

	<b>Scope of Work</b>	<b>Kusile Power Station</b>
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Performance Scope of Work**

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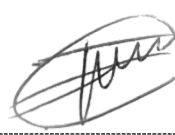
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## **1. Introduction**

The main purpose of this document is to provide a systematic approach for conducting routine Plant Performance tests activities in order to eliminate plant failures at Kusile Power Station. This document will define the Performance and Testing functions at Kusile Power Station.

## **2. Supporting Clauses**

### **2.1 Scope**

This document covers all Kusile Power Station, Performance and Testing of responsibilities and accountabilities.

#### **2.1.1 Purpose**

The aim of this contract is to provide Plant Performance monitoring and testing at Kusile Power Station Plant related systems, to optimise combustion and thermal efficiency of the station. The service duration for this contract will be valid for 60 months from the day the contractor is awarded the contract. All performance monitoring tests shall be conducted as per the employer's request. The list of services may also be required at any time for any of the following purposes but not limited to other Plant Performance request:

- To return equipment to service
- Support investigations
- As per defect raised
- As per PM raised
- As per ECN raised
- As per end user's request

The Contractor must have an effective quality management system in place and be ISO 9001 approved. Furthermore, all activities will be done as per to the level of quality management and also taking into account Input from Kusile Engineering Section, Risk assurance department and Management.

The Contractor shall provide qualified and competent teams in plant performance monitoring with all the necessary calibrated equipment to provide the service. The Contractor's teams must always be led and Supervised by Qualified, Competent and experienced team leaders. The Contractor must provide the equipment needed to provide the Service.

The Contractor shall ensure that the contracted service is performed regardless of strike and industrial action.

#### **2.1.2 Applicability**

This document shall apply throughout Kusile Power Station personnel, including contractors performing the tasks on site.

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### **2.1.3 Effective date**

This document is effective from the authorisation date.

## **2.2 Normative/Informative References**

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

### **2.2.1 Normative**

- [1] ISO 9001 Quality Management Systems
- [2] The OHS Act No. 85 of 1993
- [3] Plant Safety Regulations – GGR 0992

### **2.2.2 Informative**

- [4] AEPR 0019 Air Heater Performance
- [5] ISO 9001 Quality Management Systems
- [6] 240-87694581 Performance Testing of Air Preheaters Standard (Rev 1)
- [7] LEA01001 - Engineering Code of Conduct
- [8] 240-70734043 - Performance and Test management of thermal efficiency standard
- [9] 36-363 - STEP specification document number

## **2.3 Definitions**

<b>Definition</b>	<b>Explanation</b>
<b>Appointed contractor</b>	Means the main contractor awarded the contract
<b>Baseline risk assessment</b>	(32-520) baseline operational risks refer to the health and safety risks associated with all standard processes and routine activities in the business
<b>Cegrits</b>	Ash Sample Type
<b>CEMS</b>	CEMS (Continuous Emission Monitoring System) – is the technology used to monitor gaseous pollutants by heating extraction method. It measures and monitors the SO <sub>2</sub> , NO, CO, CO <sub>2</sub> and O <sub>2</sub> gases at the same time

