency of 99.8% based on the design coal quality at the time.

The station needs to do the relevant ESP maintenance during an outage on the internals to make sure they are in a good working condition.

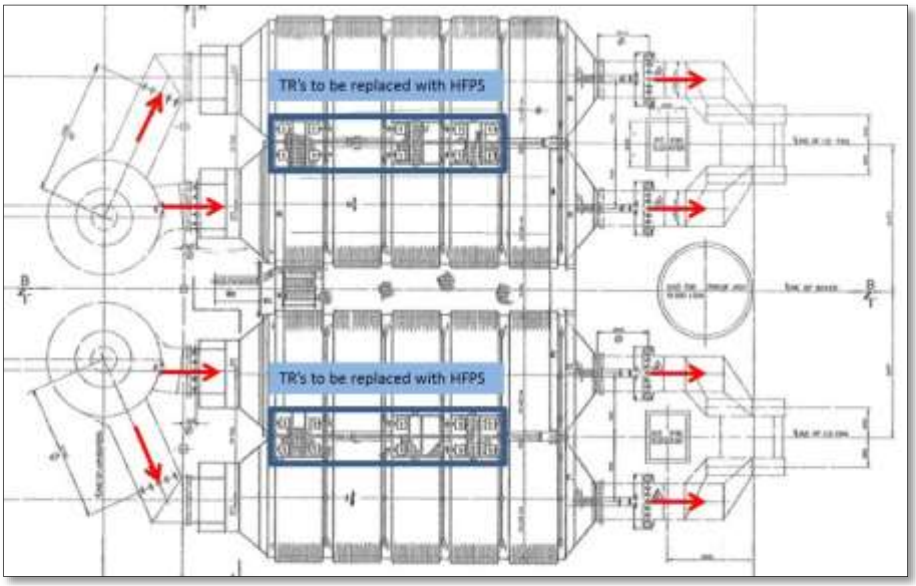

Figure 3-1: ESP plan view showing power supply layout.

The following table lists the original design specifications for the Electrostatic Precipitators. The original design data is for information only.

Table 3-1: Tutuka ESP design

STATION	
Units	1 to 6
Commissioning date	1985-1990
Manufacturer	Lurgi
ESP Design License	Lurgi

Table 3-2: Tutuka ESP design data

DESIGN DATA	**Unit**	**1 to 6**
Boiler rating (at 97% MCR)	MWe	600
Efficiency (at 97% MCR) for all fields in service	%	99.8
Parallel casings	#	2
Plate height	m	13.75
Plate length	m	4.8
Lanes per filter casing	#	66
Pitch between lanes	mm	400
Fields per casing	#	5
Plate area (total)	m^2	87120
Flow area	m^2	726
Specific collecting area	s/m	91
Number of TR Sets	#	20
Aspect ratio	#	1.7

Table 3-3: Transformer Rectifiers Unit 1-6

Number of TR sets	#	20
Output power	kVA	48 (per TR)

Table 3-4: Existing TR design data

Manufacturer	Siemens
Power Rating	87.4kW
Supply Voltage	380 V
Supply Current	235 A
Output Voltage (RMS)	65 kV
Output Voltage (Peak)	111 kV
Output Current (mean)	800 mA
Output Current (RMS full load)	1120 mA
Ambient Temperature	40 ˚C
No load loss (Power Pack + Rectifier Transformer losses)	0.95 kW + 3.0 kW = 3.95 kW
Oil Quantity	1000 kg / 890 l
Total mass	2200 kg

Table 3-5: Existing 11/0.4 kV precipitator transformer design data

Manufacturer	Siemens
Power Rating	1600 kVA
Voltage Ratio	11 / 0.4 kV
Current Ratio	84 / 2309 A
Vector Group	Dyn11
Phases	3

Frequency	50 Hz
CT Type	2500/ 1A
No.of taps	5
Cooling	AN
Total mass	4570 kg

Table 3-6: Operating design data (97% MCR)

Gas volume flow rate	Am^3/s	957
Gas temperature	°C	130
Dust burden	g/Am^3	12.2
Treatment time	S	18.2
Migration velocity (Deutsch)	mm/s	68.3
Migration velocity (modified Deutsch, k=0.5)	mm/s	424.2
Gas velocity at electrodes	m/s	1.3

Table 3-7: Tutuka minimum Coal Quality for design

Coal Specification – 6% Reject (as received)		
Nett C.V.	MJ/kg	18.56
Nitrogen	%	1.19
Oxygen	%	5.71
Carbon	%	52.57
Ash	%	30.5
Hydrogen	%	2.71
Sulphur	%	1.32
Total H_2O	%	6

3.1.2 C&I design

Unit Control System: Units 1 – 3 are operating on Siemens Iskamatic B binary control and the Teleperm C analogue control range of products whereas Units 4 – 6 has ABB P14 DCS.

PPMS: precipitator plant management system provides the HMI to the precipitator field controllers (MCSII) as well as the DHP system. The HMI is built on ClearScada system.

3.1.3 DHP Design

Tutuka's DHP is designed at a removal capacity of 72 Tph. From the process modelling it was estimated that there is a negligible increase in ash loading and as a result an upgrade is not required on the DHP for the HFPS test.

3.1.4 Civil & Structures

At present, the transformers are located on the roof of the ESP structure. Each pair of ESP casing is served by 10 electrical transformers. The 10 transformers are positioned on a structural steel platform which is support by the main roof beams of the ESP structure. Drawing 0.61/08996 Rev.02 provides a plan view of the steel platform. The steel platform is equipped with rails which allow the transformers to be moved into position from the center of the casing. A hoisting system (crawl beam) is located at the center of the casing.

The *Contractor* adheres to the following functional requirements in the detail design verification of the HF power supply project.

1) Reuse of the existing steel platform with modifications where possible.
2) Adhere to the applicable SANS and Eskom standards

The *Contractor* is required to verify, optimize and develop the structural requirements based on the HFPS physical design taking full professional accountability and liability for the structural design requirements where required.

It should be noted that on the previous HFPS replacement, it was discovered that the existing platforms were insufficient to accommodate the new HFPS units, hence additional platforms were required. The additional platforms were similar in dimensions of the existing platforms for uniformity. Figure 3-2 illustrates the position and arrangement of the additional platforms.

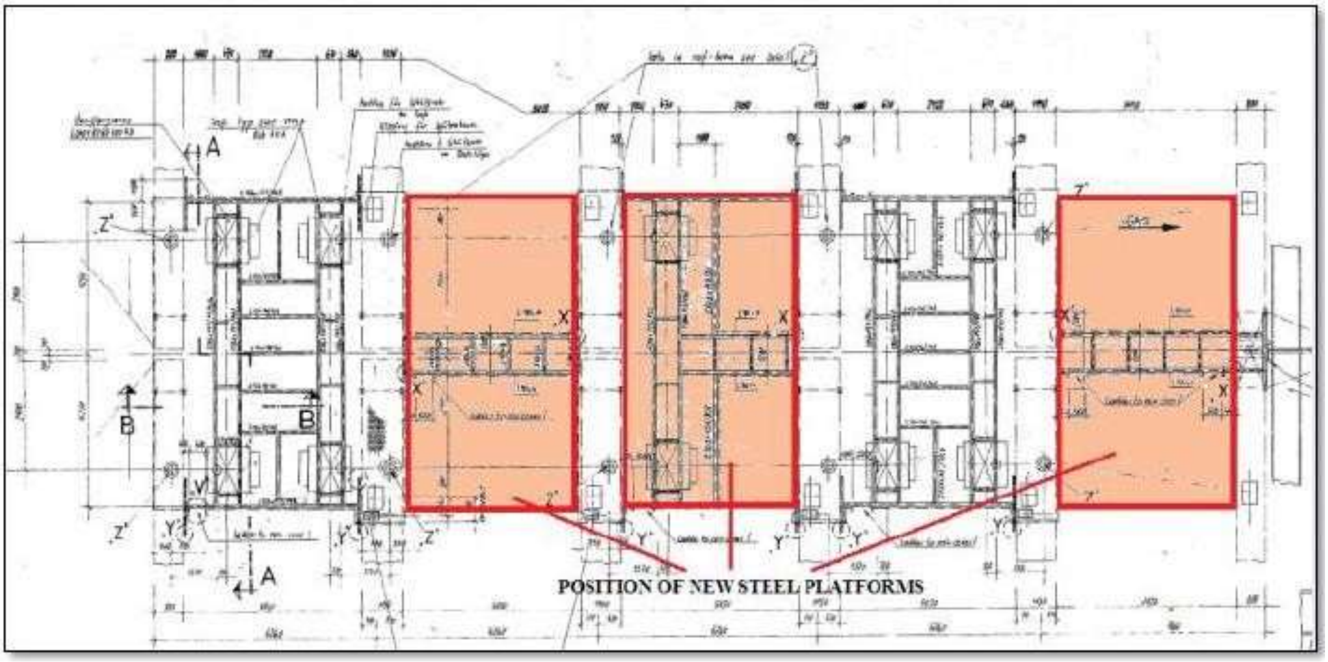

Figure 3-2: Position of new steel platform (extract from drawing no. 0.61/08996 Rev. 2)

