	Standard	Generation Engineering
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Title: **Compressed Air System Standard** Unique Identifier: **240-105929225**

Alternative Reference Number: **N/A**

Area of Applicability: **Generation Engineering**

Documentation Type: **Standard**

Revision: **3**

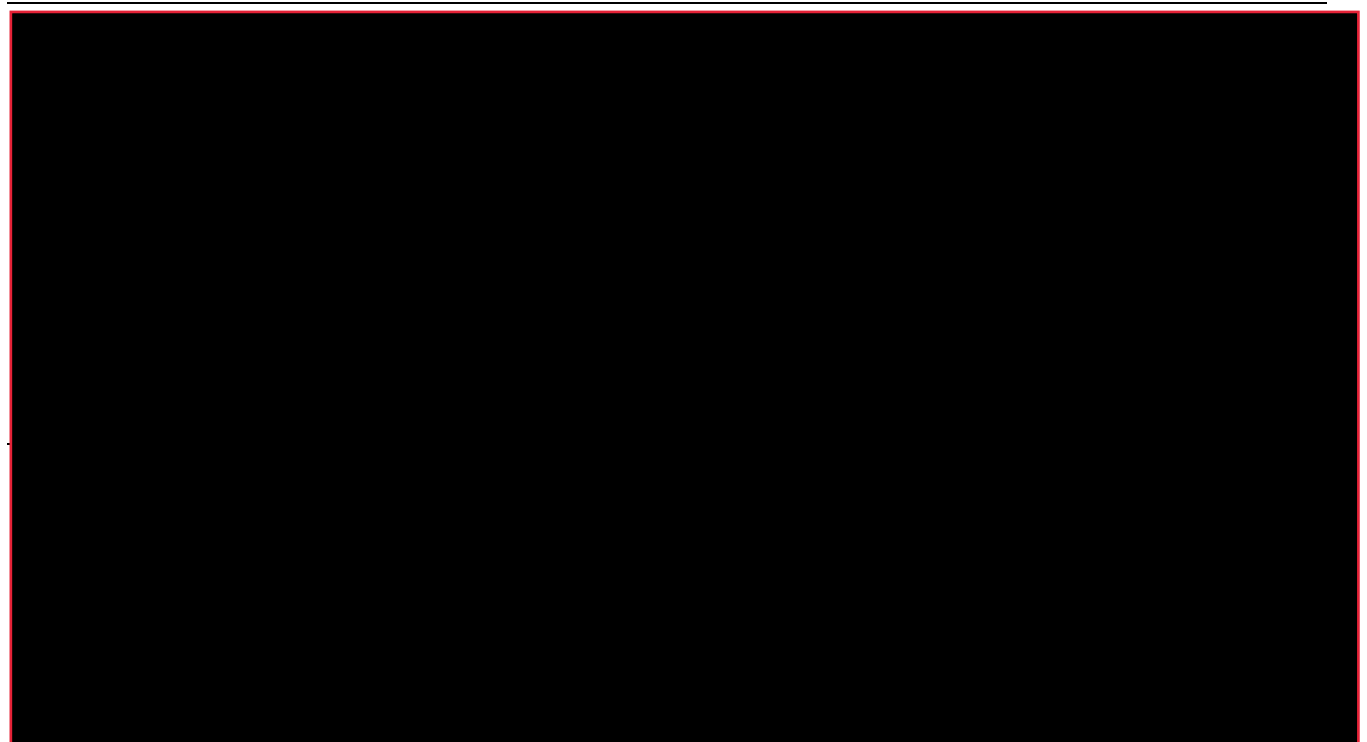
Total Pages: **31**

APPROVED FOR AUTHORISATION

☒ GENERATION ENGINEERING
DOCUMENT CENTRE ☎ x4962

Next Review Date: **May 2029**

Disclosure Classification: **CONTROLLED DISCLOSURE**



PCM Reference : **240- 53458738**

SCOT Study Committee Number/Name : **Low Pressure Services**

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1. INTRODUCTION

Compressed air is used for the operation of various plants within the power station such as Boiler, Turbine, Water Treatment Plant, Hydrogen Plant, Ash Handling Plant, Mill bunkers, Workshops, Filling station and the Pulse Jet Filter Plant, etc. Compressed air systems consist of the supply side which includes air compression and drying and primary storage systems, and the demand side which includes distribution network, secondary storage systems and end users. Ambient air at atmospheric pressure is filtered and compressed into different stages, dried and then stored into the air receiver at high pressure. Eskom uses control air and process air for plant operation and service air for the operation of the pneumatic tools for maintenance purposes.

This document stipulates the criteria for the design, selection and installation of compressed air equipment and the system as a whole for use throughout Eskom plants.

2. SUPPORTING CLAUSES

2.1 SCOPE

This Standard provides the minimum requirements to be used by all persons responsible for the specification, design, modification and construction of new compressed air systems or when existing compressed air systems are modified for Eskom Holdings, including Mobile/Temporary compressed air equipment like compressors, dryers, filters, etc.

2.1.1 Purpose

The purpose of this document is to provide the minimum requirements for persons responsible for the specification, design, construction and modification of compressed air systems at Eskom Holdings. The Standard stipulates the criteria to be used when specifying, designing, constructing new plants as well as modifying existing compressed air systems.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions when specifying new and/or modified temporary and permanent compressed air plant.

2.2 NORMATIVE/INFORMATIVE REFERENCES

All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below.

2.2.1 Normative

The following standards contain provisions which, through reference in this text, constitute provisions of this standard.

- [1] 240-108079354, Auxiliary and Ancillary Cooling Water Systems Design Guideline
- [2] 240-55864833, Chemistry for Auxiliary and Ancillary Cooling Water Systems Manual
- [3] [240-55864767, Chemistry and Microbiology Standard for Condenser Cooling Water](#)
- [4] SANS 347, Categorization and conformity assessment criteria for all pressure Equipment.
- [5] OHS Act Pressure Equipment Regulation 2009.
- [6] 240-53458738, Process Control Manual (PCM) for Perform Low Pressure Services Engineering
- [7] ISO 8573-1:2010, Compressed air. Contaminants and purity classes

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- [8] IEC 60529, Ingress Protection ratings
- [9] 240-101712128 Internal Corrosion Protection of Water Systems Chemical Tanks and Vessels with Linings Standard
- [10] South African Grid Code: Network Code
- [11] 240-53113685 Design Review Procedure
- [12] 240-123801640 Standard for Low Pressure Pipelines
- [13] 240-105020315 Standard for Low Pressure Valves
- [14] 240-56356376 On-Site Commissioning for Low Pressure Systems Standard
- [15] OHS Act 1993
- [16] VGB-R 171e, Guidelines for the supply of technical documentation for fossil-fired and regenerative power stations

2.2.2 Informative

The informative references below are not essential to the application of this Standard, but assist the user to better understand the concepts presented in a particular subject area.