### **CONTROLLED DISCLOSURE**

Definition	Explanation
<b>Client</b>	(OHS Act) Eskom representative (Internal – Asset Owner), also referred to as the contract administrator/custodian or agent or project manager (as defined in the contract). He/she is the person responsible for ensuring that the works or services are executed in terms of the contract, as well as adherence to legislation pertaining to the contract.
<b>Competent person</b>	(OHS Act) means any person having the knowledge, training, experience, and qualifications, specific to the work or task being performed, provided that, where appropriate, qualifications and training are registered in terms of the South African Qualifications Authority Act, 1995 (Act No. 58 of 1995)
<b>Contractor</b>	(OHS Act) means an employer as defined in section 1 of the Act who performs contracted work and includes principal contractors
<b>Daily Control Room Checks</b>	Daily Control Room Checks refers to all the documented information obtained by the SPOs during their plant walk down at the beginning of the shift after handover
<b>Employer</b>	(OHS Act) means, subject to the provisions of subsection (2), any person who employs or provides work for any person and remunerates that person or expressly or tacitly undertakes to remunerate him/her, but excludes a TES (ex labour broker) as defined in section 1(1) of the Labour Relations Act 1956 (Act No. 28 of 1956)
<b>EtaPRO</b>	EtaPro is high performance data historian that allows you to effectively collect, analyze and store your critical asset performance data
<b>GPSS</b>	GPSS (Generation Production and Sales System) is the source system for logging load losses events and the information is also needed in FLIP for the Operators to be able to make operating decisions
<b>Hazard</b>	(OHS Act) means a source of, or exposure to, danger
<b>Hazard identification</b>	(OHS Act) means the identification and documenting of existing or expected hazards to the health and safety of persons, which are normally associated with the type of construction work being executed or to be executed
<b>Health and safety file</b>	(OHS Act) means a file or other record in permanent form, containing the information required in relation to the contract.
<b>Lifesaving Rules</b>	(240-62196227) a rule that, if not adhered to, has the potential to cause serious harm to people
<b>Limited Access Register</b>	An access control system used by person in charge of the plant to give person to enter restricted area, or to carry out an activity on the plant
<b>LIMS</b>	LIMS (Laboratory Information Management Software) is a software based solution with features that support modern laboratory's operations whose features are not limited to workflow and data tracking support, flexible architecture, and data exchange interfaces

**CONTROLLED DISCLOSURE**

Definition	Explanation
<b>Medical Certificate of fitness</b>	(OHS Act) means a certificate valid for one year, issued by an occupational health practitioner, issued in terms of the regulations, whom shall be registered with the Health Professions Council of South Africa
<b>Method statement</b>	(OHS Act) means a written document detailing the key activities to be performed in order to reduce, as reasonably as practicable, the hazards identified in any risk assessment
<b>OPS Log</b>	OPS Log is document used to record all significant operational actions, events and incidents that could have any impact on the system or plant performance.
<b>Risk assessment</b>	(OHS Act) means a programme to determine any risk associated with any hazard at a construction site in order to identify the steps needed to be taken to remove, reduce, or control such hazard.
<b>SAP</b>	SAP (System Application and Products) is a powerful business software designed to help businesses to manage their financial, logistics, human resources, and other areas. The backbone of SAP software offering SAP ERP system which is the most advance Enterprise Resource Planning tool
<b>STEP</b>	STEP (Station Thermal Efficiency Performance) Tool is a tool designed to monitor the plant performance, identify losses and gains by monitoring all process inputs and outputs.
<b>PGIM</b>	Power Generation Information Management
<b>FLIP</b>	FlexiLOG IntelliPERMIT

## 2.4 Abbreviations

Abbreviation	Description
CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
CPD	Cyclone Pressure Drop
C&I	Control and Instrumentation
ECN	Engineering Change Notification
FD	Forced Draft
FFFR	Fossils Fuel Fired Regulation
GAH	Gas Air Heater
GPSS	Generation Production and Sales System
HP	High Pressure
H <sub>2</sub>	Hydrogen
ID	Induced Draft

### CONTROLLED DISCLOSURE

IP	Intermediate Pressure
ISO	International Standards Organisation
LAB	Laboratory
LAR	Limited Access Register
LIMS	Laboratory Information Management Software
CEMS	Continuous Emission Monitoring System
LP	Low Pressure
N/A	Not Applicable
NOx	Nitrogen Oxides
OHS Act	Occupational Health and Safety Act
O <sub>2</sub>	Oxygen
PA	Primary Air
PF	Pulverised Fuel
PJFFP	Pulse Jet Fabric Filter Plant
P&T	Performance and Testing
PSR	Eskom Plant Safety Regulation
Rev	Revision
SAP	System Application and Products
STAR	Stop, Think, Act & Review
STEP	Station Thermal Efficiency Performance
SOx	Sulphur Oxides
NEC	New Engineering Contract
SOW	Scope of Work
KPI	Key Performance Indicators
PM	Preventative Maintenance
PM	Particulate Matter
CM	Corrective Maintenance
QCP	Quality Control Plan
EOD	Electrical Office Desk
GO	General Overhaul
SDL	Skills Development Levy

## **2.5 Roles and Responsibilities**

- The Contractor shall ensure that he/she is fully conversant with the requirements of this document, specifications and all relevant health and safety, and agree to those terms and conditions, consistently demonstrate his/her competence and the adequacy of his/her resources to perform the duties as required by Eskom in terms of the contract specifications before commencing work.
- Must perform work to the highest standard and regarding to the safety regulations, hold points and notify supervisor when work is completed.

