Eskom	Philosophy	Duvha Power Station

Title: **Duvha Power Station Control and Service Air Operating and Control Philosophy**

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1. INTRODUCTION

Control and service air at Duvha Power Station is supplied from a centralised/common compressor plant which is located in the low-pressure services pump & compressor house.

The Duvha compressed air system consists of four oil-free, water-cooled electric compressors (centrifugal type rated at 52Nm^3/min@700 kPag each) and two oil-flooded, air-cooled Sullivan Palatek diesel compressors (rotary screw type rated at 45Nm^3/min@ 700 kPag each). Each compressor has a dedicated desiccant twin dryer. Air generated by these compressors is stored in the four control air receivers, and one service air receiver from which it is distributed to the respective users around the station.

2. SUPPORTING CLAUSES

2.1 SCOPE

The compressed air supply and distribution system consists mainly of the following:

- Fixed speed compressors, Air receivers, Air dryers and filters for the Control and Service Air system.
- Piping and Valves.
- Instrumentation and controllers to allow for the control and operation of the system.

2.1.1 Purpose

This document will be used to guide the Operating Department during the Operation and Control of the plant. It will serve as a quick reference about plant operation, set point, control limits, alarms values and overall response to alarms. It will also be used by Maintenance and the Engineering department as a reference to the control of the plant during fault finding, instrument set point calibration and repair work. Any changes to the Operating and Control Philosophy, as well as alarm, trip and switching set points will be controlled by changing this document.

2.1.2 Applicability

This document shall be applicable to Duvha Power Station.

2.1.3 Effective Date

This document is effective from the date of authorisation, as indicated on the title page.

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] Duvha Power Station Control and Service Air Compressors and Dryers P&ID – 24.57/47314 sheet 1 of 18

[2] Duvha Power Station Service Air to North Water Treatment Plant and Workshops – 24.57/47314 sheet 17 of 18

[3] Duvha Power Station Control Air North Water Treatment Plant – 24.57/47314 sheet 18 of 18

[4] Duvha Power Station Control and Service Air Receivers – 24.57/47314 sheet 2 of 18

[5] Duvha Power Station Water Treatment Plant Control Air Reticulation – 24.57/47314 sheet 4 of 18

[6] Duvha Power Station Water Treatment Plant Service Air Reticulation – 24.57/47314 sheet 3 of 18

[7] Duvha Power Station Unit 4 Service Air Reticulation – 24.57/47314 sheet 11 of 18

[8] Duvha Power Station Unit 4 Control Air – 24.57/47314 sheet 12 of 18

[9] Duvha Power Station Unit 5 Service Air Reticulation – 24.57/47314 sheet 13 of 18

[10] Duvha Power Station Unit 5 Control Air– 24.57/47314 sheet 14 of 18

[11] Duvha Power Station Unit 6 Service Air Reticulation – 24.57/47314 sheet 15 of 18

[12] Duvha Power Station Unit 6 Control Air – 24.57/47314 sheet 16 of 18

[13] Duvha Power Station Unit 1 Service Air Reticulation sheet 5 of 18

[14] Duvha Power Station Unit 1 Control Air– 24.57/47314 sheet 6 of 18

[15] Duvha Power Station Unit 2 Service Air Reticulation– 24.57/47314 sheet 7 of 18

[16] Duvha Power Station Unit 2 Control Air– 24.57/47314 sheet 8 of 18

[17] Duvha Power Station Unit 3 Service Air Reticulation– 24.57/47314 sheet 9 of 18

[18] Duvha Power Station Unit 3 Control Air– 24.57/47314 sheet 10 of 18

2.2.2 Informative

[19] Duvha Power Station Compressed Air System Maintenance Strategy 03A – ENS0047

[20] OC017P Rev 4 PRE-START CHECKLIST

[21] OC017R Rev 4 RUNNING CHECKSHEET

[22] OC017C Rev 4 COMMISSIONING CHECKLIST

[23] OC017S Rev 3 STANDY CHECKLIST

[24] Sullivan Palatek Operator's Manual

[25] Operation and Maintenance Manual, CENTAC 400

2.3 DEFINITIONS

Definitions	Description
Control Air	Compressed air used for operating various components on the boilers, turbines and auxiliary plant.
Dew Point Temperature	The dew point is the temperature at which the water vapour in a sample of air at constant barometric pressure condenses into liquid water at the same rate at which it evaporates. At temperatures below the dew point, water will leave the air.
Service Air	Compressed air used for any additional air requirements other than control functions.
Controlled Disclosure	Controlled disclosure to external parties (either enforced by law, or discretionary).
Human Machine Interface	Control screens used by the Operator to operate and control the plant.
Maintenance Control	Control of subsystems for maintenance purposes, normally from a local control panel via a selector switch which enables this mode. In this mode, some of the process interlocks might be disabled because maintenance personnel will

Definitions	Description
	physically be present and verify that the operation of the plant in this mode will not have an effect on safe operation or testing of plant.
Pressure Dew Point	It refers to the dew point of the compressed air at full line pressure

2.4 ABBREVIATIONS

Abbreviation	Description
LPS	Low Pressure Services
CA	Control Air
DCS	Digital Control System
HMI	Human Machine Interface
LCP	Local Control Panel
LCS	Local Control Station
NRV	Non Return Valve
P&ID	Piping and Instrumentation Diagram
PDP	Pressure Dew Point
PJFFP	Pulse Jet Fabric Filter Plant
PLC	Programmable Logic Controller
OPCR	Outside Plant Control Room
S/A	Service Air
SSCR	Station Services Control Room
m3/min	Cubic meters per minute
kPa	Kilo Pascal
HMD	Heavy Maintenance Department
OHS	Occupational Health & Safety
ROC	Required Operational Capability
SRD	Stakeholders Requirements Definition
LPS	Low Pressure Services
PLC	Programmable logic controller
kPag	Kilo Pascal Gauge
Nm3	Normal Cubic Metres
Temp	Temperature

2.5 ROLES AND RESPONSIBILITIES

Plant Operator – Inspection of the system and first line fault finding in case of plant alarms and trips

Maintenance - All Disciplines – Responsible for detailed fault finding and repair of the Compressor Air and distribution system in the event of failures or if the plant conditions deviate from the operating and control limits and requirements.