- [17] ISO 1217, Displacement compressors — Acceptance tests
- [18] ASME B31.3, Process Piping;
- [19] ASME VIII Rules for construction of pressure vessels (divisions 1, 2 and 3)
- [20] EN 13480, Metallic Industrial piping;
- [21] EN 13445 Unfired Pressure vessels
- [22] ASME B16.11 Forged Fittings, Socked-welded and Threaded or BS EN equivalents
- [23] ASME B16.9, Factory Made Wrought Butt-welded Fittings
- [24] ISO 9001 Quality Management System
- [25] SANS 10142-1, The Wiring of Premises
- [26] SANS 121:2000, Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles – Specifications and Test Methods
- [27] Atlas Copco Compressed Air Manual, seventh edition (On internet)
- [28] ISO 12500, Filters for compressed air – Test methods
- [29] ISO 7183, Compressed Air Dryers – Specifications and testing
- [30] [CAGI \(United States Compressed Air and Gas Institute\)](#)
- [31] ISA-7.0.01-1996; Quality standard for instrument air
- [32] ISO/DIS 18623-1, Air compressors and compressed air systems — Air compressors — Part 1: Safety requirements
- [33] PD 5500:2015 Specification for unfired fusion welded pressure vessels
- [34] [PNEUROP \(European committee of manufacturers of compressed air equipment, vacuum pumps, pneumatic tools and allied equipment\)](#)
- [35] [U.S Department of Energy Improving compressed air system performance](#)

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2.3 DEFINITIONS

Include all definitions applicable to this document, in table and in alphabetical order. Explain all terms used, including documents, titles and departmental references that may cause confusion if not explained. Preferably use definitions listed in international standards.

Definition	Description
Approved by	The accountability of the Approver of the document is equivalent to the specified role of Functional Responsible/Owner as identified in 240-53114186 and 32-6 for Documents and Records Management.
Absorption	Absorption drying is a chemical process in which water vapour is bound to absorption material. The absorption material can either be a solid or liquid.
Adsorption	The general working principle of adsorption is simple as moist air flows over hygroscopic material (typical materials used are silica gel, molecular sieves, activated alumina) and is thereby dried.
Aerosol	An aerosol is a colloid of fine solid particles or liquid droplets, in air or another gas
After Cooler	An after-cooler is a heat exchanger that cools the hot compressed air to condense the water that otherwise would condensate in the pipe system.
Air Quality	Quality of compressed air is guided by the degree of dryness and filtration needed and acceptable contaminant level for the end users. Classes for particles, liquid water and total oil are defined [7].
Compressed Air	Compressed air in this case is air at a pressure of greater than 1.5Bar (g)
Compressor train	Includes an inlet filter, compressor with electrical/diesel motor, switchgear and control system, pre filter, air dryer, post filter and all necessary isolating, control, blow off and non- return valves, up to but excluding the air receiver inlet manifold.
Controlled Disclosure	Controlled disclosure to external parties (either enforced by law, or discretionary).
Dewpoint	The temperature at a given pressure at which a relative humidity of 100% will be reached. At this point, the water vapour and partial pressures are equal and condensation will take place if the temperature is further reduced or if the pressure increases. The pressure dew point is the dew point at that particular operating pressure.
Free air delivery	It is the volume of air delivered by the compressor at the uncompressed inlet conditions that exist before the inlet filter. <i>If the reference conditions are not specified, the flow rates are unknown.</i>
Normal cubic meter	It is the volume of compressed air at a: <ul style="list-style-type: none"> Specified temperature, Specified pressure and

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Definition	Description
	<ul style="list-style-type: none"> Specified relative humidity. <p><i>Please note that the different manufacturers are using various reference conditions (inlet temperature, pressure and relative humidity) when quoting compressed air equipment should specifically be confirmed and not assumed. If the reference conditions are not specified, the flow rates are unknown.</i></p>
Particle	Small discrete mass of solid or liquid matter
Particle size	The length of the greatest distance between two external boundaries of a particle
Redundancy	Use of more than one independent means to accomplish a given function
Relative Humidity	The ratio of the partial pressure of a vapour to the vapour saturation pressure at the dry bulb temperature of a mixture.
Standard Temperature and Pressure	<p>Air at 20°C, 1bar (100kPa) (atmospheric pressure at sea level) and 0% Relative Humidity (completely dry air).</p> <p>Please note that the different manufacturers are using various reference conditions (inlet temperature, pressure and relative humidity) when quoting compressed air equipment should specifically be confirmed and not assumed.</p>
Standard cubic meters	<p>It is the volume of air at a particular temperature typically</p> <ul style="list-style-type: none"> 20°C, 100 kPa and 0% Relative Humidity (completely dry air). <p>and is used as reference by ISO 1217 [17] in Annex F, Pneurop [34], and CAGI [30] when specifying compressed air equipment such as compressor and dryer capacities (flow rates).</p> <p><i>Please note that the different manufacturers are using various reference conditions (inlet temperature, pressure and relative humidity) when quoting compressed air equipment should specifically be confirmed and not assumed. If the reference conditions are not specified, the flow rates are unknown.</i></p>
Surge	<p>Surge is defined as the operating point at which centrifugal compressor peak head capability and minimum flow limits are reached. At this point, the system pressure overcomes the pressure head of the compressor and reverse flow occurs.</p> <p>It is caused by reversal of flow within a dynamic compressor that takes place when the capacity being handled is reduced to a point where insufficient pressure is being generated to maintain flow.</p>
System	Assembly of components in which compressed air is delivered and used
System Pressure	The air pressure of a particular class of compressed air as measured at the air receiver directly after the dryers. Where multiple receivers are

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Definition	Description
	in service, the system pressure is average pressure of the receivers in service.
Vapour	A gas that is at a temperature below its critical temperature and that, therefore, can be liquefied by isothermal compression
Wear and Tear Derating Factor	Wear and Tear Derating Factor is a correction factor used in the design process to allow for the deterioration of the compressed air component due to normal wear and tear. The Wear and Tear Derating Factor is the percentage of the compressed air equipment's rating that would still provide acceptable performance before it needs refurbishment and restored back to the factory acceptance test performance conditions. It is used in the design process for the sizing and selection of components to ensure that the overall system will still meet the performance requirements up to the specified Wear and Tear Derating Factor. The Wear and Tear Derating Factors in Table 4: Wear and Tear Derating Factors (K_f) for various types of compressors. It should be noted that if compressors are not maintained according to the manufacturer's recommendations, the performance of the compressors can be substantially worse.