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- Ensure to have all required tools in his/her possession
- Must do proper inspection of plant equipment to identify when the replacement of the parts are necessary.
- All contractors shall work within the parameter of the job description and scope of work. To keep all instructions/ procedures on hand and supply Eskom power station with reference to be included in this document and supply record and history requirements

## **2.6 Process for Monitoring**

Performance and Testing will ensure compliance as stipulated in this document with regards to the improvement in availability and reliability of the respected plant areas.

## **3. Performance & Testing Philosophy**

### **3.1 Overview**

#### **3.1.1 Plant Verification and Measurement**

The fundamental role of Performance and Testing is the monitoring, measurement, testing of component effectiveness and verification of measurements used. The plant areas covered are from Unit 1 to Unit 6 and outside plant but not limited to areas identified but not listed on scope of work.

The testing and verification of the plant is performed to monitor various plant systems such as milling plant performance, compressors, turbine, Gas air heater, flue gas system, coal plant and ash plant, air supply, steam conditions, feed water heating, PJFFP, condenser performance, and auxiliary power consumption but not limited to any other related plant tests requirements. This is achieved by the continuous monitoring, optimisation and reporting of the abovementioned plant areas.

#### **3.1.2 Engineering Tools and Systems**

- a) OPS log
- b) EtaPRO
- c) Daily Control Room Checks/ Plant Walks
- d) GPSS
- e) FLIP
- f) SAP
- g) STEP Tool
- h) LIMS/CEMS

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**Table 1: Performance and Testing Activities**

	Area	Activities	Frequency
1	Kusile all systems	Plant Monitoring Parameters	Daily
2	Flue Gas Duct&SSC	Fly&Coarse ash sampling	Daily
3	Station all systems	STEP Report	Daily
4	Coalstockyard	Coal Book	Daily
5	Flue Gas	O2 & CO Monitoring	Weekly
6	Condensor	Vacuum Decay Monitoring	Weekly
7	Flue Gas	Cegrit Sampler Inspection	Weekly
8	Make up&Water losses	Water Consumption	Weekly
9	Coal,Ash&Limestorne	Mass Meter Inspection	Weekly
10	STEP	Final Feed Water Temperature Verification	Monthly
11	STEP	Main Steam Temperature Verification	Monthly
12	STEP	Reheat Temperature Verification	Monthly
13	STEP	Condensor back pressure	Monthly
14	FD Fans Duct	Total Airflow Verification	Monthly
15	Combustion Air Duct	Primary Airflow Verification	Monthly
16	Combustion Air Duct	Secondary Airflow Verification	Monthly
17	Milling Plant	PF Sampling(Fineness, Distribution etc)	Monthly
18	Flue Gas	Airheater Performance	Monthly
19	Flue Gas	Volumetric Flow Verification	Monthly
20	Burners	Fuel Oil Carryover Test	Monthly
21	Coal Stckyard	Coal Stockyard Safety Tests	Monthly
22	Make up&Water losses	Cycle Isolation Tests	Monthly
23	Compressors	Compressor Efficiency	Monthly
24	Coal,Ash&Limestorne	Mass Meter Calibrations	Quarterly
25	FFFR	Boiler/Furnace Leak Tightness Test	Yearly
26	Fire System Pump House	Diesel&Electrical pumps performance	Yearly
27	Stack&Aux Boilers	Stack&Emissions Test	Bi-yearly
28	STEP	Outage Pre and Post GO Test	Bi-yearly
29	Generator	H2 Leak Detection	ADHOC
30	Coal Stockyard	Coal Stockyard Surveying	ADHOC
31	Milling Plant	Clean Air Curve	Mill RTS
32	Milling Plant	Mill loadlines	Mill RTS
33	Burners	Fuel Oil Verification	Unit RTS