System Engineer

- Compiling the Operating and Control Philosophy and revision thereof:

- after commissioning and optimisation of the plant,
- during change management process
- on the date due for revision

- Assist with fault finding if maintenance has trouble identifying and rectifying the fault when operation and control is not in line with this document.

2.6 PROCESS FOR MONITORING

This document shall be reviewed annually from the last date of approval, in accordance with the Eskom generation document and record management procedure 32-644.

2.7 RELATED/SUPPORTING DOCUMENTS

[1] Duvha Power Station Compressed Air System Maintenance Strategy 03A – ENS0047

[2] Ingersoll Rand C400 Compressor Manual

3. OPERATING & CONTROL PHILOSOPHY

3.1 SYSTEM DESCRIPTION

Duvha Power Station compressed air and distribution system is made up of two subsystems namely the:

- Control air system that supplies control air to turbine, boiler, dust handing plant, hydrogen plant, water treatment plant, fire system, coal plant etc.
- Service air system that supplies service air to various plants and buildings around the power station. (fuel oil plant, workshops, turbine house, boiler house, precipitator area (DHP 4-6), water treatment plant etc.)

3.1.1 CONTROL AND SERVICE AIR COMPRESSORS

Control and service air at Duvha Power Station is supplied from a centralised compressor plant which is located in the low pressure services pump house. There is no distinction in the way in which control and service air are produced and processed at Duvha Power station. The difference exists in the distribution network. Duvha Power Station does not have compressor(s) dedicated to either control or service air production, both types of air are produced by the same compressors. The plant comprises of four electric water cooled centrifugal compressors (Ingersoll Rand C400) and two air cooled diesel compressors. Each compressor has a dedicated desiccant dryer. Air generated by these compressors is stored in the four control air receivers, and one service air receiver from which it is distributed to the respective users around the station. See Figure 4 below for compressor plant P&ID. Electric compressors are water cooled. Each compressor has a dedicated plate heat exchanger. The closed loop of the heat exchangers circulates demineralised water while the open loop circulates potable water. The potable water loop is fed from the potable water head tank.

Figure 1: Two Stage Electric Air Compressor

Figure 2: Single Stage Diesel Air Compressor

3.1.1.1 Air Filters

Air intake filters protect the compressor from any dust and dirt which it might suck in. The intake-air filter is the most important filter on your compressor.

3.1.1.2 Air Dryers

The heatless desiccant type dryer delivers a pressure at dew point temperature of -20 °C. These units make use of shuttle valves to direct air flow between the vessels. A fixed orifice purge is used during regeneration of right hand or left hand dryer as well as during the filling up of a dryer. The dryers operate on a 6-minute cycle. A vessel goes on blowdown mode for 4 minutes, during this time the pressure gauge should read 0kPa. When the blowdown is over, the vessel recovers pressure and after 2 minutes, the other vessel which was on regeneration will go on blowdown.

3.1.1.3 Control and Service Air Receivers

There are four control air receivers and one service air receiver located outside the compressor house each with a capacity of 20 m^3 and is fitted with pressure instrumentation, a pressure relief valve, drain valve and a mechanical condensate trap.

3.1.1.4 Control Air Unitized Air Receivers

Each unit has a dedicated air receiver located in the boiler house at the 0 meter level with a capacity of 20 m^3 and is fitted with pressure instrumentation, a pressure relief valve, drain valve and an electric condensate trap.

3.1.1.5 Cooling Water Booster Pumps

There are two Instream centrifugal booster pumps that circulate water in the primary and secondary cooling circuits. The primary cooling circuit booster pump circulates demineralized water between a plate heat exchanger and compressor coolers. The Secondary cooling circuit booster pump takes suction from a potable water line that taps-off of a big potable water line that gives suction to fire pumps and pumps the potable water through the plate heat exchanger before it is recovered for other use. The primary booster pump is a 7,5kw unit that delivers a flow rate of 35 m3/h at 36m head. The secondary booster pump is 5.5kw unit delivering 25 m3/h at 37m head. Pumps start when a compressor is started and stop 30 minutes after a compressor tripped or stopped.