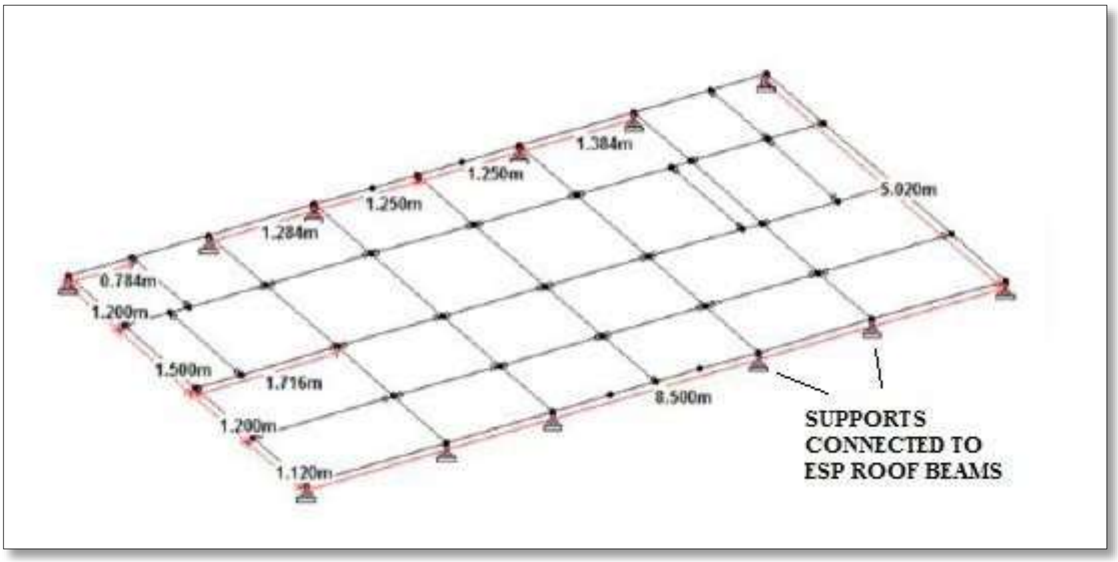

Figure 3-3: Plan view of the steel platform frame

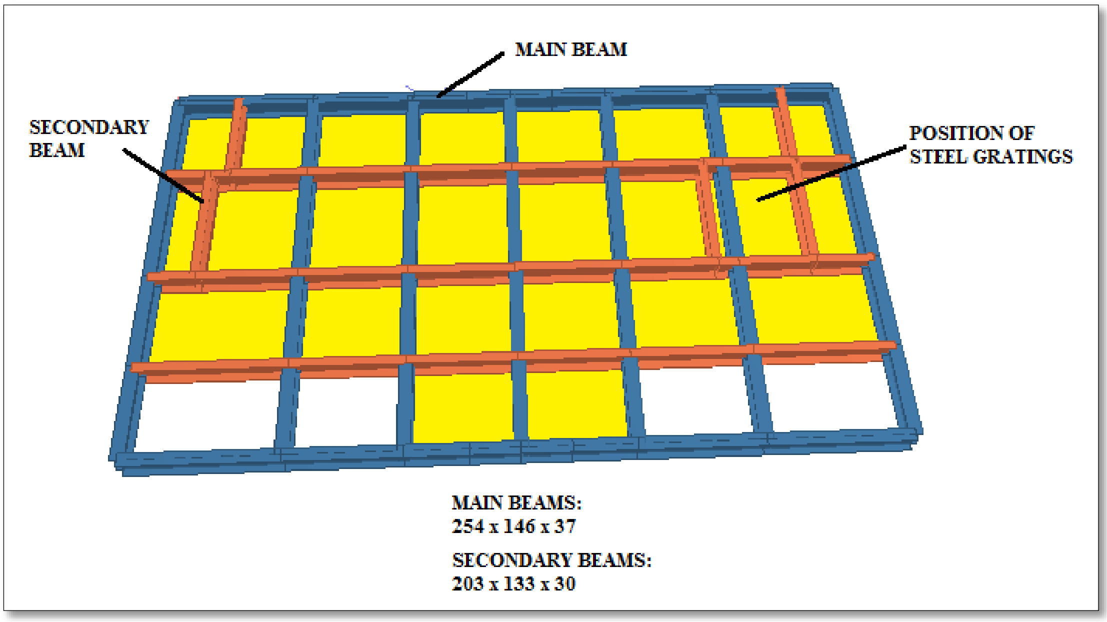

Figure 3-4: Isometric view of the steel platform frame

A preliminary structural analysis was performed on the roof beams of the ESP structure. Each beam is simply support with a span of 13.4 m. The roof beams are constructed from steel plates to form a box section beam. Longitudinal and vertical L-section angles provided stiffness to the roof beams. Refer to drawing no. 0.61/8975, Rev 01 which provides detail information on the ESP roof beams.

From the structural analysis, the roof beams of the ESP structure was found to resist the loading exerted by the new HFPS transformers and the additional steel platforms. The following modifications were recommeded based on the previous HFPS transformer replacement to ensure that the structural integrity of the roof beams are maintained:

1. Installation of additional longitudinal stiffeners on the top flange of the beam.
2. Installation of additional shear stiffeners along the beam.

3.1.5 Existing Process Conditions

Table 3-8: Existing process operating conditions

Parameter	Unit	Value
Gas volume flow	Am^3/s	1377 (max)
Inlet dust burden	g/Am^3	17.22
Outlet emissions	mg/Nm^3	>100
Inlet gas temperature	°C	140 - 170

SO_3 Injection rate	ppm	None
Site Barometric pressure	kPa	84
Site Elevation	m. a. s. l.	1619

3.2 PARTS OF THE WORKS WHICH THE CONTRACTOR IS TO DESIGN

3.2.1 General

The *Contractor* provides the *Employer* with the most suitable design for the application on Tutuka Power Station. The main aim will be to reduce particulate emission and increase ESP electrical performance.

The *Contractor* takes full responsibility for designing and supplying of all modifications that require the installation of the new power supplies and associated equipment.

The *Contractor* evaluates the required *works* on the identified unit and determines if any preparation *works* can be performed prior to unit shut down. The objective is to reduce required execution time for the scheduled shutdown. The *Contractor* submits a detailed installation plan for the acceptance of the *Employer.*

The *Contractor* removes the existing rectifier transformers, upstream supply transformers and the other redundant equipment, as stated in the relevant section of this document, and move to a location on site identified by the *Employer.*

The *Contractor* is responsible for the erection and installation of the new power supplies on the ESP roof.

The *Contractor* is responsible for the erection and installation of the new upstream supply transformers.

The *Contractor* submits a detailed method statement for the installation of HFPS units, Upstream transformers, including removal of the old equipment for the acceptance by the *Employer.*

The *Contractor* supplies the *Employer* with required drawings for the *works*. .

The *Contractor's* design is expected to meet the performance guarantee as stipulated in section 3.7

The *Contractor* provides technical support as follows for the entire HFPS warranty period:

- Telephonic support within 24 hours after a reported fault/failure.
- Based on the outcome of the telephonic support if call out support is required the *Contractor* needs to give on-site support within 48 hours from the reported fault.

The *Contractor* identifies critical spares requirements and indicates the availability locally and foreign. The *Contractor* indicates the lead time on critical spares.

The *Contractor* supplies a full operating maintenance cost schedule with associated labour cost to perform each item per maintenance item and will include the cost as a takeout option for the entire warranty period.

The *Contractor* replaces the current key interlocking safety system for safe isolation of the ESP plant. The *Contractor* ensures that it is possible to isolate a single field at a time for on-load maintenance. A complete isolation procedure for the ESP with the new interlocking system is supplied by the *Contractor*.

The PPMS is upgraded to be fully functional for control and optimisation of the ESP. It provides the capability to add flue gas conditioning plant control in future.

Complete engineering and design for the installation of the HFPS units with associated equipment and control devices.

3.2.2 Mechanical design

1. The interfacing point will be the HV connection point on the DE frame inside the ESP hot roof. The inlet to the hot roof is through the HV inlet flange on the ESP roof. This flange may be moved but the *Contractor* is responsible for the closure of the existing flange as well as the fitment and installation of the new flange to interface with the HV connection point as well as the new HV line to connect the HFPS to the DE frame.
2. The *Contractor* verifies whether the existing flange on the roof, connecting to the HV ducting, has sufficient diameter to prevent arcing in this area. If the diameter is not sufficient the flange diameter is changed or a feedthrough insulator is installed by the *Contractor* in this area.
3. The interfacing between the ESP fields and HFPS must include an open and closed circuit system for ease of maintenance and replacement of equipment.
4. The *Contractor* connects the earth switch to the station earth. The earth switch conforms to the *Employers* earthing standard (240-56356396).
5. The *Contractor* verifies the size of the HV lead connecting the HFPS unit to the ESP field and replace if required.
6. The Contractor evaluates and identifies any mechanical scope related to the *works* which can be performed prior to unit shutdown

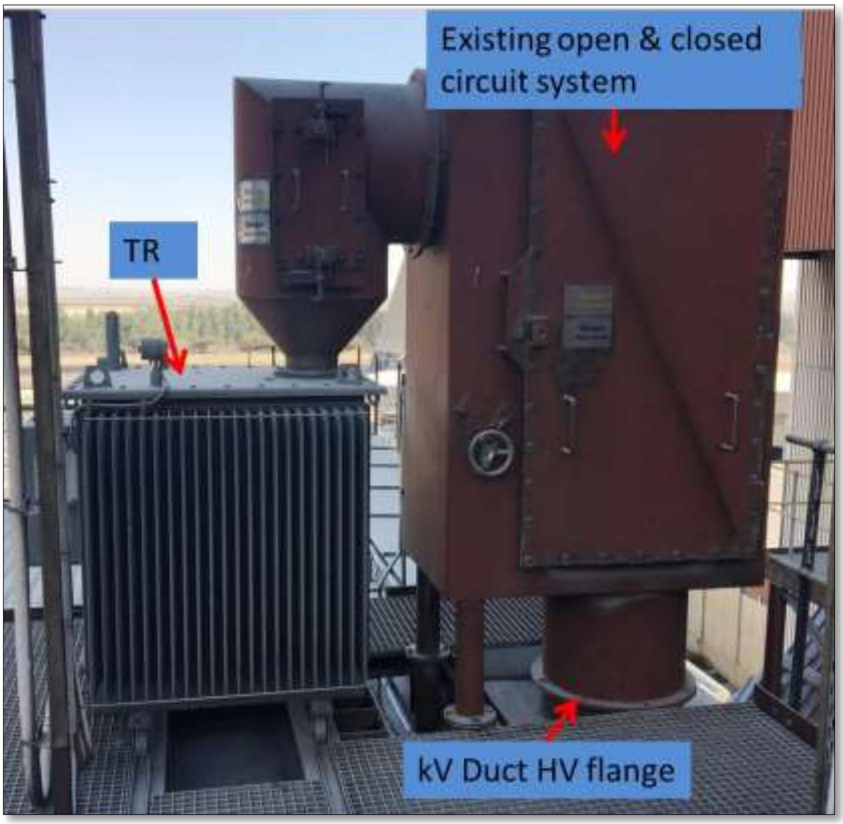

Figure 3-5: Existing TR configuration.

7. The HFPS casing which houses power electronics and control instrumentation has a rating of IP56 or higher.
8. The HFPS unit is easily accessible for maintenance. Access to the control cabinet is gained in a safe manner. In the case where it is required to step onto something to gain access the *Contractor* ensure that it is a safe and stable access platform.
9. The power supply can withstand strong wind gusts onto the side of the power supply. Wind design should be done in accordance with SANS 10160-3.
10. The *Contractor* shall be responsible for the arrangement of load testing of the existing overhead beam if the *Contractor* finds the need to use it during execution of the project. This will include the connection and disconnection as well as removal by a crane. If an existing load test certificate is valid the *Contractor* ensures that he operate the crawl beam within the certified limits of the beam.
11. The *Contractor* provides the *Employer* with approved welding procedures and welding qualifications for any welding to be done while performing the *Works* and ensures it is verified by the station welding engineer/representative.