2.4 ABBREVIATIONS

In the preceding table, list and describe all abbreviations used in the document, in alphabetical order.

Abbreviation	Description
ASTM	American Society for Testing and Materials
BS	British Standard
CFM	Cubic Feet per Minute
FdBA	A-weighted decibels,
EN	European Standard
FAD	Free Air Delivery
g	Gravitational force
ISO	International Standards Organisation
K	Kelvin
LPS	Low Pressure Services
Micron	10^{-6} meter
MM	Maintenance Manual
MUT	Multi-Unit Trip
NB	Nominal Bore
Nm ³ /min	Normal cubic meter per minute
NRV	Non Return valve
OEM	Original Equipment Manufacturer
PDP	Pressure Dew Point
PER	Pressure Equipment Regulations

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Abbreviation	Description
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram
pH	It is a numeric scale used to specify the acidity or alkalinity of an aqueous solution.
ppm	Parts per million, a way of quantifying small concentrations, usually mass.
RH	Relative Humidity
SANS	South African National Standard
SCFM	Standard Cubic Feet per Minute
SI	International System of Units
Sm ³ /min	Standard cubic meters per minute
STP	Standard Temperature and Pressure
VGB	Technische Vereinigung Der Grosskraftwerksbetreiber (German for Society of Large Power Station Operators)
VSD	Variable speed drive,

2.5 ROLES AND RESPONSIBILITIES

Engineering Managers are responsible for ensuring that this standard is implemented by a competent person, as per Eskom Governance and Competency requirements.

The competent person is responsible for ensuring that the design, the operation, and the maintenance of the Compressed Air Plant complies to this standard.

2.6 PROCESS FOR MONITORING

240-53113685 Design Review Procedure will confirm compliance to this standard.

2.7 RELATED/SUPPORTING DOCUMENTS

None.

2.8 UNITS OF MEASUREMENT

The units of measurement are the SI system.

3. COMPRESSED AIR IN ESKOM

Compressed air is processed atmospheric air under pressure which is produced by compressors, water removed by dryers, water separators and condensate traps, and stored in air receivers. Eskom along with many other industrial plants use compressed air for a variety of reasons such as:

- Control Air
- Fabric Filter Pulse Air
- Conveying Air
- Forced Air Cooling
- Service Air
- Generator Breaker Air (This will not be further discussed as it more specialised and is covered by a different document)

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4. COMPRESSED AIR QUALITY

The quality of compressed air is governed by a standard produced by International Organisation for Standardisation (ISO). The standard dictates the quality of air by referring to different classes with class 1 being of the highest quality and class 6 being the lowest quality. Below is data taken from the air quality standard (ISO 8573-1:2010, Compressed air. Contaminants and purity classes [7] and adapted for Eskom for air, which differentiates the pressure dew point temperature, oil content, particle size and the particle size concentration of compressed air for different classes.

4.1 CONTROL AIR

Control air refers to essential air that is compressed to a desired pressure and quality class which is supplied for the control of the pneumatic valves, the instrumentation and the operation of any of the processes at a power station excluding conveying air, fabric filter pulse air, forced air cooling and service air.

Control Air has the following properties:

- Dew Point - 40 °C PDP (Class 2)
- Max Oil Content < 0.1mg/m³ (Class 2)
- Max Particle Size < 1micron (Class 2)

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4.2 FABRIC FILTER PULSE AIR

The essential compressed air that is used to create a reverse pulse to clean accumulated fly ash of the fabric filter bags, using a combination of solenoids, pilot valves, pulse valves, pulse tubes and nozzles. The fabric filter pulse air has the same quality class as control air.

Fabric filter pulse air has the following properties:

- Dew Point - 40 °C PDP (Class 2)
- Max Oil Content < 0.1mg/m³ (Class 2)
- Max Particle Size < 1micron (Class 2)

4.3 CONVEYING AIR

The Compressed air is used to pneumatically convey fly ash to the hoppers (excludes the air used to operate the valves on the plant, which is control air).

Conveying air has the following properties:

- Dew Point +3 °C PDP (Class 4)
- Max Oil Content < 5mg/m³ (Class 4)
- Max Particle Size < 15micron (Class 4)

4.4 FORCED AIR COOLING

Compressed air that is used to rapidly cool the internals of the turbine and boiler pressure parts after a unit shut down, thereby reducing the cooling time. It is an intermittently operated plant and the loss of this plant will not affect the power generation process.

Forced air cooling has the following properties:

- Dew Point No additional drying required¹, but shall be provided with a coalescent type filter to prevent water droplets from being carried over to the turbine and pressure components.
- Max Oil Content < 0.1mg/m³ (Class 2)
- Max Particle Size No special requirement² (Class 2)

¹ A functional after cooler operating providing an air discharge temperature of less than 37°C will result in air dry enough for the purpose of Forced Air Cooling.

² The compressor inlet filter will provide sufficient particle filtration for this purpose, thus no additional filtration is required. However, if the air is taken after a desiccant dryer, additional filtration should be provided to filter the air to class 2 requirements.

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4.5 SERVICE AIR

Service air refers to air that is compressed to a desired pressure and quality class that is used to power portable pneumatic tools and equipment. It is an intermittently operated plant and the loss of this plant will not affect the power generation process.

Service Air has the following properties:

- Dew Point No drying required (Class 6)
- Max Oil Content No conditioning requirement (Class 6)
- Max Particle Size No conditioning requirement (Class 6)

It should be noted that where the tools or equipment require a specific air quality, it shall be treated at the point of use.

5. AMBIENT REFERENCE CONDITIONS FOR COMPRESSED AIR SYSTEM

The ambient reference conditions for the sizing and selection of compressed air systems are provided in Table 1 and Table 2.

Table 1: Ambient reference conditions to be used for the sizing and selection of compressed air systems

Inlet Parameter	Minimum	Expected	Maximum
Pressure	$P_{atm(Min)}$ $= P_{atm(Exp)} - 5kPa$	$P_{atm(Exp)}$ $= p_0 * e^{(-g*M*h)/(R*T_0)}$	$P_{atm(Max)}$ $= P_{atm(Exp)} + 5kPa$
Temperature (All Stations except Medupi & Matimba)	-10°C	25°C	35°C
Temperature (Medupi & Matimba only)	0°C	30°C	45°C
Relative humidity	20%	60%	80%

Table 2: Values for the calculation of site specific ambient reference conditions

Parameter	Description	Value
p_0	sea level standard atmospheric pressure	101 325 Pa
T_0	sea level standard temperature	288.15 K
g	Earth-surface gravitational acceleration	9.80665 m/s ²
M	molar mass of dry air	0.0289644 kg/mol
R	universal gas constant	8.31447 J/(mol•K)
h	Height above sea level	Site specific in m

The ambient reference conditions for all the Eskom Coal Fired Power Stations are available in Appendix A.