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### **3.1.3 Plant Performance on load Activities**

#### **3.1.3.1 Milling Plant**

- a) Mill and classifier internal inspection during 4000 hours mill service
- b) PF sampling and distribution every month. Also check classifier positions
- c) Load lines check monthly and after mill overhaul
- d) Feeder bar/speed check
- e) Raw Coal sampling on feeder

#### **3.1.3.2 Air supply**

- a) Verify Primary, secondary, side wall and over fire air
- b) Verify total air flow measurements

#### **3.1.3.3 Flue Gas Stream**

- (i) GAH inlet
  - Pressure measuring
  - Ash particle distribution
- (ii) GAH outlet
  - Temperature (matrix to depict the temperature stratification on the GAH outlet)
  - Pressure measurement
- (iii) Duct (after the emergency spray water delta wing mixing stage)
  - Average temperature –more representative temperature measurement pre-attemperation
  - Flue gas velocity/volumetric flow rate/mass flow rate
- (iv) Duct (After the air attemperation stage)
  - Pressure measurement
  - Flue gas velocity/volumetric flow rate/mass flow rate- Quantify air attemperation additional flows
  - Temperature matrix
  - PM concentration
- (v) PJFFP outlet Duct
  - ID fan suction pressure
  - PM concentration
- (vi) Milling plant
  - Coal sample for analysis

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#### **3.1.3.4 Combustion**

- a) Analyse the daily STEP report to evaluate the dry flue gas loss and the carbon in ash loss.
- b) Verify the airflow as above (Air supply) as well as the milling criteria (see Milling plant above) when these parameters deviate from target values
- c) Take coarse and fly ash samples for chemical services to analyse
- d) Raw coal sampling for coal qualities
- e) Economiser O<sub>2</sub> verifications weekly
- f) Nox, SO<sub>x</sub>, CO and O<sub>2</sub> verifications at the smoke stacks.

#### **3.1.3.5 Heat Transfer**

Verification of main, reheat steam and feed water temperatures monthly

#### **3.1.3.6 Turbine and condensing**

- a) HP and IP cylinder efficiency tests pre- and post-GO
- b) Monitor the Turbine vacuum decay test
- c) Perform a Helium, H<sub>2</sub> other leakage tests as and when required
- d) Monitor the Demin make up water consumption test
- e) Perform cycle isolation test

#### **3.1.3.7 Common Plant**

- a) Perform performance and efficiency of compressors

#### **3.1.3.8 Cooling towers**

- a) Analyse Check effectiveness of cooling system

### **3.2 Outage Inspections**

#### **3.2.1 Boiler**

- a) Tramp Air inspection (Sealing Trough, doors etc.)
- b) Draught Groups and PA Fans: inspection and stroke checking of Vanes
- c) Cegrit sampler inspection
- d) Draught Groups Ducts and turning Vanes Inspection
- e) Boiler internal, heat exchangers, wind-box, PF firing equipment section

#### **3.2.1 Secondary & Primary Air heater inspections**

- a) Inspect the visible seals in the gas air heater

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- b) Test for air heater pack blockages
- c) Check for erosion.

### **3.2.2 Air and Gas Ducts**

- a) Inspect all control dampers and turning vanes for erosion
- b) Inspect all flow measuring devices for wear and blockage
- c) Check for ash built-ups in ducts
- d) Assist C&I with stroke setting of the air and gas dampers.
- e) Evaluate the condition of the O<sub>2</sub>s and Fly-ash sampling measuring device
- f) Check on the condition of the air and gas duct thermocouples that are used for thermal efficiency monitoring.

### **3.2.3 Turbine**

- a) Check the general cleanliness of the tube plates. If lots of debris is visible, the condition and operation of the CW outlet ducts screens need to be investigated.
- b) Check for tube cleanliness, if there is any scaling is present
- c) If access is possible on the steam side, check the extend of possible scaling on the outside of the tubes that can hamper heat transfer
- d) Pre a HP and IP cylinder test
- e) LP and HP feed water heater performance
- f) Condenser performance test

## **3.3 Post Outage Step Test**

### **3.3.1 Air heater Performance**

- a) Economiser Inlet traverse (LH + RH)
- b) A/H inlet Traverse (LH + RH)
- c) A/H outlet Traverse (LH + RH)

### **3.3.2 Coal flow verification**

- a) Boiler and Mill Mass and Energy Balance
- b) O<sub>2</sub> Traverse test
- c) Total air flow measurement.