12. The HFPS units will operate in a dusty environment. The HFPS units must be able to operate in these conditions with low maintenance requirements.
13. The HFPS units are adequately designed to operate optimally under the following abnormal conditions.
    - Ambient temperatures of up to 50°C in full sun on top of the ESP roof due to reflective radiation.
    - Ambient dusty environment >1500mg/m^3 per day
14. The *Contractor* will have to ensure that his product is able to operate under the above conditions. It is a requirement that the oil cooling system be operational in a dusty environment with a minimum maintenance intervention period of 1 year.
15. The HFPS layout on the roof is such that it is easily removable for maintenance or replacement. The existing TR's utilise tracks and steel wheels to move it to the crawl beam from where it is railed to the end and lowered.

3.2.3 Civil and Structural Design

1. The *Contractor* reviews and completes the full structural design of the *works* in accordance with the specifications and standards indicated herein.
2. The *Contractor* is required to confirm the available space for the new HF power supplies and performs a structural analysis and design on the existing support platform for its reuse in the supporting of the proposed HF power supplies to be installed.
3. The *Contractor* is responsible for the design of a new support platform or the modification of the existing support platform or any other existing structures to accommodate the new HF power supplies.
4. The *Contractor* is required to conduct structural assessments to determine if the supporting columns and the roof beams for the ESP structure are able to withstanding the additional loading of the new HF power supplies and all modifications which will be required.
5. The *Contractor* is required to verify if the existing crawl beam is able to support the new HF power supplies. If the crawl beam is found to be unusable, then designs or modifications are required to ensure that the crawl beam can support the new HF power supplies.
6. The *Contractor* is required to conduct tests to determine the material properties of the structural steel used in the construction of the ESP structure to complete his design.
7. The *Contractor* is responsible for the surveying and production of any as-built information of the existing ESP required for the design.
8. The *Contractor* is responsible for the complete surveying and setting out of the *works* including establishment of any benchmarks, within Tutuka Power Station, which is required to complete the *Works*.
9. If survey information on existing benchmarks within Tutuka Power Station are unavailable, the *Contractor* is required to consult the Surveyor-General's office to obtain information on available registered beacons near Tutuka Power Station which can be used to establish any required benchmarks close to the *Works*.

10. The new platform is required to be equipped with removable hand-railings and access steel ladders.
11. The *Contractor* is required to ensure the structural integrity of all structural modifications and takes full accountability for any modifications made to the existing structure.
12. The *Contractor* is responsible to reinstate (to the original design) all affected finishes during the construction which includes ensuring the structure is gas tight, all insulation and cladding damaged during the *works*.
13. The *Contractor* submits the detailed design report and finalised drawings for acceptance before any construction can take place.
14. All designs or modifications are required to be designed for a lifespan of 35 years .
15. All structural designs are to be in accordance with 240-56364545 - Structural Design and Engineering Standard as well as all other standards and specifications referenced in this Works Information.
16. All structural steel used is required to be grade S355JR in accordance with SANS 50025.
17. Welded connections are required to be welded all around with a minimum of 6 mm fillet welds or the appropriately designed fillet weld size. Butt welds are required to be full penetration welds.
18. Grade 8.8 bolts are used throughout, as a minimum. These bolts are not hot-dip galvanised.

3.2.4 Electrical Design

The *Contractor* shall take full responsibility, professional accountability and liability for the electrical works, providing the following for review and acceptance before commencement of the works:

1. Consolidated detailed electrical design report, signed off by an electrical engineer, professionally registered with Engineering Council of South Africa (ECSA).
2. A list of all design criteria and parameters, specifications and standards used.
3. Electrical calculations with assumptions, design models used for performing such calculations, sources of information and any record of information associated with the completed works.

All drawings shall be subject to *Employer's* review, with final drawings to be signed by a professional electrical engineer, with name and ECSA registration number marked on all drawings. The *Contractor* shall provide detailed drawings of the entire electrical system, in Microstation Intergraph V8i DGN format as a minimum.

Any discrepancy or ambiguity between the *Contractor's* design and the *Employer's* specifications or requirements is to be immediately brought to the attention of the *Employer* for clarification and discussion.

3.2.4.1 HFPS Point of Supply

The existing panels shown in Figure 3-6 have been earmarked as the point of supply for the new HFPS units. The *Contractor* shall include calculations confirming the suitability of using these panels, based on the available capacity and the requirements of their design.

The naming convention of these panels shall be maintained, as per Table 3-5, where the first number on each panel label refers to the respective Unit number.

Figure 3-6: Control Panels for Existing Precipitator Rectifier Transformers

Table 3-5: Naming Convention of Existing Panels

Electrostatic Precipitator Left Hand 1 HY 11 - 1 HY 25	
Panel Label per Circuit	Description on Load Schedule (380V Precipitator Board A)
1 HY 11	Rectifier Field 1
1 HY 12	Rectifier Field 2
1 HY 13	Rectifier Field 3
1 HY 14	Rectifier Field 4
1 HY 15	Rectifier Field 5
1 HY 21	Rectifier Field 6
1 HY 22	Rectifier Field 7
1 HY 23	Rectifier Field 8
1 HY 24	Rectifier Field 9
1 HY 25	Rectifier Field 10

Electrostatic Precipitator Right Hand 1 HY 31 - 1 HY 45	
Panel Label per Circuit	Description on Load Schedule (380V Precipitator Board B)
1 HY 31	Rectifier Field 11
1 HY 32	Rectifier Field 12
1 HY 33	Rectifier Field 13
1 HY 34	Rectifier Field 14
1 HY 35	Rectifier Field 15
1 HY 41	Rectifier Field 16
1 HY 42	Rectifier Field 17
1 HY 43	Rectifier Field 18
1 HY 44	Rectifier Field 19
1 HY 45	Rectifier Field 20

The *Contractor* is responsible for design and supply of all equipment required for modifications to the existing panels shown in Figure 3-6.

The *Contractor* is also responsible for removal of any equipment in these panels that is not required for implementation of the HFPS system, with such removal only to be carried out after the written approval from the *Employer*. The *Employer* reserves the right to keep whatever existing equipment is removed, as possible spares for other units.

3.2.4.2 Ratings of Upstream Transformers and Switchgear

There are two identical 1600 kVA upstream transformers per unit, with one supplying the 380V Precipitator Board A and the other supplying the 380V Precipitator Board B, with main busbar rating for each of these boards being 2500A.

Note: Upstream transformers shall be replaced by (2x) 2000 kVA dry type transformers per unit in order to optimise the plant without overloading it.

3.2.4.2.1 Upstream Transformers High Level Scope

- The Works includes the complete replacement for 6 units' upstream supply transformers, of which each unit consists of 2. In summary a total of twelve (x12) 1600 kVA, 11/0.4 kV exisiting cast resin dry type transformers will be replaced with twelve (x12) 2000 kVA, 11/0.4 kV dry type transformers.
- The scope include provision for the procurement, design, manufacture, factory testing, delivery and transportation, storage and preservation, off-loading, installation, site testing and commissioning, acceptance testing, project management, quality control, training and handover of the new transformers and interfaces, ensuring a fully operational and functional electrical system.
- The Works include the interface design and restoration to the Employers existing electrical protection, alarm and control systems,
- The scope includes the decommissioning, removal, transportation, storage, preservation of the existing transformers, transformer auxiliaries to a site storage area identified by the Employer.
- The design include load calculations in order to determine the supply cables to these upstream transformers are adequate to carry the load.
- The Contractor shall perform a structural integrity test to ensure the floor will carry the load of the new transformers.

3.2.4.2.2 Employer's objectives and purpose of the Works

- The objective of the project is to replace the existing (x12) 1600 kVA, 11/0.4 kV cast resin dry type precipitator transformers and their auxiliaries.
- The new transformers shall provide sufficient power to optimally operate the HFPS installed.

3.2.4.2.3 Battery Limits - 11/0.4 kV Transformers

- The Contractors scope for these transformers is effectively limited between the 11/0.4 kV primary and secondary transformer terminals, inclusive of all transformer auxiliaries and equipment required to provide a safe and functional system.
- The Contractor shall execute associated civil, control and instrumentation, cabling and electrical bonding scope in accordance with Parts of the Works which the Contractor is to Design.

3.2.5 Parts of the Works which the Contractor is to Design

3.2.5.1 Scope of Work – 11/0.4 kV Transformers

- The Works are located at Tutuka Power Station, located in the Mpumalanga Province.
- The scope includes the provision for the procurement, design, manufacture, factory testing, delivery, storage and preservation, off-loading, installation, site testing decommissioning and commissioning, acceptance testing, project management, quality control, training and handover of twelve (x12) new dry-type precipitator transformers. A total of x12 transformers are required.
- The Contractors major equipment that forms part of the scope include the following:
  a) Provision of (x12) dry-type transformers.
  b) Assessment of environmental conditions influencing the transformer design, transformer enclosure and transformer ventilation systems.
  c) Reuse of the existing transformers plinths by means of civil structural assessments or modification of the existing transformer plinth where required.
  d) Provision of electrical power, protection and control cabling, racking and routing designs.
- The Contractor shall ensure that entire Works are designed to ensure safe, fully operational and functional electrical Plant.
- The Contractor shall be responsible for the removal and transportation of decommissioned Plant off from site or to an area identified by the Employer.
- The Contractor will be responsible to remove the existing transformers out of the transformer bay to the area identified by the Employer.
- The Contractor shall, in the execution of the Works, accordingly employ a uniform approach across the Works with respect to design philosophy, basic functional and performance characteristics, system interfaces and documentation.

- The Contractor shall maximise the level of compatibility, inter-changeability and commonality in the operational, procedural, material, technical and administrative fields to achieve, simplified operation and maintenance, optimised spares holdings and reduced lifecycle management costs.
- The Contractor promptly notifies the Employer in writing of any deviation from the specifications prescribed. Deviations that are not formally submitted to the Employer shall be interpreted by the Employer to mean that the offer and Works are in full compliance.
- The Contractor shall only offer new components and materials utilized in the manufacture and construction of the Plant.
- The Contractor shall design the Works to operate effectively for at least 35 years (expected design life).
- The Contractor shall ensure the Works perform as designed for the ambient and other environmental conditions currently prevailing in the transformer bay area without detrimental impact to the performance and equipment normal life expectancy.
- The Contractor must provide a Certificate of Compliance (COC) for work completed.
- The Contractors safety design methodology shall take into consideration the following as a minimum:
  a) The Contractor shall not mount electrical equipment on removable walkways or structures.
  b) The design shall as reasonably practical, shroud or shield electrical live parts to prevent unintentional electrical, physical or mechanical contact by personnel or objects.
  c) The Contractor design shall take into consideration the Employers Plant Safety Regulations specifically around the elements of *Live Chambers* and *Restricted Access*.
  d) Any physical barriers, enclosures, auxiliary panels or operating devices required for the design shall be implemented by the Contractor and accessed by means of the Employers operating padlocks **Error! Reference source not found.** ensuring restriction of these areas or operating devices to un-Authorised persons.
  e) The Contractor design shall ensure that the Works are designed fail safe.
- Where the Contractor tender submission transformer design has not been proven for at least five years of operational service, the affected parts and the extent of the operational experience shall be declared in the tender / proposal.
- The Contractor shall submit all documents as prescribed in the**Error! Reference source not found.**VDSS.
- The Original Equipment Manufacturer (OEM) shall execute all major equipment and scope of the Works. If the major equipment offered is manufactured under licence, the tenderer shall provide an official proof of licence agreement made with the OEM. The duration of the agreement should match

that of the Contract. Distributors or agents shall similarly provide the OEMs authorization of the agent/distributor to execute the Works.