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6. COMPRESSOR AND COMPRESSED AIR EQUIPMENT CAPACITY SPECIFICATION

All compressed air volumetric flows for compressed air equipment (except compressors) shall be indicated in m³/min FAD and also always include reference back to the FAD conditions applicable for that specific volumetric flow. Thus, if the compressed air demand is 30 m³/min FAD, the FAD conditions should be specified in terms of Temperature and Pressure as stipulated in Appendix A for that particular site.

Where volumetric flow rates are stipulated for compressors, it shall always be accompanied by the FAD conditions (Temperature, Pressure and Relative Humidities) and discharge operating pressures as well. Thus, a compressor has a rating of 30 m³/min FAD at 700 kPa(g) with the FAD conditions of Temperature, Pressure and Relative Humidities as stipulated in Appendix A for that particular site.

7. CONSTITUENTS OF A COMPRESSED AIR SYSTEM

A typical compressed air system consists of many components and in some cases supporting systems.

A compressed air train configuration is preferred in order to eliminate common mode failures where a single failure may result in the loss of more than one train. Where the design deviates from the recommended train configuration, it will record a detailed fault analysis to ensure that failures of multiple trains will still be acceptable and tolerable. (Also refer to Section 7.16).

A compressed air train includes an inlet filter, compressor with electrical/diesel motor, switchgear and control system, pre filters, air dryer, post filter and all necessary isolating, control, blow off and non-return valves, after filter up to and including the . Where the compressor is water cooled, the cooling water system also forms part of the compressed air train.

See examples for a typical configuration in Appendix B: Typical Configuration of a Compressed Air Plant.

7.1 INLET FILTER

An air-end inlet filter is placed on the suction side of the compressor and is necessary to ensure filtered air is delivered to the compressor. Compressor internals have small clearances which vary amongst different compressor manufacturers. Contaminants such as dust, sand, fly ash and the like, that typically exist in a power station environment can be harmful to compressor internals hence an inlet filter is required to protect the compressor internals. If these contaminants pass through the inlet filter they can build up on or erode internal components such as rotors, impellers, vanes and coolers leading to premature wear and inefficiencies.

The compressor inlet filter should be provided with a differential pressure transmitter and interfaced to the compressor controller to:

- raise an alarm where the filter is blocked (high pressure), and
- raise an alarm (low pressure) and trip (low-low pressure) where the filter element is not installed.

The inlet air shall be drawn from inside the compressor house or hall.

The intake pipe or ducting shall have a circular cross section relating to an air speed of not more than 7m/s.

Note that in some cases the motor, inter and after coolers (for air cooled compressors) are also provided with air filters to improve the cooling to these components. In these cases the air intake must be completely separate from that of the air end to ensure that the air end is not starved from airflow, or the air not heated by the other components.

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7.2 BLOW-OFF PIPING

Piping shall be provided for the blow-off air from the compressors. The blow-off piping shall consist of separate pipe runs from the compressor blow-off outlet and either conveys the blow-off air to the outside of the compressor house or directly back to the inlet pipework between the filter and the compressor inlet. Where the blow-off is vented back to the intake pipework, it should be noted that the intake pipework will also become part of the pressured system and should be designed as such.

Suitable insulation with cladding shall be provided on all piping with an expected operating temperature of above 50°C.

The blow off should be provided with a suitable silencer to ensure that the noise limit of 85 dB(A) is not exceeded.

Pipe supports shall be designed to satisfy sustained and occasional load requirements.

7.3 COMPRESSORS

The compressed air requirements must be established before the selection and sizing of a compressor can take place. This information is most often defined by the end user of compressed air and shall be verified by the compressed air system designer (Minimum, Expected and Maximum pressures and flows for each end user).

The minimum and maximum pressure of the individual compressed air users shall be used to determine the System Pressure and to size the air receivers in Section 7.12.

In order to ensure that the compressed air system will be able to operate efficiently while in operation, the parameters in Tables 3-5 should be used to ensure that the compressors will be able to meet the maximum demand and also not run in continuous blow off for extended periods of time.

First the compressor minimum and maximum flow rates are determined by the compressor OEM as per Table 3. Then, using the information from the compressor OEM, and combining it with the Wear and Tear Derating Factors from Table 4, the useable operating range for the compressor can be determined as in Table 5. The operating range for the selected compressors should be such that the compressors will not blow down for extended periods of time during the operation of the plant, as this will result in unnecessary energy wastage and increased maintenance costs of the compressors.

Table 3: Key Parameters required when sizing and selecting a compressor

Parameter	Minimum Flow Rate	Maximum Flow Rate
Name Plate Rating	<1> Typically given at “N” normal or “S” standard inlet conditions or expected FAD conditions.	<2> Typically given at “N” normal or “S” standard inlet conditions or expected FAD conditions
Expected Performance Calculated using the Expected Atmospheric Conditions from Table 1 The calculated Expected Atmospheric Conditions for the various stations can be obtained from Table 6 in Appendix A. Note that that Cooling Water Temperature should be obtained for the same Expected	<3> Minimum flow rate as calculated by the compressor OEM without blow-off or deloading at the specified site ambient conditions and required discharge pressure to meet the System Pressure with a normal differential pressure over filters and dryers.	<4> Maximum flow rate as calculated by the compressor OEM at the specified site ambient conditions and required discharge pressure to meet the System Pressure with a normal differential pressure over filters and dryers.