3.1.2 C&I EQUIPMENT

Table 1: C&I Equipment

AKZ	Description
00US11P008	Compress 1 intake differential press
00US12P008	Compress 2 intake differential press
00US13P008	Compress 3 intake differential press
00US14P008	Compress 4 intake differential press
00US11P005	Compress 1 1st stage air outlet press
00US11P006	Compress 1 2nd stage air outlet press
00US12P005	Compress 2 1st stage air outlet press
00US12P006	Compress 2 2nd stage air outlet press

00US13P005	Compress 3 1st stage air outlet press
00US13P006	Compress 3 2nd stage air outlet press
00US14P005	Compress 4 1st stage air outlet press
00US14P006	Compress 4 2nd stage air outlet press
00US11T003	Compress 1 Lube oil temp
00US12T003	Compress 2 Lube oil temp
00US13T003	Compress 3 Lube oil temp
00US14T003	Compress 4 Lube oil temp
00US11T005	Compress 1 1st stage air outlet temp
00US11T006	Compress 1 2nd stage air outlet temp
00US11T008	Compress 1 CW inlet temp
00US11T009	Compress 1 CW outlet temp
00US12T005	Compress 2 1st stage air outlet temp
00US12T006	Compress 2 2nd stage air outlet temp
00US12T008	Compressor 2 CW inlet temp
00US12T009	Compressor 2 CW outlet temp
00US13T005	Compress 3 1st stage air outlet temp
00US13T006	Compress 3 2nd stage air outlet temp
00US13T008	Compressor 3 CW inlet temp
00US13T009	Compressor 3 CW outlet temp
00US14T005	Compress 4 1st stage air outlet temp
00US14T006	Compress 4 2nd stage air outlet temp
00US14T008	Compressor 4 CW inlet temp
00US14T009	Compressor CW outlet temp

3.2 PROCESS FLOW AND SYSTEM LAYOUT

The compressors are housed in a compressor house that also houses demineralised water pumps, fire protection system pumps and potable water pumps. Compressors house is situated at the south area of the power station next to water treatment plant.

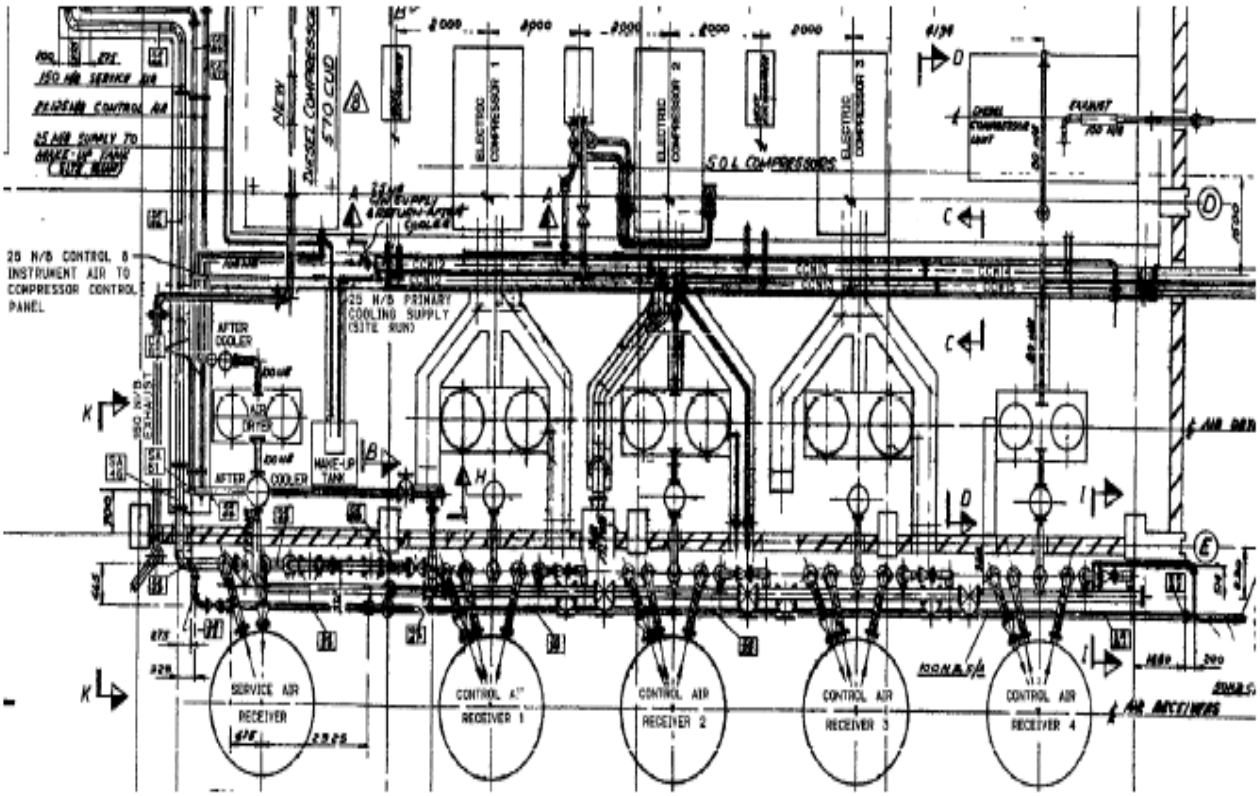

Figure 3: Compressor House Layout

All air compressors feed air dryers from which air is fed into air manifolds that in-turn feed air receivers. There are four control air receivers that store and distribute control air to various plant areas in the station. There is only one service air receiver that stores and distributes service air to various plant areas in the station. Service and control air are one and the same system in Duvha Power Station. Service air is equipped with a valve that gets closed when the system pressure drops drastically.

The control air system supplies air to the following areas:

- Boilers
- Turbines
- Water Treatment Plant
- Hydrogen Plant
- Fire Protection System
- Dust Handling Plant
- Etc.

The service air system supplies air to the following areas:

- Boiler house
- Turbine house
- Water Treatment Plant

- Workshop
- Etc.