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### 3.3.3 Turbine

### 3.3.4 P&T – Equipment List

Plant Performance tests utilise the below tools and instruments to carry out some of their functions. All instruments must be calibrated periodically and by an authorised testing authority. SANAS accreditation is mandatory.

**Table 2: Plant Performance Equipment list**

Equipment Description	QTY
H2 Leak Detector	2
Pitot Tubes(0.5m to 7.5m)	20
Thickness gauge	2
Tachometer	2
Strobe Light	2
Temperature Gun	2
Ultrasonic Flexim Flowmeter F601	2
Digital Camera	2
PF Sampler	2
Manometers	16
Silicon Tubing	10
Endoscope	2
Thermometers	2
Humidity meter	2
Data-taker/logger	2
Gas Analysers	8
Coal test temperature probes	2
Oxygen cylinders	2
Toolbox	6

### CONTROLLED DISCLOSURE

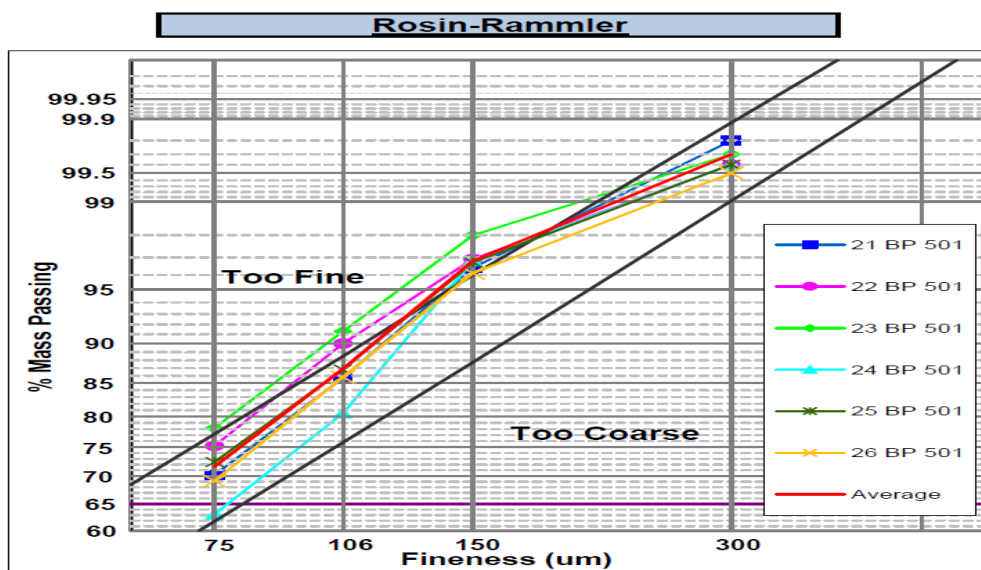


Figure 1: Example of P&T Performance Curves(Rosin Rammler Curve)

### 3.3.5 Outputs and Reports

The following list includes the minimum reports produced by the section:

- Monthly Ash figures Report -Monthly
- Coal stockyard temperature measurements -daily
- Coalbook-daily
- STEP Report Daily
- LIMS report Daily
- Outage inspection report After an outage
- Routine and adhoc Test reports As and when required
- Mill service inspection report Every 4000hrs mill service
- O2 verification correction sheet Weekly

Table 3: Example of DCS Recordings Sheet

DCS RECORDINGS			Variables
Description	KKS Codes	SI Unit	
Date:			
Boiler Load	10HFB00FF950	MW	
Generator Output	10MKA 10CE901Z	MW	
Furnace Pressure	10HBK40CP902	kPa	
Boiler Lambda Controller PV	10HHL70DU001		
Boiler Lambda Controller SP	10HHL70DU002		
Boiler Lambda Controller Output	10HHL70DU003		