- All documentation shall be provided and presented in English.

3.2.6 General Electrical Requirements

3.2.6.1 Dry Type Transformer Requirements

- The Contractor provides all twelve (x12) dry-type transformers.
- The transformers shall be of the following specification
  a) 2000 kVA
  b) 11/0.4 kV
  c) Dyn11
  d) Resin encapsulated dry type transformers (or better)
  e) Air Natural (AN) cooling method is preferred
  f) Forced Air (FA) cooling may be submitted as an alternative offer.
- The encapsulated Dry-type transformers shall comply with SANS 60076-11, including all relevant parts of this specification.
- The new dry-type transformer will be located in the current location of the existing 1600 kVA transformers at 16m level at Tutuka Power Station.
- Where there are local control and indication instruments, they shall be accessible without the necessity to open cubicle/enclosure doors.
- As a tender returnable the Contractor shall complete Schedule B of Dry Type Transformer Schedule A&B.
- In accordance with SANS 60076 -11, the Contractor shall design an encapsulated dry-type transformer capable of emergency operating conditions and interim controlled transformer overloading which shall not impact on the operating life of the transformer as required in Schedule A.
- The Contractor shall design the encapsulated dry-type transformer to resume normal operation without causing damage to the Works and without operator intervention, while not affecting the guaranteed life expectancy of the electrical equipment.
- The Contractor shall ensure that the transformer design, auxiliaries and control panels consider the service conditions as stated in SANS 60076-11 clause 4.1. The Contractor shall thus design the transformers taking into consideration fine dust and coal particles present in the precipitator transformer bay areas.
- The Contractor shall ensure that the equipment design is suitable for safe operation by personnel.

3.2.6.2 Electrical Input Quality of Supply

3.2.6.2.1 Frequency

The system nominal frequency is 50Hz. The deviations and durations to rated frequency will be provided in schedule A.

3.2.6.2.2 Voltage Unbalances

The transformer must be capable of normal operation without any deleterious effects when exposed to unbalanced voltages of not more than 3% negative phase sequence and/or the magnitude of one phase not lower than 5% than any of the other two for 6 hours.

3.2.6.2.3 Harmonic Distortion

A total harmonic distortion with a total harmonic content not exceeding 5 % and an even harmonic content not exceeding 1 %, applies unless otherwise specified in Schedule AB.

3.2.6.3 Transformer Cooling

3.2.6.3.1 (AN) Air Natural Cooling Class

- Air Natural (AN) cooling method is the preferred cooling method.
- Forced Air cooling may be submitted as an alternative offer.
- Water cooled medium transformers shall not be provided or offered.
- The Contractor shall perform an assessment of the environmental and ambient conditions that may influence the transformer cooling and ventilation design.

3.2.6.4 Wheels and Undercarriages

The dry-type transformer shall be equipped with bi-directional wheels permitting insertion and removal of the transformer from its operating position. These wheels shall be permanently installed and can be locked or dismantled during transportation or operational service mode.

3.2.6.5 Transformer Protections and Interface

- The Employer is responsible for the provision of transformer protection schemes and switchgear transformer protection equipment.
- The Contractor transformer design shall further take note of the Employers transformer protection scheme requirements defined in 240-143485806 Generation Auxiliary Plant Medium Voltage Protection Standard par 3.4.7 and inform the Employer on unique specific dry type transformer protections required.
- As a minimum and in conjunction with the protection requirements stipulated in the Employers standard 240-143485806 the Contractor shall design the Plant enabling for the following dry type transformer protections:
    a) Current differential protection
    b) Winding temperature protection

c) Over current protection

d) Earth fault protection

3.2.6.6 Transformer Auxiliary Power Supplies

- The Contractor shall use the existing transformer power supplies and indicate the auxiliary transformer power supply requirements in the 240-56227927 electrical load list template if any changes, enabling the Employer to allocate the required power supplies circuits to the appropriate switchgear circuits.
- Where the available power supply source is a spare-unequipped-circuit, the Contractor is required to procure and install all the necessary electrical components (e.g. MCB's, live and neutral wiring etc.) at the power supply source (i.e. Switchgear) identified.

3.2.6.7 MV Power Cabling

- Based on the design requirements, the Contractor shall reuse the existing 11kV power cables or advise the Employer if new cables are required. In this case the Employer will supply the Contractor with the cables for the Contractor to install.
- The Contractor shall disconnect, test and re-terminate the existing MV power cables.
- The new dry-type transformers shall permit effective installation and termination of the existing MV cables on both the primary and secondary side of the transformer. The Contractor is responsible to take detailed measurements of the MV cable termination take off details for reuse of the 11kV cables. The LV cables will be replaced by the 150 mm^2 cable, of which the Employer will supply.
- The Contractor shall be responsible for any MV cable joints and cable boxes complete with all the fittings necessary, and safety signs for attaching and connecting the existing cables as specified.
- The Contractor shall complete the Employers cabling schedules templates (240-5616097) indicative of the existing and new cabling requirements.

3.2.6.8 Special Tools and Equipment

- The Tenderer / Contractor shall provide, as part of the Works and free of charge, all the special tools and equipment which are required for the normal maintenance of the transformer.
- The Tenderer / Contractor shall provide a complete listing of such equipment and tools with their specific characteristics, including type, manufacturer and purpose.
- Such tools and equipment may be used for the erection of the transformer provided that it shall be handed over to the Employer/Engineer in an as good as new condition approved by the Employer/Engineer.

3.2.7 Dry Type Transformer Functional Requirements

3.2.7.1 Rated Power

- The values of rated power as specified in Schedule A shall be the continuous conventional apparent power rating, in MVA.
- Each of the transformer windings and tap positions shall be designed for the specified (MVA) rating at a voltage equal to the appropriate nominal system voltage as specified in Schedule A.
- The design shall ensure that the transformers operate under normal conditions without exceeding the temperature rise limits.

3.2.7.2 Rated power with cooling fans or heat exchangers

- Air Natural (AN) cooling method is preferred.
- In accordance with SANS 60076-11 (5.2.2) the rated power for naturally air cooled and forced air cooled transformers where applicable shall be declared in Schedule B by the manufacturer.

3.2.7.3 Rated Voltage

In accordance with IEC 60076-1 the rated voltages are specified in Schedule A.

3.2.7.4 Rated Frequency

Transformers shall be designed for a rated frequency of 50 Hz and a frequency deviation in the following range unless otherwise specified in Schedule A.

a. 48 to 52 Hz continuously;

b. 47.5 to 52.5 Hz for not more than an hour per incident

3.2.7.5 Loading Beyond Rated Power, Voltage and Frequency

- In respect of IEC 60076-11 [5.2.6 and 5.6] the manufacturer shall provide the dry type transformer overload capabilities accordance with IEC 60075-12.
- In accordance IEC 60075-12 Appendix A & B the manufacturer shall as a tender returnable provide for the equipment offered, a detailed loading guide report inclusive of supporting data and mathematical graphs indicative of the transformers capabilities to continuously operate without damage for higher power, voltage and other than rated frequencies.
- In accordance to IEC 60075-12 the loading guide should detail as a minimum:

  a) Operating temperatures and thermal ageing under varying loading conditions and cooling scenarios

  b) Impact and consequence of loading above the nameplate rating with respect to the transformer life span

c) Permissible loading parameters during continuous loading, short time and long-time emergency overloading.

d) Continuous operation at rated power for “overfluxing” conditions.

e) The loading capabilities shall be demonstrated by an enclosed temperature rise test carried out in accordance with paragraph 3.2.7.7.

f) The transformer tapping’s shall be at Full-Power Tapping as defined in SANS/IEC 60076-1 [3]

3.2.7.6 Tappings

The requirements in IEC 60076-1 Clause 5 applies. The tapping range is ± 5 % in steps of 2,5 % (5 tap positions). Tapping selection shall be made off-circuit by the use of bolted links.

3.2.7.7 Thermal Performance

- The Contractor shall stipulate the insulation system thermal class in Schedule B.
- The most onerous temperature of any part of the core, metallic parts, adjacent materials and supporting structures in contact with the insulation or other thermally non-conducting material should not exceed the safe operating temperature of that material and adequate safety margins shall be included in the material selection criteria.
- The hot spot temperature shall not exceed the rated hot spot winding temperature as specified in Table 2 of IEC 60076-12.
- The Contractor shall declare, stipulate and apply corrections (if required) as specified in IEC 60076-11 for all reduced temperature rise applicable considerations as well as high altitude temperature rise corrections.
- The Contractor shall by submission of the loading guide demonstrate by thermal endurance testing or calculation methods compliance to the temperature rise prescripts stipulated in IEC 60076-11 and 60076 -12.

3.2.7.8 Transformer Climatic, Environmental and Fire Classification

- The transformers shall have unless otherwise stated in Schedule A
- A climatic class - C2
- Environmental classification - E2 and
- Fire classification of F1.

The classifications shall be verified by tests as prescribed in IEC 60076-11 and this specification

3.2.7.9 Mechanical construction

- The core and frame shall be of adequate strength to withstand, without damage, the stresses that shall be endured during handling, transportation, installation and service.
- All nuts shall be effectively locked by means of locking plates, standard machined lock nuts or other approved means. Pinning of bolt-ends and/or threads alone or the use of tempered pressed steel nuts shall not be acceptable.

3.2.7.10 Active part Materials

The Contractor shall provide:

- Details of the winding insulation application process and insulating materials used.
- Provide a cross-sectional diagram of the windings showing relative position to the core, dimensioned to indicate inner and outer diameters and axial length of each coil.
- The epoxy used shall be self-extinguishing and of a thermal class as indicated in Schedule A.