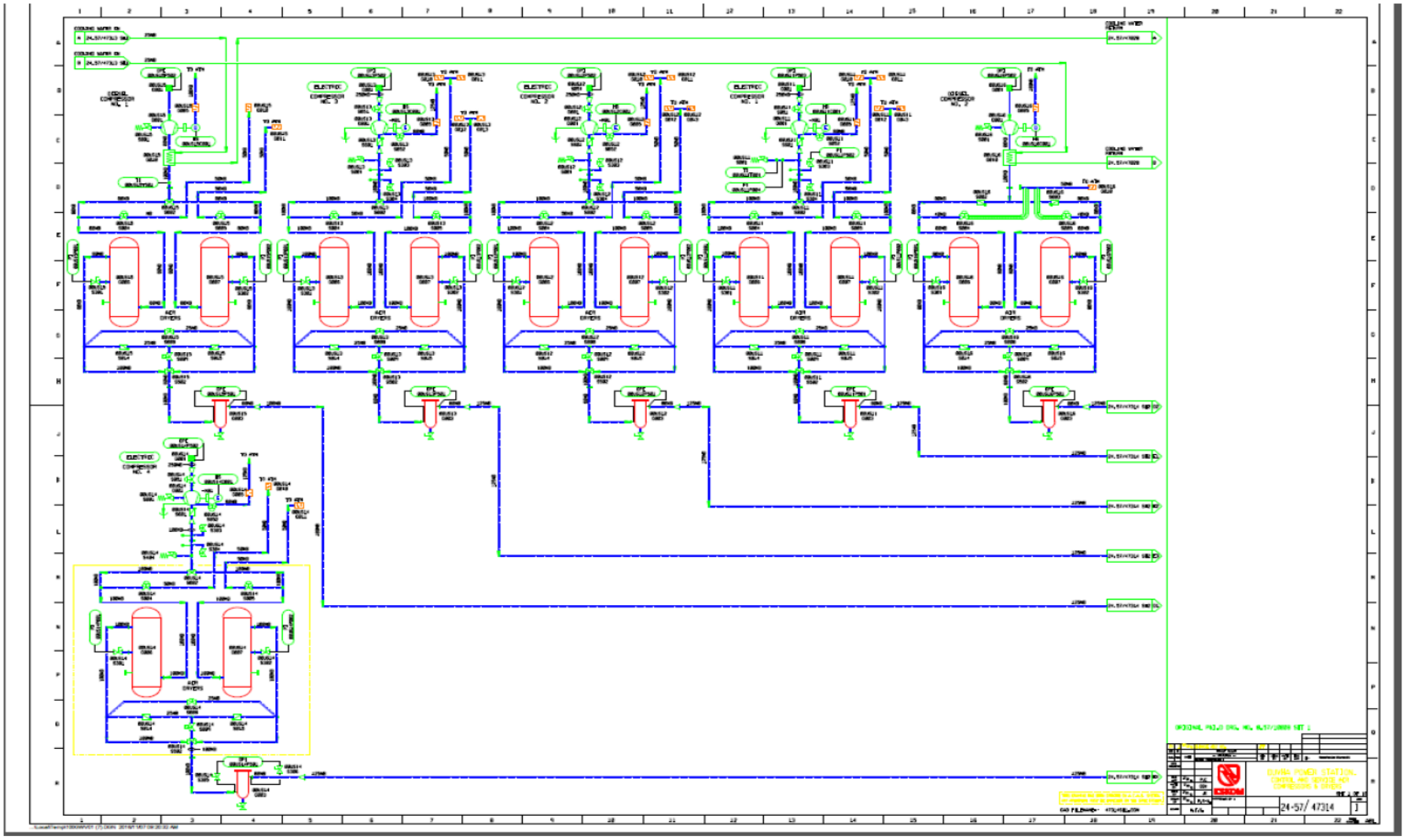

Figure 4: Compressor Plant P&ID

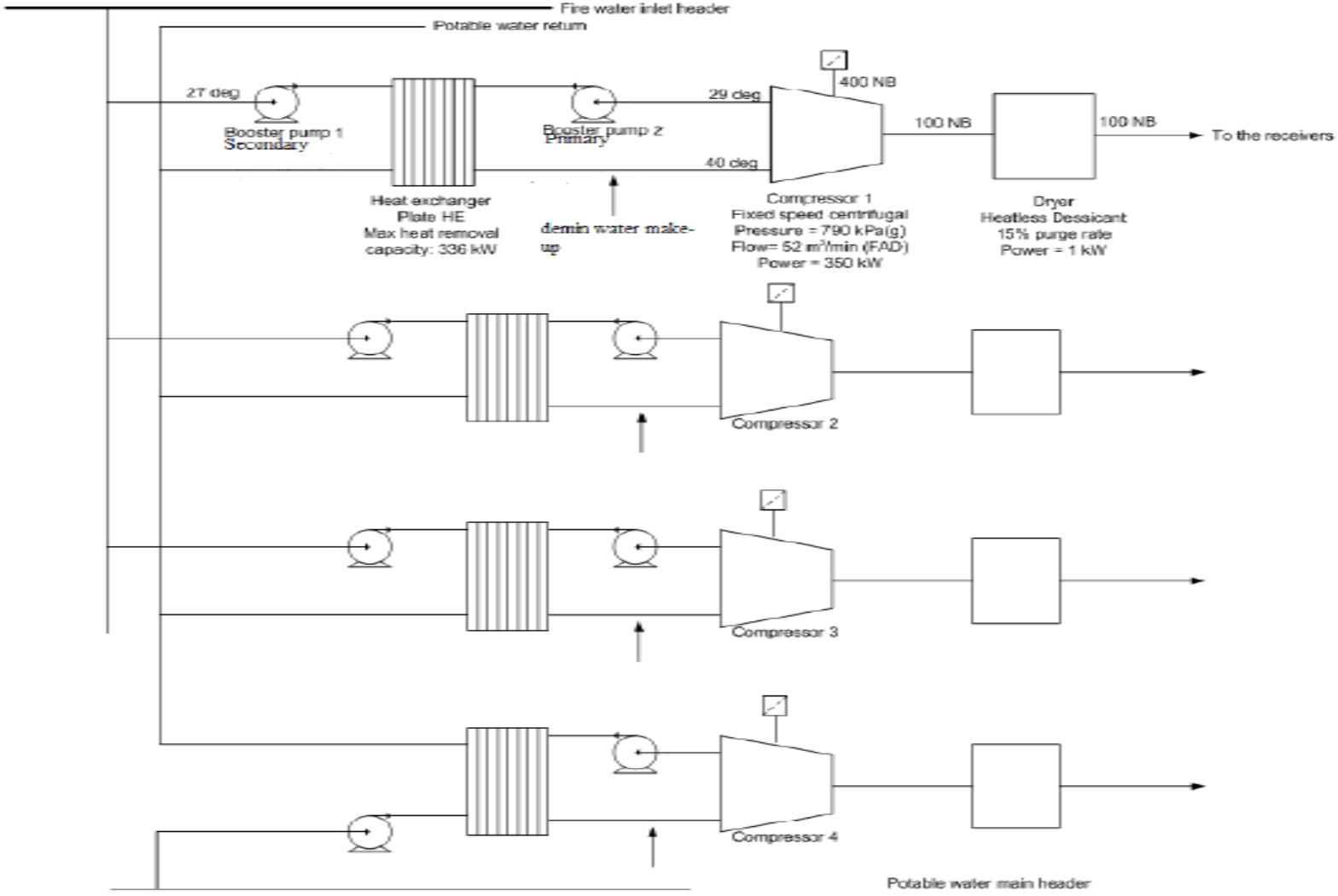

Figure 5: Compressor Plant Basic Flow Diagram

3.3 PERFORMANCE REQUIREMENTS

The following table shows the list of Air Compressors performance requirements:

Table 2: Performance Requirements

System	Quantity	Type	Rated Power	Air Flow Rate (/min)
Electric Compressors C400	4	Oil-Free Centrifugal	350kW	52 Nm^3
Diesel Compressors D1600QM8CA	2	Oil-Flooded Rotary Screw	375kW	45 Nm^3

3.4 OPERATING PHILOSOPHY

This section will provide an overview of the normal operation for the complete Compressed Air Supply and Distribution System. It will also indicate what is required from the operator for normal operation. This paragraph does not provide details with regards to the detailed control of the plant and the values of the control parameters. This will be done in the next paragraph under the control philosophy.

3.4.1 Control and service air compressors

3 electric compressors should run under normal circumstances to sustain a system pressure of 650kPa for both control and service air. One electric compressor and two diesel compressors must be on standby. The electric compressors are centrifugal type and will attempt to sustain the required pressure by operating the inlet and bypass valves. The discharge pressure on each compressor is set to run/maintain at 700kPa. If the system demand is high, the inlet valve will fully open and discharge valve will fully shut. If the demand is low, the inlet valve will attempt to limit the air-flow by throttling the inlet valve first, but if the compressor continues to run at a high pressure, the bypass valve opens gradually to try and maintain the set pressure. The drive motor on the compressor is fixed speed and therefore can only change the loading on it by means of controlling mainly the inlet valve and to a lesser extent the bypass valve.

The four electric compressors are supplied from 3,3 kV Service Boards 1 and 2, with two connected on each board. The two boards are electrically connected via a bus section breaker, with isolators on each side of the breaker, and a breaker earth switch. Each board is supplied by a cable from the 11/3,3 kV transformer, and in turn, there are VTs connected to the cables to supply the busbar under-voltage relays. The bus bars are electrically connected through the bus section. See circuit below:

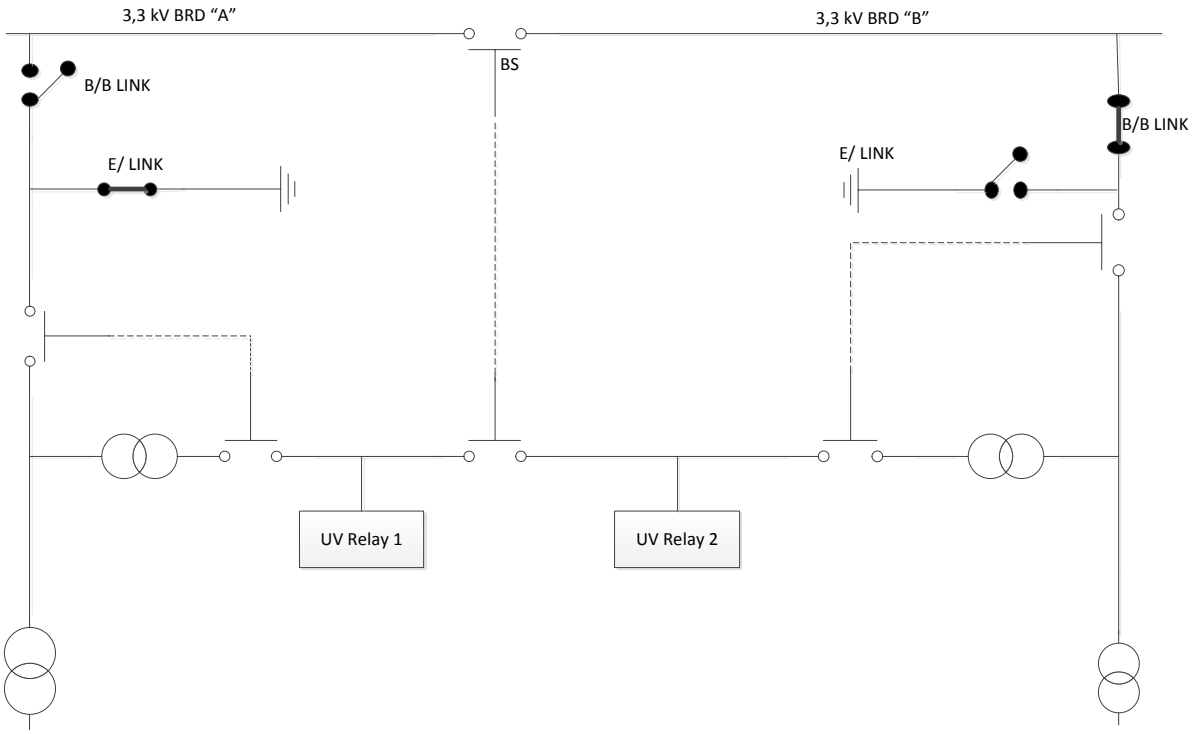

Figure 6: Electric Compressors 3,3kV Service Boards Circuit

If a board that supplies two electric compressors trips, the standby electric compressor that is connected on the other board must start automatically as well as the standby diesel compressor depending on the pressure deficit caused by the trip.

3.5 CONTROL PHILOSOPHY

The paragraphs below will give the details of the control for the Compressed Air and Distribution System.

3.5.1 Control Station Locations

3.5.1.1 System normal Control Station

The Compressed Air and Distribution System is controlled and operated from the Outside Plant Compressor House

3.5.1.2 Local Control Stations

The local control station consists of a START and a STOP push button as shown on the pictures below

Figure 7: Local Control Electric Compressors

Figure 8: Diesel Compressor Local Panel

Figure 9: Diesel Compressor Local Panel

3.5.2 Alarms set points and actions

Table 3: Trouble shooting electric compressors

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Failure to Start	• Failure to reset and interlock systems • No voltage to compressor control panel or starter • Loose or corroded power cable • Motor starter or starting system malfunctioning • No seal air	• Remove trip or interlock conditions • Check voltage to panel/starter • Check cables. Clean, tighten and replace as necessary • Troubleshoot motor starter • Supply seal air
Pre-lube oil pump malfunctioning	• Pump not running • Improper setting of pre-lube oil pump overflow valve • Broken motor • Defective pump	• Troubleshoot pump contactor and thermal protection. Check for proper supply voltage. • Adjust the overflow valve in order to obtain desired pressure valve • Repair or replace motor or motor pump • Repair or replace pump
High oil temperature	• No water flow or insufficient cooling water flow to oil cooler	• Restore correct water flow to oil cooler

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
	• Excessively high water temperature • Improper temperature pick up setting • Dirty or clogged oil cooler on water side	• Lower water temperature • Provide correct instrument setting • Clean cooler tubes
Low oil pressure	• Improper setting of oil control valve • Oil circuit leakage or narrowing • Dirty oil filter • Defective main oil pump • Low oil level inside the tank	• Adjust the valve set screw for correct pressure setting • Repair or replace the oil pipe • Replace oil filter cartridge • Repair or replace main oil pump • Add oil
High air temperature	• No or insufficient water flow to air cooler • Improper temperature pick up setting • Dirty or clogged air cooler on water side	• Restore correct water flow to the cooler. • Carry out correct instrument calibration • Clean cooler water passes. Provide water strainers as necessary
Low seal air pressure	• Low instrument air pressure • Improper setting of seal air pressure regulator • Defective seals	• See “low instrument air pressure” described below • Adjust regulator to obtain correct seal air pressure • Replace seals
Low instrument air pressure	• No supply pressure • Cut-off or leaking air lines • Improper air regulator setting	• Establish instrument air supply pressure • Repair or replace air lines • Adjust regulator to obtain correct instrument air pressure
High Vibration	• Low oil pressure • Defective coupling/insufficient coupling greasing • Rotor unbalance • Induced vibration from electric motor	• Allow warm up period for oil • Grease coupling/replace coupling
Compressor unable to reach full load conditions	• The operating mode selector is on the unload position • Pressure controller set point too low • Bypass valve not completely closed or inlet valve not open	• Turn selector to desired operating mode • Set controller correct pressure valve • Check for air leaks or valve supply system
System discharge pressure low	• Compressor not leaded • Dirty or clogged inlet air filter • Compressor surge with too low pressure values • Compressed air request higher than compressor flow rate or lie air leakage	• See above • Replace filter cartridge or clean it (for cleanable filters • See “continuous surging” below • Repair all system leaks. Turn off unnecessary utility

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Continuous surge	• Shut-off valve on discharge line closed • Dirty or clogged air filter • Improper setting of chocking point • High interstage temperature • Cooling water temperature higher than expected • Damaged streamlined parts	• Open shut-off valve • Replace filtering element • Adjust the choking limit point • Check water flow to coolers • Lower water temperature • Service compressor
Excessive power consumption	• Very low ambient temperature • Too low supply voltage • Reduction in motor efficiency	• Reduce compressor load • Check power grid voltage at the supply cabin • Contact motor manufacturer