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TOTAL AIR SUPPLY			Variable
FD Fan 1 Air Mass Flow	10HLB10FF902	kg/s	
FD Fan 1 Air Volumetric Flow	10HLB20FF902	m3/s	
FD Fan 2 Air Volume Flow	10HLB10FF902	kg/s	
FD Fan 2 Air Volumetric Flow	10HLB20FF902	m3/s	
FD Fan 1 Blade CV	10HLB10AS001	%	
FD Fan 2 Blade CV	10HLB20AS001	%	
SECONDARY AIR			Variable
Combustion Air Flow	10HLY00FF901	kg/s	
Secondary Air Flow	10HHL00FF901	kg/s	
OVERFIRING AIR			Variable
Over Fire Air Control Damper Front	10HHL70FF001	kg/s	
Over Fire Air Correlation Nozzle	10HHL70AA001	%	
Over Fire Air Control Damper Front	10HHL70FF002	kg/s	
Over Fire Air Correlation Nozzle	10HHL70AA002	%	
Over Fire Air Control Damper Front	10HHL80FF001	kg/s	
Over Fire Air Correlation Nozzle	10HHL80AA001	%	
Over Fire Air Control Damper Front	10HHL80FF002	kg/s	
Over Fire Air Correlation Nozzle	10HHL80AA002	%	

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FLUE GAS			Variable
A/H 1 Inlet Flue Gas O2	10HNA11CQ901	%	
A/H 2 Inlet Flue Gas O2	10HNA21CQ901	%	
A/H 1 Outlet Flue Gas O2	10HNA12CQ901	%	
A/H 2 Outlet Flue Gas O2	10HNA22CQ901	%	
G/A Inlet 1 F/G temperature	10HNA11CT901	°C	
G/A Inlet 2 F/G temperature	10HNA21CT901	°C	
GA/H 1 Outlet Flue Gas Pressure	10HNA12CP001	kPa	
GA/H 2 Outlet Flue Gas Pressure	10HNA22CP001	kPa	
ID Fan 1 Flow	10HNC10FF901	kg/s	
ID Fan 2 Flow	10HNC20FF901	kg/s	
ID Fan 1 Suction Pressure	10HNA13CP901	kPa	
ID Fan 2 Suction Pressure	10HNA23CP901	kPa	
ID Fan 1 Discharge Pressure	10HNA14CP901	kPa	
ID Fan 2 Discharge Pressure	10HNA24CP901	kPa	
ID Fan 1 Volumetric Flow	10HNC10FF901	m <sup>3</sup> /s	
ID Fan 2 Volumetric Flow	10HNC20FF901	m <sup>3</sup> /s	
ID Fan 1 Pitch Position	10HNC10CG001	%	
ID Fan 2 Pitch Position	10HNC20CG001	%	
ID Fan 1 Motor Speed	10HNC10CS901	rpm	
ID Fan 2 Motor Speed	10HNC20CS901	rpm	
Back End temperature Lane 1	10HNACT12CT901	%	
Back End temperature Lane 2	10HNACT22CT902	%	
ID Fan 1 specific work force	10HNC10FP901	Nm/kg	
ID Fan 2 specific work force	10HNC20FP901	Nm/kg	
ID Fan 1 Blade Position	10HNC10CG001	%	
ID Fan 2 Pitch Position	10HNC20CG001	%	
ID Fan 1 Sealing Pressure	10HNC14CP901	kPa	
ID Fan 2 Sealing Pressure	10HNC24CP901	kPa	
ID Fan 1 Suction DP	10HNC10CP002	kPa	
ID Fan 2 Suction DP	10HNC20CP002	kPa	
ID Fan 1 Differential Pressure	10HNC10CP003	kPa	
ID Fan 2 Differential Pressure	10HNC20CP003	kPa	
ID Fan 1 Hydraulic Room Temperature	10HNC10CT003	°C	
ID Fan 2 Hydraulic Room Temperature	10HNC20CT004	°C	

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#### 5. Revisions

Date	Rev.	Compiler	Remarks
April 2021	1	NR Ntusi	New Work Instruction

#### 6. Development Team

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

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- Nthabi Khanye

#### 7. Acknowledgements

All P&T Personnel

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