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Atmospheric Conditions.		
<p>Worst Performance</p> <p>Calculated by the compressor OEM using the following parameters from Table 1 to determine the Worst Atmospheric Conditions:</p> <ul style="list-style-type: none"> • Minimum Atmospheric Pressure • Maximum Temperature • Maximum Relative Humidity <p>The calculated expected atmospheric conditions for the various stations can be obtained from Table 6 in Appendix A</p> <p>Note that that water cooled compressors the Cooling Water Temperature should be calculated using the same Worst Atmospheric Conditions.</p>	<p><5> Minimum flow rate as calculated by the compressor OEM without blow-off or deloading at the specified Worst Atmospheric Conditions and the required Discharge Pressure to meet with the maximum allowable differential pressure over the filters (compressor inlet, and all dryer pre and after filters) and dryers).</p>	<p><6> Maximum flow rate as calculated by the compressor OEM at the specified Worst Atmospheric Conditions and the required Discharge Pressure to meet System Pressure with the maximum allowable differential pressure over the filters (compressor inlet, and all dryer pre and after filters) and dryers.</p> <p>Note: Where the maximum flow rate requires throttling of the inlet control valve, it should be specifically noted as well as the constraint.</p>
<p>Best Performance</p> <p>Calculated by the compressor OEM using the following parameters from Table 1 to determine the Best Atmospheric Conditions:</p> <ul style="list-style-type: none"> • Maximum Atmospheric Pressure • Minimum Temperature • Minimum Relative Humidity <p>The calculated expected atmospheric conditions for the various stations can be obtained from Table 6 in Appendix A</p> <p>Note that that water cooled compressors the Cooling Water Temperature should be calculated using the same Best Atmospheric Conditions.</p>	<p><7> Minimum flow rate as calculated by the compressor OEM without blow-off or deloading at the specified Best Atmospheric Conditions and the required Discharge Pressure to meet System Pressure with the minimum allowable differential pressure over the filters (compressor inlet, and all dryer pre and after filters) and dryers.</p>	<p><8> Maximum flow rate as calculated by the compressor OEM at the specified Best Atmospheric Conditions and the required Discharge Pressure to meet System Pressure with the minimum allowable differential pressure over the filters (compressor inlet, and all dryer pre and after filters) and dryers.</p> <p>Note: Where the maximum flow rate requires throttling of the inlet control valve, it should be specifically noted as well as the constraint.</p>

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Table 4: Wear and Tear Derating Factors (K_f) for various types of compressors

Compressor Type	Wear and Tear Derating Factor (K_f)
Water Cooled Centrifugal Compressor	85%
Water Cooled Reciprocating Compressor	75%
Water Cooled Oil Free Screw Compressor	85%
Water Cooled Oil Flooded Screw Compressor	80%
Air Cooled Oil Free Screw Compressor	85%
Air Cooled Oil Flooded Screw Compressor	80%

Table 5: Determination of Compressor Operating Range

Description	Available Minimum Flow Rate for the Design	Available Maximum Flow Rate for the Design
Compressor Operating Range	<p><9> Minimum flow rate as calculated by the compressor OEM without blow-off or deloading at the specified Best Atmospheric Conditions and the required Discharge Pressure to meet System Pressure with the minimum allowable differential pressure over the filters (compressor inlet, and all dryer pre and after filters) and dryers. (From <7> in Table 3 above)</p> <p>This is equivalent to the minimum flow rate achievable by a brand new compressor during best environmental conditions.</p>	<p><10> the maximum flow rate as calculated by the compressor OEM at the specified Worst Atmospheric Conditions and the required Discharge Pressure to meet System Pressure with the maximum allowable differential pressure over the filters (compressor inlet, and all dryer pre and after filters) and dryers (From <6> in Table 3 above) multiplied by the Wear and Tear Derating Factor (K_f) for the type of compressor as per Table 4.</p> <p>This is equivalent to the maximum flow rate achievable by a compressor that (almost) requires refurbishment during worst environmental conditions.</p>

Both oil free and oil flooded compressors will be considered and evaluated using a combination of least lifecycle cost methodology for the overall system (including auxiliaries) as well as the user requirements of the compressed air.

The requirements when specifying a compressor, should contain as a minimum the following:

- The required compressed air flow rate (See Section 6).
- Discharge pressure at which the compressed air is required
- Atmospheric pressure range for the power station from Appendix A Table 6.
- Atmospheric Temperature range from Appendix A Table 6.

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- Relative Humidity range from Appendix A Table 6.
- Ducting of the hot air to the outside of the compressor house (for air cooled compressors)
- Cooling water supply temperature (for water cooled compressors) as per Table 1, as well as the flow rate, pressure, and quality available (see 240-55864833, Chemistry for Auxiliary and Ancillary Cooling Water Systems Manual [2]).
- Discharge air connections, as well as cooling water (if applicable) connection terminal point details, including location.
- Standardisation of equipment taking into consideration spares interchangeability on existing equipment like compressors, dryers, motors, instruments, valves etc.
- The noise level generated by a single compressor shall be below 85 dB(A).
- Electrical voltage available or that a diesel engine is required.
- All HMI and instrumentation units to conform to SI system.

During the evaluation of the compressor to determine its suitability for incorporation into the compressed air system design, the following should be determined and compared:

- Minimum Flow Rate Available for the Design (See Table 5)
- Maximum Flow Rate Available for the Design (See Table 5)
- Life Cycle Costing, including the capital, operating and maintenance costs, including that for the auxiliaries.

The compressor is supplied as a complete unit by the manufacturer, including:

- Replaceable inlet filters (see Section 7.1),
- Automatic inlet control valve
- A main electrical motor or diesel engine;
- Anti-condensate heater for MV electric motors;
- IP54 Ingress Protection Rating according to IEC 60529 [8] control and electrical panel;
- Electronic VSD for Variable Speed compressors
- Standard Compressor Controller including Human Machine Interface on the Compressor – refer to Section 7.9
- Intercoolers
- Aftercooler (where Heated dryers are used in conjunction with air cooled compressors)
- Automatic condensate drain traps to allow condensate to drain from the compressor coolers (see Section 7.6
- A check valve upstream of the compressor discharge nozzle;
- Sound Attenuating Enclosure when required to attenuate the noise to below 85dB(A)
- Cooling water flow switch/transmitter to confirm the valve is open and the flow established, prior to starting the compressor, where the compressor is water cooled
- A safety valve on the discharge of last stage of the compressors before any other valve
- A blow-off silencer (where applicable).
- A compressed air discharge connection;

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- A cooling water inlet and outlet connections (where applicable).

7.4 WATER SEPARATOR

- The system shall be provided with a suitably sized water separator installed between the compressor and filters to remove any excess water droplets from the airstream that might overwhelm the filters and dryers.
- The water separator shall be provided complete with automatic condensate drain traps to allow condensate to drain from the water separator (see Section 7.6)
- The water separator vessel shall comply to the PER [5].

7.5 PRE AND POST FILTERS

- The filter vessel shall comply to the PER [5]
- Filter sets shall be selected for each of the air dryers that are able to accommodate the entire flow range that can be delivered by the compressors.
- Coalescent Oil/Water pre -filters shall be fitted upstream of the air dryer, for removal oil and water mist and vapour.
- A Post filter shall be fitted downstream of the air desiccant dryer, for removal of particulates.
- A particle filter shall be fitted upstream of a refrigerant dryer, for removal of particulates to protect the dryer from damage.
- Filters shall be fitted in a filter housing such that can be easily opened and fitted with automatic drains for oil/condensate removal (See Section 7.6).
- Post filter efficiency shall conform to the air quality class indicated in Section 4.
- The filter equipment shall be provided with differential pressure transmitters that will provide alarm at the HMI for both high and low differential pressure values. These filters shall be inspected and the filter cartridge replaced when required as indicated by the differential pressure.