Table 4: Trouble shooting diesel compressors

Station Diesel Compressors Troubleshooting	
Symptom	**Possible causes**
Discharge pressure too low	Start-run valve in “start” position
	Too much air demand
	Service valve open
	Service line leaks
	Compressor inlet filter restricted
	Control system operation
	Regulator valve set too low
Discharge pressure too high or relief valve blows	Inlet valve not closing properly
	Discharge pressure gauge faulty
	Control regulator valves faulty
	Oil separator plugged
	Pressure relief valve faulty
	Compressor shaft seal leaking
Relief valve blows with throttle lever in idle position	Inlet valve plate leaking
	Discharge pressure regulator faulty or improperly set
	Control system leaks
Faulty blowdown valve	Automatic blow down valve may be in operative
	Air line from inlet valve or sump to blow down valve may be restricted

Oil in service line	Oil return line plugged
	Separator element plugged or damaged
	Discharge pressure below 70 psi
Compressor oil consumption high	Oil line leaking
	Oil cooler leaking
	Compressor shaft seal leaking
Engine fails to accelerate or maintain full load speed	Compressor discharge pressure too high
	Improper control operation
	Engine idle speed set too low
	Operating above maximum altitude rating of the engine
Separator plugging	Check system for leaks
	Check compressor oil filter element
	Check air inlet filters and dust blockage
Engine speed control lever not moving to its idle position with service valves closed	Insufficient pressure in control line to operator throttle cylinder
	Air system is blocked between the sump and inlet valve. Also check the filter/condensate trap
	Air system leaks between sump and inlet valve
	Engine governor speed control lever binding or throttle cylinder faulty
	Discharge pressure regulator faulty
	Inlet valve faulty(broken or worn rings in modulation piston)
Engine speed control lever not moving to full speed when there is air demand	Start/run valve is positioned in “start” instead of “run”
	Engine governor speed control lever binding or throttle cylinder faulty
	Modulating spring broken
	Control rod disconnected between the engine governor and cylinder

	Discharge pressure regulator faulty or improperly set
Full load speed cannot be obtained	Control cylinder rod to engine governor is incorrectly set or binding
	Machine operating with excessive sump pressure
	Inlet valve faulty; modulating spring broken
	Engine governor incorrectly set
	Operating above maximum altitude rating of engine
High compressor discharge temperature	Check compressor oil level
	Clean outside of oil cooler
	Check fan belt
	Check thermal bypass valve thermostat
	Change oil and oil filter element
	Clean oil system cooler internally

3.5.3 Control and service air compressors and dryer pairs

This section will give the detailed control steps, requirements and limits for Control Air and Service Supply.

3.5.3.1 Field Devices Associated with the Compressed Air Compressors

The field devices associated with the Compressed Air Compressors are given in the table below:

Table 5: Control Air Compressors Field Devices

Functional Location (KKS)	**Functional Location Description**
00A_AVGSTNPRES	AVERAGE STATION PRESSURE
00A_US10P010	STATION PRESSURE 1
00A_US10P011	STATION PRESSURE 2
01NX01P001..XQ01	CONTROL AND SERV A PRESS TX
02NX01P001..XQ01	CONTROL AND SERV A PRESS TX
03A_NX01P002	OIL BURNER CONTROL AIR PRESSURE
04A_NX01P002	OIL BURNER CONTROL AIR PRESSURE
05A_NX01P002	OIL BURNER CONTROL AIR PRESSURE
06_NX01P001..XQ01	CONTROL AND SERV A PRESS TX

Functional Location (KKS)	Functional Location Description
01B_SK71P970_XG51	CRTL AIR PRESS < 500 kPa
02B_SK71P970_XG51	CRTL AIR PRESS < 500 kPa
03B_SK71P970_XG51	CRTL AIR PRESS < 500 kPa
04B_SK71P970_XG51	CRTL AIR PRESS < 500 kPa
01BS_RM90P002_XH01	PLANT AIR PRESSURE
01BS_RM90P002_XH01	PLANT AIR PRESSURE
01BS_RM90P002_XH01	PLANT AIR PRESSURE
01BS_RM90P002_XH01	PLANT AIR PRESSURE
01BS_RM90P002_XH01	PLANT AIR PRESSURE
01BS_RM90P002_XH01	PLANT AIR PRESSURE
05B_SK71P970_XG51	CRTL AIR PRESS < 500 kPa
06B_SK71P970_XG51	CRTL AIR PRESS < 500 kPa
00A_US10S041	PLANT AIR V/V POS
01US101F001..XQ01	CTRL AIR FLOW
02US101F001..XQ01	CTRL AIR FLOW
03RB_U10F001	UNIT CONTROL AIRFLOW
04RB_U10F001	UNIT CONTROL AIRFLOW
05RB_U10F001	UNIT CONTROL AIRFLOW
06RB_U10F001	UNIT CONTROL AIRFLOW
04RB_U10F002	DHP CONTROL AIRFLOW
05RB_U10F002	DHP CONTROL AIRFLOW
06RB_U10F002	DHP CONTROL AIRFLOW
04B_PAH307_1	SO3 PROCESS AIR PRESS
05B_PAH307_1	SO3 PROCESS AIR PRESS
06B_PAH307_1	SO3 PROCESS AIR PRESS

Some of these devices are all used in the control of the compressed air system described below:

3.5.3.2 Normal Control

SYSTEM PRESSURE. Average station air pressure	
Pressure decreasing.	
>600kPa average station pressure	3 electric compressors running to maintain system press between 600 and 650 kpa.
590kPa average station pressure	Standby electric compressor starts.
570kPa average station pressure	Diesel compressor 1 starts
550kPa average station pressure	Diesel compressor 2 starts
520kPa average station pressure	Plant/service air valve 100% shut
500kPa (Unitized air receiver)	Oil burner control air pressure alarm
<400kPa	Inlet & bypass valves close
200kPa (Unitized air receiver)	Boiler trip
<100kPA	Seal air pressure low trip
Pressure increasing:	
< 550kPa	4 electric and 2 diesel compressors in service.
620kPa average station pressure	Both diesels stop
660kPa average station pressure	Switch off one electric compressor Service air valve opens