3.2.7.11 Lifting facilities

Lifting lugs or other means shall be provided for the convenient lifting the transformer and without imposing undue stress on the transformer assembly. The press beams must be adequately dimensioned so as to enable the entire transformer to be lifted as often as required.

3.2.8 Current Transformers

The final number, type and ratings of built-in current transformers shall be clarified with the Employer during the detailed design review phase.

3.2.9 Transformer short-circuits and overload

Current transformers shall be capable of withstanding mechanically and thermally the same over currents and overload, for the same periods, as the associated windings of the transformer.

3.2.10 Insulation levels and short circuiting for testing

- Current transformers shall withstand all dielectric tests applied to the power transformer windings, and shall be installed, in position and in circuit during the power transformer voltage withstand and impulse tests.
- Open circuits shall be avoided during testing of the transformer.
- All current transformers shall be shorted in the factory and delivered as such to Site.

3.2.11 Tests for current transformers

The current transformers shall be tested as per the latest IEC 61869-2 specification and test certificates provided.

3.2.12 Terminals and locknuts

Current transformer secondary terminals, where applicable, shall comply with the requirements described below, and they shall be indelibly marked for identification. All current transformer terminals shall be of the stud type and all connections shall be securely locked by means of lock nuts or locking plates. Steel lock washers are not acceptable.

3.2.13 Required data

The following information relating to protective current transformers shall be submitted for approval:

- Magnetization curve;
- Secondary winding resistance (temperature compensated to 75 °C, and
- Secondary winding leakage reactance.
- Insulation resistance

3.2.14 CT Designation

Where more than one protective current transformer is provided in any one phase, the current transformer designated "main protective current transformer" shall be located furthest from the transformer windings.

3.2.15 Data for rating and diagram plates

- Where current transformers are built into the transformer, the combined rating and diagram plate shall provide full details of each current transformer's location, polarity, secondary terminal markings and also all the information required by IEC 61869-2 as applicable, with the provision that no information be duplicated.
- The following symbols may be used on rating and diagram plates:
  a) IL = Secondary insulation Level (2 kV DC)
  b) Hz = Rated frequency
  c) Ith = Rated short-time current and rated time kA-s
  d) Rs = Secondary winding resistance at 75 °C
  e) N = Turns ratio
  f) Vk = Kneepoint voltage
  g) Im = Magnetising current

h) Ip = Primary current

i) Is = Secondary current

j) VA = Output in (VA).

3.2.16 Auxiliary Supplies, Terminal Boxes, Wiring and Cabling

3.2.16.1 Auxiliary Supply Voltage

The quality-of-supply of the transformer auxiliary equipment shall be considered and the Contractor shall ensure that this auxiliary equipment is not damaged by the specified voltage deviations or interruption or loss of auxiliary supplies.

3.2.16.2 Marshalling and Terminal boxes

- Marshalling boxes and terminal boxes shall be suitably IP rated , vermin-, dust- and weather proof and shall be provided with easily removable covers fixed by not more than two screws.
- Covers for terminal boxes may be of the slip-on type, and those for Marshalling boxes shall be hinged in a vertical plane.
- Marshalling kiosk access doors shall open to a minimum angle of 120 degrees and shall be provided with a door open retainer.
- The door opening in the box shall have a double-curved flange around its entire perimeter, the outer face of which shall form the gasketed joint.
- The top of the box shall be made to overhang the cover, except in the case of slip-on covers. These shall be double-curved and fitted with drip ledges for internal corrosion proofing.
- Each marshalling box shall be provided with not less than 10 % spare terminals with a minimum number of twelve spare terminals.

3.2.16.3 Incoming auxiliary circuits

- To prevent entry of water, the auxiliary wiring from current transformers and other auxiliary apparatus, shall be arranged for side or bottom entry into the marshalling or terminal box.
- If bottom entry is adopted, the gland plate used shall be independent of that provided for the Employers outgoing cables. If cables enter the terminal boxes or marshalling kiosk from the side, drip-loops shall be provided to prevent water from entering the cable gland.

3.2.16.4 Auxiliary Cabling and Wiring

- The wiring, terminals, lugs, identification and installation shall be in accordance with the Employers standard
- Only corrosion resistant cable glands for armoured cables shall be used.

- Plastic compression type cable glands shall not be used on armoured cables.
- All cable terminations shall be provided with cable numbers fitted to the cables on both ends.
- Only permanently engraved, non-corrodible, ultra violet, oil and heat resistant material shall be used for cable numbering.
- These labels shall be permanently fixed to the cable ends just before the glands on the outside of the terminal box.
- The cable armouring shall be earthed at least one side.
- Earthing shall be by means of the steel cable gland.

3.2.16.5 Auxiliary wiring insulation and test voltage

- Wiring insulation shall be oil and moisture proof, and, where affected by temperatures above that of the ambient air, shall have thermal characteristics at least equal to class ‘A’ of IEC 60085.
- All auxiliary circuits shall withstand a test voltage of 2 kV DC for 60 seconds to earth and to all other circuits.

3.2.16.6 Supporting and securing of cables

- All control wiring shall be of a neat appearance, suitably braced, placed in wire trunks, clipped and/or laced to prevent vibration and not to be deformed under through fault conditions.
- Routing of cables shall be done to eliminate the cable from touching sharp edges.
- No cables in steel conduit will be accepted.

3.2.16.7 Terminals

- All terminals shall be subject to the Employers approval.
- All terminals, except those with soldered lugs, shall be suitable for use with crimped or compression type terminations.
- Moulding materials shall be self-extinguishing, or resistant to flame propagation, substantially non-hygroscopic and shall preferably not carbonise when tested for tracking.

3.2.17 Rating and Diagram Plates

- The rating and diagram plates shall be mounted on a suitable location on the transformer and or transformer enclosure situated in an accessible position not more than 1,5 m above ground level, and secured by stainless steel screws
- The plates must be finished in accordance with 240-56030674.
- Rating and diagram plates shall be of stainless steel not less than 1,2 mm in thickness, weather proof and fitted in a visible position.

- The required information shall be engraved on the plate and the engravings filled with glossy black, baked enamel.
- Any other arrangements in this regard shall be submitted to the Employer for approval.
- The minimum information to be displayed on the rating and diagram plate shall be in accordance with the requirements of SANS 60076 -11 with addition of the following:

3.2.17.1 Additional Information to be displayed

- The information displayed on the rating and diagram plate shall be in accordance with the requirements of SANS/IEC 60076-11 and, in addition, include the following:
  a) Tapping current values shall be shown for primary and secondary terminals for the principal tapping positions for all tapping positions.
  b) Transformer capability (including bushings and tap changers) to carry overloads in accordance with the emergency duties detailed in IEC 60075-12.
  c) Transformer system fault levels in kA (as specified in Schedule AB);
  d) Current transformer data as per 3.2.15 shall be shown;
  e) Employer reference, purchase and asset number;
  f) Working altitude and temperature;
  g) Average winding and hotspot temperature rises;
  h) Transformer insulation class
  i) Power rating for both forced (If applicable) and natural cooling;
  j) No-load and full load loss figure;
  k) Winding resistance, referenced to the permitted average winding temperature rise;
  l) Impedance and winding resistance reference temperature.

3.2.18 Contractor’s Transformer Design

3.2.18.1.1 General:

- The Contractor takes full professional accountability and liability for the Works as described in the works information.
- The Contractor supplies and/or procures all labour, equipment and materials required to provide the works. Furthermore, the Contractor constructs any works that can be reasonably inferred from this Employer’s specifications and drawings.
- The Contractor adheres to all design requirements, codes of standards and regulations stated in this works information.
- It is the Contractor’s responsibility to provide design and construction which is fit for purpose, in accordance with sound engineering principles and prudent industry practice. The Contractor and his subcontractors perform the works in compliance with legislation, rules and regulations, applicable national and international engineering codes, environmental standards, other applicable standards, statutory requirements and this Works Information.

No deviation from this works information and its referenced documents is permissible without documented acceptance from the Project Manager. The Contractor includes a list of exceptions and/or clarifications as part of his tender. This list of exceptions and/or clarifications includes the section deviated from as reference number, the requirement in question and a detailed

3.2.19 Existing Precipitator Boards (A and B) Loading

Based on the *Employer's* calculations, the estimated loading on each Precipitator Board (A and B), without the existing Rectifier Transformers, is as follows:

- Apparent Power Load = **171.4 kVA**

Under these assumptions, the available capacity per Precipitator Board for supplying HFPS units is:

- Available Apparent Power = 1600 − 171.4 = **1428.6 kVA**

The *Contractor* shall confirm these calculations, highlighting any discrepancies to the *Employer* as and when they arise. Based on the agreed available capacity, the *Contractor* shall optimise the operation and loading of the new HFPS units, in such a way that the upstream switchgear and transformers are not overloaded.

Note: The *Contractor* shall ensure that no additional harmonic content generated through HFPS operation is seen on the 380V side, by other loads supplied from the 380V Precipitator Boards. The *Contractor* shall provide confirmation of this and shall also prove this during Site Acceptance Testing via appropriate means of harmonic measurement.

3.2.19.1 Cabling Considerations

The existing cables shown in Figure 3-7 and Figure 3-8 terminate in each of the panels shown in Figure 3-6 and listed in Table 3-5. These cables have been earmarked for reuse for supplying the new HFPS units.

Figure 3-7: Control Panel Internals

Figure 3-8: Cable Arrangement

The cables shown in Figure 3-7 and Figure 3-8 are four-core, with each core being 95mm^2.

The existing Precipitator Rectifier Transformers are single-phase, with live and neutral each supplied using two parallel cores, meaning that each phase currently has an effective copper cross-section of 190mm^2. It is important to note that while the existing Precipitator Rectifier transformers are single phase, the new HFPS units will be 3-phase. The *Contractor* shall replace the 95mm^2 cable with the 150mm^2 cable in order to meet the load requirements.

The *Contractor* installs an additional dropper from the main busbar to accommodate 3-phase power supply to the HFPS unit.

The *Contractor* carries out an assessment of all cabling supplying the HFPS units and if any additional cables are required, then an assessment of existing racking shall also be carried out by the *Contractor*, to assess any new requirements.

The *Contractor* shall take into account derating factors included in Table 3-6 for sections of cable exposed to solar radiation. The *Contractor* shall assess all existing cabling, and where cables are exposed to solar radiation, shading shall be installed, to avoid the need for derating.