7.6 CONDENSATE TRAPS

All the following equipment shall be provided with individual automatic condensate traps:

- Inter Coolers
- After Coolers
- Water Separators
- Pre Filters
- Post Filters
- Air Receivers
- Distribution system low points

The condensate traps on the inter-coolers shall incorporate water level monitoring in order to give an alarm when the water level in the condensate trap does not reduce when blowdown is required. In addition, if this alarm does not clear within a predetermined time, the compressor shall be tripped to protect the subsequent stage. These inter cooler condensate traps' operation shall also be monitored and if the trap did not operate within predetermined length of time, initially raising an alarm to indicate a blockage upstream from the condensate trap. If the trap did not operate, following the alarm, the compressor shall be tripped to protect it from damage due to water carryover to the subsequent stage.

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Condensate traps shall be of the automatic types and drain into the closest dirty drain, except where it's oily condensate. No timer based solenoid drains may be provided.

Where oily condensate is collected and blown down, it shall be specifically captured at the compressor location and not allowed to drain into the water systems unless filtered to conform to the required environmental regulations. The captured oily condensate and oily contaminated used parts shall be disposed of in accordance with site environmental regulations.

All condensate traps shall be installed downstream of a manual lockable isolating valve to allow these condensate traps to be maintained.

All condensate traps shall be provided with manual test buttons to allow the drain system to be tested. Eskom prefers the use of the Pneumatic No Loss Drains (PNLD) and the ball float trap. The detail LCC should be conducted before installing the condensate/water trap.

7.7 AIR DRYERS

Each compressor shall be provided with a dedicated dryer (where applicable to the type of air being produced).

The power supplies and control system functional distribution shall be matched to that of the compressor as well as all the auxiliaries.

The dryers shall be of the refrigeration and/or desiccant type and shall be selected to provide the dew point as required for the compressed air class.

The compressor and dryer shall be optimised and matched as a system taking into consideration the capital, operating and maintenance costs the combined system.

The dryer shall be provided with a controller including Human Machine Interface on the dryer, and shall be interfaced to the compressor's controller.

In addition, the following shall be specified to select a compressed air dryer:

- Required air quality (Refer to Section 4 for the quality requirements of the different compressed air types)
- Maximum allowable inlet compressed air temperature to the air dryer (compressor outlet temperature trip value)
- Minimum inlet compressed air temperature to the air dryer (required for HOC dryers)
- Minimum operating pressure. This shall be the lowest of either the starting pressure of the last compressor started by the coordinator or 90% of the System Pressure operating setpoint.
- Maximum compressed air pressure to be used for the pressure rating of equipment to comply to the PER [5].
- Maximum flow rate of compressed air (Maximum flow rate of the compressor at Best Environmental Conditions).
- Minimum flow rate of compressed air (Minimum flow rate of the compressor at Worst Environmental Conditions).
- The make and model of the compressor, including all specifications (if available).
- For refrigerant dryers, it shall be specified if the dryers are to be air or water cooled.
- For water cooled dryers, the cooling water supply temperature shall be calculated and provided for the atmospheric conditions as per Appendix A Table 6, as well as the flow rate, pressure, and quality available (see 240-55864833, Chemistry for Auxiliary and Ancillary Cooling Water Systems Manual [2]).

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- Inlet and outlet air connections as well as water connection terminal point details and location.

7.7.2 Refrigerant Dryers

Only refrigerant dryers of a design that does not make use of Hydro chlorofluorocarbons (HCFC) refrigerant may be considered for use in Eskom.

All the individual dryer units shall have the following general features as a minimum:

- Inlet and outlet air connections;
- Coalescent Oil/Water Filters as well as Particle filters shall be provided to the inlet of the dryer and each filter fitted with automatic drains for oil/condensate removal (See Section 7.5 and Section 7.6);
- Automatic condensate traps to allow condensate to drain from the dryer air coolers (See Section 7.6);
- Dryer outlet pressure dew-point measurement;
- Safety valve/s on dryer units shall be sized for the capacity of the compressor upstream of the dryer.

7.7.3 Desiccant dryers

The life of the desiccant shall maintain the PDP for minimum of a 3 year period. If the desiccant fails to maintain the PDP, the desiccant must be replaced with the same as specified by the dryer manufacturer.

All the individual dryer units shall have the following general features as a minimum:

- Supplied with matched pre and after filters (See Section 7.5), complete with automatic condensate traps (See Section 7.6);
- Coalescent Oil/Water Filters to the inlet as well as Particle filters to the outlet of the dryer shall be provided and each filter fitted with automatic drains for oil/condensate removal (See Section 7.5 and Section 7.6);
- Purge orifice or control valve for purge flow limiting for desiccant dryers of a heatless regeneration design;
- Inlet and outlet air connections;
- Regeneration air outlet silencers (if applicable);
- Noise levels shall comply with the OSH Act and be less than 85dB(A).
- Automatic condensate traps to allow condensate to drain from the dryer air coolers (Heat of Compression Dryers);
- Dryer outlet pressure dew-point measurement;
- Pressure dew-point control regulation of the individual dryer vessels, with an alarm when the required pressure dew point is exceeded;
- The controller should automatically default to a timer based regen when the dew-point measurement fails.
- Dryer vessels of desiccant dryers using heat for regeneration shall be insulated;
- Safety valve/s on dryer units shall be sized for the capacity of the compressor upstream of the dryer.

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7.8 COOLING SYSTEM

Both water and air cooled cooling systems are acceptable and should form part of the lifecycle cost evaluation.

7.8.1 Water Cooled Systems

A suitable cooling water system should be designed to provide closed circuit cooling water to the compressors and dryers.

For standalone cooling water systems dedicated to the compressor dryer train, the cooling water system shall conform to the cooling water requirements of the compressor and dryer for the worst ambient conditions (high temperatures, pressures and relative humidities as indicated in Appendix A Table 6.

Where the Auxiliary Cooling Systems are being used, the Compressed Air System Designer shall confirm that the compressors and dryers meet the performance criteria at the temperatures provided by the Auxiliary Cooling System operating at the worst case environmental conditions as provided in Appendix A Table 6.

The compressor and dryers shall be matched with the cooling systems to ensure that the system provides the required performance at all times by also making use of a Wear and Tear Derating factor of 70% to allow for the deterioration of the system (flow, and heat transfer) before maintenance is required.

The compressor and dryer suppliers shall supply the required water flow rate, inlet and outlet temperature for the various conditions requested. The suppliers shall ensure that water quality conditions and parameters are suitable for compressors, heat exchangers, dryers etc.