3.5.3.3 Abnormal Control

Loss of 3,3KV services boards A&B	
System Pressure Average station air pressure	
Pressure decreasing.	
570kPa average station pressure	Diesel compressor 1 starts
550kPa average station pressure	Diesel compressor 2 starts
520kPa average station pressure	Plant/service air valve 100% shut
500kPa (Unitized air receiver)	Oil burner control air pressure alarm
<400kPa	Inlet & bypass valves close
200kPa (Unitized air receiver)	Boiler trip
<100kPA	Seal air pressure low trip

3.5.3.3.1 Steps to start the compressor plant from an MUT incident

From previous experience, it has happened that both 3.3kv station services boards that supply all electric compressors tripped due to unforeseen faults on the system and consequently an MUT happened. Below are the steps that need to be followed to restore the compressed air system after an MUT once power supply to electric compressors has been restored:

- Manually isolate all air supplies to the station and water treatment plant by closing the following valves:
  - 00US10S025 – CTRL AIR TO WTP BYPASS ISOL V/V
  - 00US10S024 – CTRL AIR TO WTP BYPASS ISOL V/V
  - 00US10S023 – CTRL AIR TO WTP ISOL V/V 2
  - 00US10S022 – CTRL AIR TO WTP ISOL V/V 1
  - 00US10S011 – SERVICE AIR PRESS CTRL V/V OUTL ISOL V/V
  - 00US10S015 – SERVICE AIR PRESS CTRL V/V BYPASS ISOL V/V
  - 00US10S032 – CTRL AIR TO STATION BYPASS ISOL V/V 2
  - 00US10S030 – CTRL AIR TO STATION SOL V/V 2
  - 00US10S029 – CTRL AIR TO STATION ISOL V/V 1
  - 00US10S031 – CTRL AIR TO STATION BYPASS ISOL V/V 1
- Make sure that diesel compressors are running
- Build-up pressure to 400kPa
- Perform a full pre-start check as per doc. OC017P Rev 4 PRE-START CHECKLIST
- Start all four electric compressors in any order

- Perform running checks as per doc. OC017R Rev 4 RUNNING CHECKSHEET
- Once system pressure reaches 600kPa, quickly open all the isolated valves mentioned above.

3.5.3.4 Protections and alarms

Electric compressors		
Signal	**Alarm**	**Trip**
Vibration stage 1	22.10	25.15
Vibration stage 2	19.05	24.13
Inlet water temperature	38	45
Outlet water temperature	38	41
Oil pressure low	160	110
Oil temperature low	25	20
Oil temperature high	51	57
Air stage 1 temperature	43	46
Air stage 2 temperature	43	46
Cooling water flow low	Alarm only	
Compressor surge	Alarm only	
Intake filter differential pressure high	Alarm only	
Starter feedback signal	Alarm only	
Comp seal air press low.	100	50
Phase A temperature high	110	130
Phase B temperature high	110	130
Phase C temperature high	110	130
Inboard temperature high	90	95
Outboard temperature high	90	95
Diesel Compressors.		
Compressor discharge temp high		116
Engine temperature high		93
Engine oil pressure low		100
Engine water temperature		101

3.6 PRESERVATION

There is no special control preservation required as the system will run on duty cycle.

3.7 SHEQ AND STATUTORY CONSIDERATIONS

The following Compressed Air System equipment will be inspected and pressure tested as per statutory requirement every 3 years or as per RBI recommendations:

Table 6: SHEQ and Statutory Considerations List

Equipment	KKS Code
Outside Plant Control Air Receiver 1	03-00UG11G008
Outside Plant Control Air Receiver 2	03-00UG12G008
Outside Plant Control Air Receiver 3	03-00UG13G008
Outside Plant Control Air Receiver 4	03-00UG14G008
North WTP Air Receiver	03-00US21G001
South WTP Air Receiver	03-00US30G001
Service Air Receiver	03-00US10G001
Unit 1 Control Air Receiver	03-01US10G001
Unit 2 Control Air Receiver	03-02US10G001
Unit 3 Control Air Receiver	03-03US10G001
Unit 4 Control Air Receiver	03-04US10G001
Unit 5 Control Air Receiver	03-05US10G001
Unit 6 Control Air Receiver	03-06US10G001
Electric Compressor 1 Dryer	03-00US11G006/7
Electric Compressor 1 Dryer	03-00US12G006/7
Electric compressor 1 Dryer	03-00US13G006/7
Electric Compressor 1 Dryer	03-00US14G006/7
Diesel Compressor 1 Dryer	03-00US15G006/7
Diesel Compressor 2 Dryer	03-00US16G006/7
Electric Compressor 1 After filter	03-00US11G003
Electric Compressor 1 After filter	03-00US12G003
Electric Compressor 1 After filter	03-00US13G003
Electric Compressor 1 After filter	03-00US14G003
Diesel Compressor 1 After filter	03-00US15G003
Diesel Compressor 2 After filter	03-00US16G003

4. ACCEPTANCE

This document has been seen and accepted by the following people:

Name	Designation
Morris Marebane	Operating Group Manager

Name	Designation
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Andile Nqayane	Electrical Engineering Manager
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5. REVISIONS

Date	Rev.	Compiler	Remarks
March 2021	0	N Ngcobo	Mandatory review of document.

6. DEVELOPMENT TEAM

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

- N Ngcobo

7. ACKNOWLEDGEMENTS

None