Table 3-6: Derating factor for Solar Radiation

Cross-Sectional Area of Conductor	Correction Factors	
	Solar Radiation	
mm^2	1000 W/m^2 (Coastal)	1250 W/m^2 (Highveld)
50 - 95	0.65	0.53

3.2.19.2 Junction Box and Isolation Switch

The *Contractor* shall install a junction box to accommodate any cable length discrepancies between the 400V isolator and the HFPS. The *Contractor* shall install an additional isolation switch to link the HFPS and the 400V supply cable. The junction box and isolation switch shall both have a minimum of IP65 rating.

3.2.19.3 Electrical Protection and Interfaces

The *Contractor* shall implement the requirements of *240-56227516 LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard*. Existing control panels shown in Figure 3-6 shall be retrofitted with isolator and fuses, once any unused components from the existing installation have been removed from the control panels.

Where possible, existing interfaces, operating philosophies and procedures shall be maintained and matched to the existing system, as shown in system documentation (0.61/4721 and 0.61/4722).

3.2.19.4 Earthing and Lightning Protection

The existing earthing and lightning protection system for the precipitators shall be reused. The new HFPS units shall be connected to the existing lightning protection that is connected to the station earth-mat. New metallic auxiliary equipment to the HFPS units will also be linked to the existing earthing and lightning protection system.

3.2.19.5 Earthing between Switchgear (380V Precipitator Board) and the HFPS panel

In the case of the existing four-core cable running from the 380V Precipitator Boards to individual HFPS Control Panels, either the fourth conductor of the four-core cable will be used as an earth conductor.

In the event that an additional single-core cable is pulled as an earth conductor, a single-core PVC insulated protective cable will be pulled from the 380V Precipitator Boards to individual HFPS Control Panels on the roof. This shall be a flame retardant reduced halogen emission cable.

This work shall comply with Eskom's Cabling Standard (240-56227443) and cable sizing referred from SANS 1973 and Employer Earthing and Lightning Protection Standard (240-56356396).

3.2.19.6 Pre-commissioning Requirements

The *Contractor* shall provide a consolidated Detailed Electrical Design Report in response to the contents of this Technical Specification and the referenced documents. The *Contractor* shall submit the Detailed Electrical Design Report for any and all parts of the electrical installation to the *Employer* for review and approval, before commencement of any construction, installation and commissioning of electrical infrastructure supplying the HFPS units.

The report shall include a list of all design criteria and parameters, specifications and standards used, as well as electrical calculations with assumptions, design models used for performing such calculations, sources of information and any record of information associated with the completed works.

Once the Detailed Electrical Design Report has been approved by the Employer, it shall be signed off by the *Contractor's* electrical engineer, professionally registered with Engineering Council of South Africa (ECSA), together with engineer's full name and ECSA registration number.

3.2.19.7 Decommissioning Requirements

The *Contractor* decommissions and removes the sixty existing Precipitator Rectifier Transformers. Once removed, the *Employer* indicates to the *Contractor* a location on site to deliver the Precipitator Rectifier Transformers. The *Contractor* decommissions the existing control panels, remove any unnecessary equipment and deliver this to the *Employer's* Stores. The control panels themselves shall not be removed, as the *Contractor* shall be required to retrofit and reuse these panels for the new HFPS units.

3.2.19.8 Commissioning Requirements

The Detailed Electrical Design Report provided by the *Contractor* shall include all procedures associated with commissioning of the electrical infrastructure supplying the HFPS units, with detailed of the following as a minimum:

- A detailed procedure describing the step-by-step process to be followed when commissioning the electrical infrastructure.
- A detailed Quality Control Plan (QCP), defining what needs to done at each stage of the commissioning and highlighting points for Employer's involvement (Hold, Review, Witness and Inform).
- A detailed description of any and all isolation requirements for safe testing and commissioning of the electrical system.

3.2.20 C&I design

3.2.20.1 Requirements for New System

The HFPS's integrated controller needs to be interfaced to the new Precipitator Plant Management System for control, monitoring, storage and alarming. Further, the Precipitator Plant Management System must handle as a minimum, the signals available on the OPC addresses (via OPC interface) from the ABB client at present servicing the PPMS, located in Unit 4 equipment room for Unit 4-6. It is believed that the OPC client is servicing Unit 1-3 via a VA client and is connected to the Castlet network via unit 1. The PPMS should be configured to handle all the signals requested.

The PPMS upgrade scope to replace the existing PPMS forms part of the HFPS project and will be executed the same time with the first unit to be installed. The strategy is to install the new PPMS or alternatively a standalone PPMS for the first unit.

The existing PPMS should be upgraded. The upgrade covers the PPMS servers, SCADA/HMI, SixNet I/O modules and minor modification in the ESP substation control cubicles to cater for the HFPS design.

The HFPS system design will interface with the upgraded PPMS via new interface junction boxes or panels. The existing rapping on all fields will be achieved by the HFPS integrated controllers.

The PPMS interfaces to VAview and PGIM for data storage and to the ABB P14 DCS in ALL the units.

3.2.20.2 General High Level Scope of Work

The C&I scope of work includes but is not limited to the following:

- Install the new PPMS by installing the new servers, SCADA software (Latest revision of the software or alternatively the latest technology) and operator clients in the control rooms. The existing PPMS servers common to unit 1-6 are obsolete and not in service. The old servers and equipment are decommissioned and removed when all the units are interfaced to the new PPMS servers.

- HFPS to be interfaced to the PPMS for control, storage, monitoring and alarming.
- New HFPS integrated controller, field equipment, field instruments, junction boxes and cabling for the complete system including interfacing to the PPMS.
- The PPMS will have the following process signals as a minimum: boiler load, back end temperatures, O_2 and hopper levels.
- All signals to be hardwired to the PPMS.
- A new or modified HFPS HMI mimic design for the PPMS.
- The PPMS shall be able to cater for Station's rapping philosophy (including rapper control).
- Power supply requirements for all C&I associated equipment.
- Cabling, racking (if necessary) and routing for entire HFPS system and interfacing to the PPMS.
- Special tools, programming devices and software for HFPS C&I system.
- The new HFPS process information must be linked to the PPMS for data storage. The PPMS is interfaced to the Plant Historians such as PGIM and VAview for long term information storage.
- Replace the obsolete SixNet I/O modules
- Provision of hardware and engineering for additional interfaces and control requirement on control systems.
- Updating of documents and drawings for the entire HFPS system and the PPMS.
- Training to be provided to Eskom on the HFPS including new PPMS interface.
- A C&I maintenance strategy to be provided of the entire HFPS system.
- Provision of Cyber Security since the PPMS is required to interface to external systems such as VAview and PGIM. Compliance to Software standard as well as cyber security standards to be specified
- Labelling of field equipment, including cabling.
- Provision of commissioning engineering support as well as commissioning spares

3.2.20.3 HMI

The *Contactor* makes provision for the design of the HMI mimic for the *Works*. The *Contactor* adheres to the Human Machine Interface Design Requirements Standard, 240-56355728.

3.2.20.4 Controllers

The HFPS has its own control system (integrated HFPS controller) with rapping and control capability. All the fields will be retrofitted with the HFPS units.

The *Contractor* does the field design for the HFPS unit's installation and ensures the correct interface to the PPMS. The overall interface to the PPMS is the responsibility of the *Contractor*. C&I design follows the mechanical and electrical designs in terms of redundancy and system configurations.

The HFPS interfaces to the control panel located in the ESP sub-station via interface boxes/panels. The required modifications of the existing control cubicles/panels to cater for the HFPS design is the responsibility of the *Contractor*.

3.2.20.5 PPMS Design

The existing PPMS at Tutuka will be ugraded. The scope of work for the upgrade of the PPMS includes the following as a minimum:

- There is currently no server that is operational. New redundant servers to be provided for the PPMS (Old servers to be removed/decommisioned). The existing not operational servers were common to unit 1-6. The first unit to get the HFPS will be interfaced to the new PPMS, then with the rollout of the project the second unit will follow and so forth.
- Operator clients in the control rooms to be replaced and upgraded with the latest alternatively similar technology. 20 Inch LCD screens are provided for unti 1-3 control rooms.
- The existing communication network is retained for the HFPS design but the integrity checks need to be performed and corrective actions implemented if necessary before the new systems can be installed.
- Provision will be made for the interface with VAview and PGIM plant historians.

The latest revision of the PPMS software shows the following as a minimum:

- Dust Density
- Sparking and Arcing
- Firing angle and must be digital

- Preciptator inlet and outlet temperature
- Secondary currents and voltages
- Start/Stop fields (Auto Start, Auto Stop and Manual Start)
- Show which sootblowing was in service
- Show which Mill is in service
- Field numbering
- Hopper Level Indication
- Local mode should be red in color showing that the field is not in auto
- Rapping
- Cleaning rapping left casing and right casing, cleaning rapping must be done separately
- Clarify information on field data screen such as START/TR, STOPPED, FIELD AUTO and etc
- Configured Alarms (how it works)
- Field cell trend screen must also default to 24 hours when it opens.
- Main screen trends to be on scale and make a full screen available and this full screen must default to 24 hours trend when opened.

3.2.20.6 Local Operation Interface

The Contractor designs for Local control panel for the HFPS unit systems.

Each of the HFPS display unit (Touch Screen KeyPad or Similar Technology) will be located in the ESP substation with associated power and communication cabling and interfaced to the control panel for the control and monitoring of the HFPS unit and its respective field.

The local operator interface allows for the following as a minimum:

- The setting and visualisation of the regulator parameters
- The display of measurement values and alarm messages
- Local start/stop of the equipment
- The system reset after a trip
- Conducting V-I curves.

3.2.20.7 Field Equipment and Cabling Design

The field design will make provision for interface junction boxes housing the network switches and associated network equipment. C&I designs follows mechanical configurations, thus HFPS signals from the left and right train will be interfaced via the left and right interface junction boxes respectively. HFPS controllers are capable of performing sequencing, queuing and rapping. Surger arrestors and associated cabling and junction boxes must be provided as part of the field design.

All field equipment to be installed according to the Field Instrument Installation Standard 240-56355754.

All junction boxes, enclosures and panels shall adhere to the Employer's standard 240-56355815, junction boxes and cable termination standard.

Temperature measurement systems are in line with the document 240-56355888, temperature measurements installation standard.

The routes for cabling between various equipment such as interface junction boxes/panels, unit control room, precipitator substation and roofing will follow the cable routes of the electrical system according to the 240-56227443 standard: Requirements for control and power cables for Power Station.

All field equipment to be integrated to the PPMS via interface junction boxes and panels. All cabling must be in conduits and racks as required by the works.

The racking and trunking that were used by the TR sets are reused for the HFPS's as much as possible.

3.2.20.8 Control philosophy and functional design specification

The Contractor compiles the control philosophy and functional specification for the HFPS unit systems (including the PPMS interfaces).