The following types of water cooling systems for the compressors and dryers are acceptable:

- Closed Circuit Cooling Water Cooling Tower (with or without wet assistance)
- Closed Circuit Cooling Water with a Heat Exchanger, with the heat sink provided by a secondary fluid such as potable water or raw water, or open circuit evaporative cooling water linked to a cooling tower.
- Closed Circuit Auxiliary Cooling

The water in the closed circuit cooling water system shall conform to the 240-55864833, Chemistry for Auxiliary and Ancillary Cooling Water Systems Manual [2]. The system designer and component supplier shall confirm that the compressor, dryer, heat exchangers and all the wetted components exposed to this closed circuit water, are all compatible with the water parameters as specified in this manual.

For open circuit evaporative cooling, the open circuit water chemistry must conform to either the 240-55864767, Chemistry and Microbiology Standard for Condenser Cooling Water [3] if the cooling water that is used is from the main cooling water system or the 240-55864833, Chemistry for Auxiliary and Ancillary Cooling Water Systems Manual [2] if the cooling water that is used for cooling is from an independent auxiliary cooling system. The designer/supplier shall confirm that the components exposed to this open circuit water are all compatible with the water parameter as specified in this manual.

The cooling system shall be considered as an integral part of the compressor system when calculating the availability and reliability of the overall system and when determining the Multiple Unit Trip risk exposure (See Section 7.16.).

Auxiliary Closed Circuit Cooling water shall be used for Green Field Projects, where water cooled compressor and/or dryer equipment is selected.

7.8.2 Air Cooled Systems

Where air cooled system are used for the compressor and/or dryer, the ventilation shall take fresh air from inside the room and ventilate the hot air to the outside of the compressor house.

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If the equipment is located in a large hall (turbine hall or boiler house) and the heat loading confirmed to be negligible on the surrounding equipment, the hot air should be vented and diffused away from the compressor and dryers, as to prevent re-entrainment into the compressor and dryer.

7.9 INSTRUMENTS AND CONTROL

Compressed air systems normally contain a number of instruments to measure, monitor and control the compression processes as well as protect the compressed air equipment.

The control, protections and instruments for the compressor and dryer shall be provided by the respective OEM of the compressor and dryer equipment, which in turn are interfaced to the unit or outside plant control system where the system including the auxiliaries and distribution system, is remotely monitored, controlled and trended.

The individual compressor controllers shall control the individual compressors based on the System Pressure set-point.

The individual compressor controllers shall also ensure that each compressor operates in a stable manner and away from the region where the protections will operate.

The individual compressor controller shall be able to operate independently from the coordinator compressor controller and not be affected by the coordinator failing or coming back online.

The controls and protections of each compressor train (including the auxiliaries) shall be independent from each other and not be subjected to a common mode failure, such as using a single transmitter or the same power supply amongst more than one train, etc. This independency of power supplies and instrumentation shall also be extended to the Redundant or Common compressed air trains to prevent the common mode failure of the overall system.

The automatic scheduling of the compressed air trains should be done by the coordinator compressor controllers, based on the duty selection made from the control rooms. In the event that the duty compressed air train fails to load or not be able to supply sufficient air, the coordinator compressor controller can start the next duty compressed air train sequence upon getting the fault/alarm signal.

The coordinator compressor controller shall have a capability to automatically cycle compressor trains based on user selected criteria such as:

- Fixed priority ranking, where the user selects the ranking of the duty compressor trains.
- Running hour matching, where the controller will keep the running hours of the compressor trains similar to each other.
- Running hour spreading, where the controller will keeping the predetermined difference in running hours between the compressors constant.

Pressure dew-point transmitters shall be provided on the outlet of each dryer.

Pressure indicator transmitters shall be supplied to all the receivers.

The following indications and trending shall be available for the distribution system

- Pressure indicator transmitter on each air receiver
- Flow meters:
 - Each compressor's delivery flow rate
 - Water Treatment Plant, total station and each Unit's flow rate and consumption for Control Air,
 - Each Unit's flow rate and consumption of other types of air as well as the outside plant.
- Averaging differential pressure type flowmeters (Annubar/Itabar or similar) shall be used as flow meters on compressed air.

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7.10 NOISE LEVEL

Noise generation shall be attenuated by the compressor housings. Noise levels shall comply with the OSH Act [15] and be less than 85dB(A).

7.11 COMPRESSOR HOUSE VENTILATION

The compressor house ventilation shall be designed to cater for the heat loads of the compressors and dryers.

All compressors (including the motors) shall take cold air compression and cooling from inside the room and vent all hot air to the outside of the room as far as reasonably practicable. See Section 7.8.2.

All air cooled dryers shall take cold air for cooling from inside the room and vent all hot air to the outside through ducting as far as reasonably practicable. See Section 7.8.2.

Compressor houses with natural ventilation are preferred.

In exceptionally dusty environments, the compressor houses shall be pressurised and filtered to prevent severe dust contamination of the equipment and should be sized to include for the air used by the compressor for compression well as cooling. The pressurisation system is sized so that even with all compressors/blowers in the building at full load, the pressure in the building is still higher than atmospheric pressure.

7.12 AIR RECEIVERS

The air receivers shall have a minimum capacity to allow for

- Pulsation/ripple of maximum of 10% of the system operating pressure.
- Sustain the users during the complete failure of the compressor plant for at least 5 minutes when system operating pressure decays to the required pressure of the end user demanding the highest pressure (see Section 7.3.).

The receivers shall be designed according to the latest version of the OSH Act pressure equipment regulation [5] and the approved international standard EN 13445 [21] or ASME VIII Div1 [19]. The vessel shall be complete with inlet and outlet nozzles, instrument and manhole connections, pressure relief valves, drain valves and automatic condensate traps.

The receivers shall be internally corrosion protected according to 240-101712128 Internal Corrosion Protection of Water Systems Chemical Tanks and Vessels with Linings Standard [9].

Air Receivers vessels shall preferably be of the vertical type to save floor space.

Bottom nozzles of the air receiver shall be a minimum of 500mm above the floor level to allow for the installation of drains and condensate traps.

All the information as required by the selected design standard shall be provided for the design and manufacture of the receiver.

To ensure moisture that accumulates in the receiver vessels is drained, the air receivers shall be fitted with automatic condensate traps, refer to Section 7.6.

7.13 SYSTEM CONFIGURATION AND LAYOUT

A train configuration with segregated compressor dryer, receiver combinations are preferred.

Where multiple units' compressed air supplies are tied together, the use of automatic pneumatic operated islanding valves shall be used to prevent multiple unit trips, during emergency's where the compressors of a unit is lost for any reason.