3.2.20.9 C&I system and equipment requirements

The following requirements must be read in conjunction with the applicable Codes and Standards:

3.2.20.9.1 Redundancies

All hardware, software and control network redundancy with regard to the control system and power supplies will be configured to match the redundancies of the various mechanical process areas. The C&I system redundancies will be consistent with the mechanical plant and electrical power redundancy and distribution configuration to minimise the effects of equipment failure on the overall unit. Through functional distribution of equipment, the C&I system will be designed and configured for the following reliability:

A. Safety

No individual C&I fault or no two concurrent faults endanger the safety of the people, plant or jeopardise the integrity of the major plant.

B. Unit trip/Load Loss

No individual C&I fault causes the unit load to drop below 45% MCR, or causes a forced outage or unit trip.

C. Multi-Unit Trip

No individual C&I fault or two concurrent faults cause a multi-unit trip.

3.2.20.9.2 Over capacity

This is not applicable for the project.

3.2.20.9.3 System expandability

This is not applicable for the project.

3.2.20.9.4 Spares

The Contractor will supply a spares list for the complete system.

Installing the new equipment on a single unit will impact overall spares and maintenance cost and strategy.

3.2.20.9.5 Security

The Employer will have full access to all configurable areas in the software. The system will have at least three fully configurable environments with password lockout to allow different access levels for Operating, Maintenance and Engineering.

The Contractor designs the C&I solution to meet the Security requirements in the Eskom Standard 240-55410927 Rev1 - Cyber Security Standard for Operational Technology.

3.3 ADDITIONAL REQUIREMENTS OF THE CONTRACTOR'S DESIGN

1. The *Contractor* takes full professional accountability and liability for the *works* and provides the following for review and acceptance:
    - A Level 3 schedule (schedule with defined activities) for the design verification scope clearly highlighting all activities involved, major milestones and provision.
    - Consolidated detailed design report signed by a Professional Civil Engineer which includes:
        - Design criteria/parameters, specifications and standards used, loadings, assumptions, calculations results including detailed design calculations, design models, sources of information and any record of other information associated with the completed *works*.
    - Detailed drawings for construction. All drawings are required to be submitted in CAD formats. All submitted drawings to be signed by a Professional Civil Engineer with ECSA registration number stated on drawing.
    - Construction Specifications for the *works* including measurement and payment items
    - Bill of Quantities for the *works*
2. Any discrepancy or ambiguity between the *Employer's* Specifications or requirements is immediately brought to the attention of the *Project Manager* for clarification.
3. The *Contractor* is mandated in terms of Construction Regulations 2014: Duties of Designer, 6(1) g to fulfil the duties described therein for the detailed designs done by the *Contractor*. Any risk associated with the *Contractor's* design is highlighted to the *Employer* together with mitigation measures.

3.3.1 General

1. The *Contractor* is required to confirm all site dimensions, drawings, levels and cast-in items positions on site prior to any fabrication of steel or casting of concrete.
2. The *Contractor* is required to submit a comprehensive method statement of the *works* to the *Project Manager* for acceptance prior to the start of the *works*
3. The *Contractor* is responsible for the design, erection, maintenance and removal of all temporary bracing or propping required for the execution of the *works.*

3.3.2 Structural Steelwork

1. All work is required to be in accordance with the latest edition of SANS 2001-CS1
2. The *Contractor* is responsible for the stability of the entire structure and all structural elements during all the erection stages.
3. All dimensions are required to be verified on site by the *Contractor* before any fabrication of steelwork commences.
4. All welding is required to be conducted by coded welders. Supporting documentation is also required to be submitted to the *Project Manager* for acceptance. All welding is required to comply with AWS D1.1.
5. All welds are required to be inspected using visual aids.

6. The *Contractor* is required to supply all bolts, washers, nuts etc. for the structural steelwork.

The table below indicates particular specifications pertaining to SANS 2001-CS1 and must be read in conjunction with the code.

Table 3-7: Specifications pertaining to SANS 2001-CS1

Clause	**Particular Specification**
4.1	**Materials**
4.1.1	Add the following: • All structural steelwork is required to be grade S355JR
4.1.4.1	• Electrodes for electric welding are required to be E7018.
4.1.5.1	• Bolt grade 8.8 is required as a minimum
5.3	**Non-destructive testing of welds**
5.3.3	• Fillet welds are required to undergo magnetic particle inspection (20 % of welds)
5.3.4	• All butt welds and full penetration welds are required to undergo ultrasonic non-destructive testing (100 % of welds)

3.3.2.1 Corrosion protection

1. All structural steelwork to be hot dipped galvanised to be in accordance with SANS 121.

3.3.3 Tender Returnable

The tenderer submits the following as a minimum in the tender submission:

1. Method statement for the entire *works* clearly demonstrating compliance with the full scope of work as detailed in the Works Information.
2. Design Methodology for the design scope as described in the Works Information indicating compliance with required design specifications
3. Relevant experience in the construction of similar projects. List of verifiable references must be provided. (At least 5 years relevant experience)
4. Organogram reflecting the key project staff together with CV's of the professionally registered (with ECSA) Design Engineers and Construction Manager's involved in the *works*.

The power supply needs to be easily removable to do maintenance on them. The *Contractor* must provide a procedure and schedule for on load and off load power supply replacement. The replacement of power supplies must be according to the *Employers* safety regulations.

All new components relevant to the design must be coded in accordance with the AKZ numbering system.

3.3.3.1 Training documentation and drawings

The *Contractor* shall supply the list of documentation per VDSS. The *Contractor* will also provide the following:

- Full training on all equipment installed including installation, configuration and customization.
- A Customization document containing all custom configurations, settings, scripts etc.
- Copies of all Software and drivers installed.
    - All software licenses and license keys/codes
    - Installation and disaster recovery procedures

3.3.3.2 Project Execution Methodology

The systems development methodology to be followed after Contract Award for the HFPS C&I system is as follows:

1. Detailed Engineering: Detailed Engineering Design Freeze
2. Procurement, Fabrication & Manufacturing: FAT
3. Erection and Installation
4. SIT
5. Cold and Hot Commissioning
6. Optimisation
7. As Built Documentation Compilation

3.4 PROCEDURE FOR SUBMISSION AND ACCEPTANCE OF CONTRACTOR'S DESIGN

The *Contractor* needs to supply the *Employer* with a design to install the new high frequency power supply and PPMS system.

The following documentation needs to be provided in concept format during tender submission and will be required in detail design format after contract award.

3.4.1 Mechanical

- Interfacing drawings for HV duct connection
- Open and Close circuit test link box design/drawing
- Transformer removal and installation procedure
- Key interlocking procedure for isolation of a single field on-load and complete isolation during an outage.

3.4.2 Electrical

- Line diagrams with measurement points
- Electrical design showing details of changes
- Earthing drawing/ design
- Performance specification of the HFPS
- EMI Compliance standards
- Predicted harmonics spectrum
- Surge protection
- List of Test equipment to be used to validated electrical performance
- Electrical test procedure and compliance standards

3.4.3 C&I

Enquiry/Tender Phase

The Tender submits typical drawings (or preliminary documentation) of the following at tender:

- I/O lists
- Equipment lists
- C&I equipment load list
- Alarm lists
- Proposed instrument, drives and equipment datasheets
- Proposed instrument, panel, JB, equipment & drive locations

- Typical or proposed cable routing and cable rack layout drawings
- JB general arrangements, specification and materials
- General arrangement layouts/location drawings for instrumentation, junction boxes, marshalling PLC panels and local control panels
- Preliminary functional design specification, narrative control & operating philosophies and functional logic diagrams
- Cable specification
- Typical power supply drawings or power requirements (concepts)
- Typical maintenance strategy document for C&I equipment

Detailed Design Phase Documentation

Detailed design documentation may include detailed information of the drawings/docs already submitted during tender process. The following forms the baseline for this phase of the project.

- I/O lists
- Equipment lists
- C&I equipment load list
- Alarm lists
- Instrument, drives and equipment datasheets
- Instrument, panel, JB, equipment & drive locations details
- Instrument stand location details
- Typical or proposed cable routing and cable rack layout drawings
- JB general arrangements, specification and materials
- General arrangement layouts/location drawings for instrumentation, junction boxes, marshalling PLC panels and local control panels
- Preliminary functional design specification, narrative control & operating philosophies and functional logic diagrams
- Cable specification
- Power supply drawings or power requirements (concepts)
- Maintenance strategy document for C&I equipment
- Hook-up diagrams
- Cable specification
- Cable block diagrams

- Functional design specification, narrative control & operating philosophies and functional logic diagrams
- HMI mimic diagrams and description together with alarm management and other related concepts
- Loop connection diagrams
- Earthing, lightning protection drawings
- Data communication and system network architectural drawings
- Control system hardware conceptual structure and functional distribution
- Control system and network systems manuals
- Design, installation and commissioning QCP. Quality manual including list of tests to be performed.
- The preliminary list of tags required for the PIS
- List of recommended spares with their MIN and MAX ratings
- Troubleshooting manual for possible faults on the C&I systems
- Typical power supply drawings or power requirements (concepts)
- Typical maintenance strategy document for C&I equipment
- CV's of all C&I engineering resources

3.4.4 Civil

- See section 3.3.3 for requirements at tender stage
- See section 3.2.3 and 3.9 for requirements after contract award

3.4.5 General

The Contractor indicates the expected emissions reduction from the installation of HFPS units.

The *Employer* needs to approve and sign off all design documentation for acceptance.

The *Contractor* supplies the *Employer* with the test plan and testing procedure.

3.5 EQUIPMENT REQUIRED TO BE INCLUDED IN THE WORKS

All equipment required to execute the works will be the responsibility of the *Contractor*.

The ESP roof is equipped with six 220 volt power supply points, three on the LH roof and three on the RH roof. These points can be used to power normal power tools during the installation of the power supplies.

3.6 AS-BUILT DRAWINGS, OPERATING MANUALS AND MAINTENANCE SCHEDULES

The *Contractor* need to supply the *Employer* with all the relevant modification drawings, operating and maintenance manuals required to operate and maintain the transformers. The *Contractor* provides a maintenance schedule for 25 years. It must be noted that at least 5 people (2 people to isolate and 3 to do the work) from the *Employer* is required to isolate a transformer for maintenance. The maintenance schedule includes running and outage maintenance.

This documentation is required in hard and soft copy after commissioning. A minimum of 3 hard copies per document is required.

Updated and new drawings approved by ECSA registered person and done according to the Eskom Standard (240-86973501: Engineering Drawing Standard).

3.7 PERFORMANCE GUARANTEE DESIGN BASE CONDITION

The performance guarantee will be measured against the increase in maximum power input to the fields evaluated on a per field basis. It will be calculated using the following formula:

$\frac{\text{kV} \times \text{mA}}{1000} = \text{kW}$, where kV and mA are the secondary input conditions.

When the unit returns to service after an outage, baseline measurements will be taken at full load from existing transformers. After the installation and optimisation, another set of readings will be taken at full load and used to evaluate the increase in maximum power input. The minimum expected increase is 15% in maximum power input from the baseline to the HFPS installation.

If major internal defects are suspected on a specific field the Employer and Contractor may mutually agree to exclude the specific field.

3.8 PERFORMANCE TEST BEFORE AND AFTER INSTALLATION

The *Contractor* provides full ESP efficiency test results before and after the HFPS installation. The efficiency test before the HFPS installation is done after the outage. The measurements shall include as a minimum:

- Gas volume flow – ESP inlet and outlet
- ESP flue gas inlet temperature
- Moisture in flue gas
- Inlet and outlet dust burden (dry basis and 10% O_2)
- Oxygen at ESP inlet and outlet
- Coal proximate and ultimate analysis
- Coal ash composition

All efficiency measurements shall comply with the requirements of EN 13284-1.

The pre- and post-installation performance tests are costed as take-out options.

The test done before the HFPS installation shall serve as the baseline performance to the Employer.

In the case where the unit is on outage longer than expected and the opportunity is available to install the HFPS units during the outage, this will take preference and discard the baseline test.

These performance tests after the HFPS installation must be conducted within the proving period of 3 months after commissioning.

The *Contractor* complies with the Quality Assurance standard EN14181 and ISO 9096. The particulate emission measurements must be carried out employing procedures which comply with the requirements of USEPA, Method 17, “Determination of particulate matter emissions from stationary sources.”

The *Contractor* will be responsible to supply the Employer with formal performance report after the performance test.

3.9 CONSTRUCTION

3.9.1 General

The *Contractor* is required to:

1. Adheres to the South African Environment Protection Act, the waste management code of practice and the South African Occupational Health and Safety Act No. 85 of 1993, the regulations promulgated thereunder and Eskom Safety, Health, Environment and Quality (SHEQ) Policy 32-727 for all *works*.
2. Submits a comprehensive method statement of the entire works to the Project Manager for acceptance prior to the start of the works
3. Submits a project specific safety file to the Employer for comments / acceptance.
4. Submits a detailed level 3 schedule for the works to the Project Manager for acceptance after contract award.
5. Takes all necessary precautions to ensure that none of the existing structures / facilities not forming part of the works is damaged during construction.
6. Stores salvaged plant/materials/components elevated off the ground to protect from ingress of dust and rainwater, etc.
7. Continuously monitor the conditions within the working and surrounding areas for any hazardous substances or situations, and in such case, the Contractor is required to take necessary precautionary measures.
8. Manages his access to the working areas and the Site.
9. Manages his activities on Site to ensure that no interference takes place between his work and that of others.
10. Completes "Contract Activities Daily Reports".
11. Liaises with the Supervisor regarding utilities and telephone facilities required for his Site establishment.
12. Liaises with the Supervisor regarding the location of waste disposal sites and rubbish dumps.

3.9.2 Construction and Erection

1. The *Contractor* is responsible for the construction of the facility and all associated services in accordance with the accepted detailed drawings and specifications.
2. The Contractor disposes of all construction waste at a licenced waste disposal site to be accepted by the Project Manager. The waste disposal site is selected to suit the classification of the materials to be disposed of. Certificates of disposal are required to be submitted to the Employer.

3.9.3 Quality Management

1. The *Contractor* submits a fully detailed Quality Control Plan (QCP) for acceptance within one week of the Contract Date.
2. The Contractor submits a schedule of unpriced orders to be placed and this is updated regularly.
3. The Contractor is responsible for defining the level of QA/QC (intervention Points) or inspection to be imposed on his Subcontractors and suppliers of material in the Quality Control Plans (QCPs). This level is based on the criticality of plant and materials, and is submitted to the Employer for acceptance.

4. Product data sheets and product samples are submitted for review and acceptance by the Project Manager after contract award and prior to the commencement of work.
5. The Contractor submits on a monthly basis, the following QA returns:
    - A register of Defects with those older than 30 days being flagged and an explanation attached
    - Register of accepted Defects
    - A register of Non Conformance Report
    - Monthly Project Quality Report
    - Monthly updated Site and pre-site programmes
    - Inspection dates
    - Site Acceptance Tests
    - Inspections completed / outstanding
6. All quality control documentation is submitted to the Project Manager within 7 days of Contract Date.

3.9.4 Handover

1. Apart from any statutory data packages required, the *Contractor* also compiles a data package of the relevant drawings, test certificates etc. to the *Project Manager* for acceptance. These include, but are not limited to:
    - Welding procedure specifications
    - Welder qualifications
    - Non-destructive weld test results
    - Weld test certificates
    - Steel grade certificates
    - Bolt grade certificates
    - As-built data and drawings of the completed *works* upon handover. As-built drawings are submitted in PDF and native CAD formats
    - Structural Certificate signed by the *Contractor's* Professional Civil Engineer confirming that structure has been constructed in accordance with the design

3.10 LIST OF STANDARDS AND DRAWINGS

The *Contractor* is required to adhere to the latest editions of and the normative references within the following SANS standards and other codes of practice, regulations & standards:

3.10.1 National and International standards

Number	Rev	Title
SANS 121	2011	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
SANS 1700		Fasteners
OHSA Act 85 of 1993	2015	Occupational Health and Safety Act
15ENG MN SYS-0075		AKZ Coding Manual (Tutuka Power Station)
PGZ 45-24	OA	Hazard and Operability (HAZOP) Study Guideline
SANS 10162	2011	The structural use of steel
SANS 346	2012	Categorization and conformity assessment criteria for all pressure equipment
ISO 9000: 2005	2005	Quality Management System – Fundamentals and Vocabulary
ISO 9001: 2008	2008	Quality Management System - Requirements
ISO 10006: 2003	2003	Quality Management System – Guideline for Quality Management in Projects
NRS 048 - SANS 1816		Instrumentation and method of measurement of harmonics
CISPR 16		Radio interference levels from ISM equipment
AWS D1.1		American Welding Society - Structural Welding Code - Steel
SANS 10044-1		Welding Part 1: Glossary of terms
SANS 2553		Welded, brazed and soldered joints - Symbolic representation on drawings
SANS 9606-1		Approval testing of welders - Fusion welding Part 1: Steels
SANS 10064		The preparation of steel surfaces for coating
SANS 2001-BS1		Construction works Part BS1: Site clearance
SANS 2001-CS1		Construction works Part CS1: Structural steelwork
SANS 50025 series		Hot rolled products of structural steels Parts 1-6
SANS 10400		The Application of the National Building Regulations
240-106365693	1	Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings

3.10.2 Eskom Standards

Number	Rev	Title
240-73413511	1	Process Information Standard
240-56355754	2	Field Instrument Installation Standard
240-56355728	1	Human Machine Interface Design Requirements Standard,
240-56355888	2	Temperature Measurements Installation Standard.
240-56355815	1	Field Instrument Installation Standard Junction Boxes and Cable Termination
240-56227443	1	Requirements for Control and Power Cables for Power stations Standard
240-56356411	1	Fire Barrier Seals for Electrical Cable Installations at Power Plants Standard
240-57859210	1	Alarm System Performance of Digital Control Systems Applied in Fossil Plant Standard
240-56355731	2	Environmental Conditions for Process Control Equipment Used at Power Stations Standard
240-65463322	5	Contractor Area/Site Establishment Request and Administration
240-55410927	2	Cyber Security Standard For Operational Technology
240-56227516	1	Specification for switchboard and associated equipment for voltages up to and including 1000 V AC and 1500 V Standard
240-55714363	1	Lighting and Small Power Installations for New and Existing Coal Fired Power Stations
240-56227589	3	List of Approved Electronic Devices to be used on Eskom Power Stations
240-56357424	2	MV And LV Switchgear Protection Standard
240-56356396	1	Earthing and Lightning Protection Standard
240-56358929	1	Electronic Protection and Fault Monitoring Equipment for Power Systems Standard
GGR 0992	2	Plant Safety Regulation, Eskom
240-105658000	1	Supplier Quality Management: Specification
240-56242363	2	Emissions Monitoring and Reporting Standard
NRS002	2	Graphical Symbols for Electrical Diagrams

240-71273834	1	Coal Quality Specifications for ESKOM Power Stations at Staithe/Silo Inlet Standard
240-106628253	1	Standard for Welding Requirements on Eskom Plant
240-56364545	2	Structural Design and Engineering Standard
240-86973501	3	Engineering drawing Standard
240-66920003	1	Documentation Management Review and Handover Procedure for Gx Coal Projects
240-76992014	1	Project / Plant Specific Technical Documents and Records Management Work Instruction
240-143485806		Generation Auxiliary Plant Medium Voltage Protection Standard

3.10.3 Drawings to be issued to contractor for information

Drawing number	Revision	Title
0.61/8975	2	Roof Beams
0.61/8979	1	Sealing Cover
0.61/8981	1	Treadproof Rain-tight Cover
0.61/8986	1	Collector Plate Carrier
0.61/8996	2	Cranerail and Platform with location of rectifier on room beam
0.61/9016	0	Casing of precipitator
0.61/9017	0	Casing of precipitator: Section A-A
0.61/9018	2	Casing of precipitator: Section B-B and View
0.61/9000	0	Railing on roof beam gelander and den dachtragern
0.61/3385	7	General layout of gas cleaning plant
0.61/9009	1	Details of roof beam
0.61/9005	4	Protective covering for HT rectifier
0.61/9559	1	Discharge frame with discharge electrode
0.61/9556	0	Spacing Bracket
0.61/ 9548	0	Support frame and Gas inlet
061/8982	0	Lower plate spacing and internal catwalk

4. AUTHORISATION

This document has been seen and accepted by:

Name and Surname	Designation
[redacted]	Engineering Manager (Tutuka)
[redacted]	Maintenance Manager (Tutuka)
[redacted]	Operating Manager (Tutuka)
[redacted]	Programme Manager (Tutuka)
[redacted]	Project Leader (Tutuka)
[redacted]	Civil Engineering Manager (Tutuka)
[redacted]	C&I Engineering Manager (Tutuka)
[redacted]	Boiler Engineering Manager (Tutuka)
[redacted]	EMD Manager (Tutuka)

5. REVISIONS

Date	Rev.	Compiler	Remarks
19 July 2022	0.1	[redacted]	Draft document
25 July 2022	1	[redacted]	Final Document

6. DEVELOPMENT TEAM

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

[redacted]