Electrical actuators may not be used for the automatic islanding or segregation of systems.

The station's exposure to MUT shall be specifically evaluated for the particular system configuration and layout as described in Section 7.16.

7.14 PIPING & FITTINGS

All piping and fittings shall comply with 240-123801640 Standard for Low Pressure Pipelines [12] with all piping to be galvanised and colour coded, except for small bore tubing which shall be stainless steel.

It is important that all piping shall slope in the direction of air flow, and provided with a drain point with a condensate trap. See Section 7.6.

Where hoses are used, the design should specifically cater for hose failures. Protection shall be provided for the operators that may be in the area as well as the protecting the compressed air system from draining in case of hose failure by providing the necessary NRV's.

Interface from the distribution system to compressed air users shall be positioned on the top of the pipe in order to prevent moisture carry-over and provided with a condensate trap at the bottom (see Section 6.6).

The piping and fittings for the compressed air supply and distribution shall be designed according to the latest version of the OSH Act pressure equipment regulation [5] and the approved international standard EN 13480 (All parts) Piping [20] or ASME B31.3 3 Code for pressure piping – Process piping [17]. Fittings (elbows, bends, tees and reducers) between 15NB and 50NB are suited for socket welding as far as possible and shall be in accordance with ASME B16.11, "Forged Fittings, Socked-welded and Threaded" [22] or BS EN equivalents.

Fittings of 65NB and larger shall be suited for butt welding and are in accordance with ASME B16.9, "Factory Made Wrought Butt-welded Fittings" [23] or BS EN equivalents.

All piping, fittings and flanges shall be hot dipped galvanized in accordance SANS 121:2000, "Hot Dip Galvanized Coatings on Fabricated Iron and Steel Articles – Specifications and Test Methods" [26].

Mixing of codes (ASME or BS EN) shall not be permitted for new build projects. One Code must be selected and used through the system until terminal points. At existing power stations the codes used for the existing design will be considered during modifications. Screwed fittings shall only be allowed for 25 NB and smaller.

7.15 VALVES

All the valves shall comply to 240-105020315 Standard for Low Pressure Valves [13]

7.15.1 Isolation valves on compressed air:

- Isolation Valves larger than 32NB shall be flanged stainless steel ball valves on critical applications and zero offset resilient seal butterfly valves for non-critical applications. Butterfly valves larger than 100NB shall be provided with a gearbox. Where diaphragm valves are present on existing power stations these diaphragm valves can be retained.
- Isolation valves smaller than 25NB shall be lever operated threaded end stainless steel ball valves
- Flanged ball valves are used for all drain valves of 50NB and larger.

7.15.2 Isolation valves on cooling water (open and closed circuit):

- Isolation Valves larger than 32NB shall be flanged resilient seal gate valves or zero offset resilient seal butterfly valves. Butterfly valves larger than 100NB shall be provided with a gearbox.
- Flanged gate valves are used for all drain and vent valves
- Valves for the cooling water systems shall comply to the Cooling Plant Design Guideline [1].

7.16 REDUNDANCY AND EXPOSURE TO MUT

The compressed air system designer shall base the overall compressed air system design and perform an MUT analysis in accordance with the requirements of the South African Grid Code: Network Code [10] in Section 3.1.5 Multiple unit tripping (MUT) risks (GCR5).

“(1) A power station and its units shall be designed, maintained and operated to minimise the risk of more than one unit being tripped from one common cause within the time window and load limits described below. Two categories of multiple units tripping are used to categorise the impact on the IPS.

Category 1: Unplanned disconnection or tripping of more than one unit instantaneously or within a one hour window, where the total maximum continuous rating (MCR) of those units exceeds the largest credible multiple contingencies.

Category 2: Unplanned disconnection or tripping more than one unit instantaneously or within ten minutes, where the total MCR of those units exceeds the largest single contingency.

(2) The power station shall be designed such that no MUT category 1 trip risk can occur and a MUT category 2 trip will not occur more than once in ten years.”

If at any stage during normal operation the redundancy is no longer available, the station should make available a temporary compressed air train of a similar capacity, while ensuring that it will not contribute to an increased MUT risk, e.g. adding another electrical compressor on the same board will increase the possible loss of compressed air if the board fails for any reason, therefor additional standby diesel compressors will be required.

8. DESIGN BASE DOCUMENTATION

8.1 PFD

A process flow diagram system shall be developed for the entire compressed air system. It shows the different process design values for different operating modes and as a minimum contain the pressures, temperatures, pressure drops, flow rates and mass flow rates delivered to each user.

8.2 P&ID

A P&ID which shows all of the piping including the physical sequence of branches, reducers, valves, equipment, instrumentation and control interlocks and is used to indicate the process of a system shall be available for the supplier of the equipment.

8.3 COMPRESSED AIR USER LIST

A compressed air user list (including dryer) shall be developed to list all users of compressed air in terms of the key compressed air parameters;

- Pressure in kPa(g) (minimum , maximum, expected operating)
- PDP Temperature (minimum, maximum, expected operating)
- Flow in m3/min FAD or (minimum, maximum, expected operating, continuous or cycle rates)
- Operating condition that will result in the particular user to demand the maximum air flow.

8.4 COMMISSIONING

- Commissioning procedures shall comply with 240-56356376 On-Site Commissioning for Low Pressure Systems Standard [14] and provided before any cold or hot commissioning proceeds.
- A compressed air train shall be fully recommissioned following compressor refurbishment or major off-site repair.

8.5 OPERATING AND MAINTENANCE MANUALS

- Operating and maintenance manuals shall be provided in hard and soft copies for all systems and components supplied.
- Operating Manuals (OM) shall contain the information necessary for the operating personnel to operate the individual systems and components.
- Maintenance Manuals (MM) shall contain the necessary information for the maintenance (servicing, inspection and repair) of plant parts, technical equipment and components, and the technical assessment of such measures, including performance and design data and descriptions of methods of operation. Where the supply is for components only, the MM should also contain procedures for operating the components.
- The manuals shall conform to the requirements stipulated in the VGB guidelines [16].

9. TEMPORARY COMPRESSED AIR SYSTEM

The temporary system shall meet or exceed the same requirements of existing compressed air system with regards to quality (see Section 4) and redundancy (see Section 7.16)

Detailed works instructions shall be developed for the commissioning and decommissioning of the temporary compressed air system, as well as how the respective train will be started and stopped during normal and emergency operations.

Where the compressor and/or dryers are provided as standby units, detailed operating and maintenance instructions should be developed to ensure the availability of the plant at all times.

Special consideration shall be given to the following prior to the installation:

- Ensure that the ground is levelled
- Determine and implement a suitable method for containing any diesel spillage or oil that may drip from the compressor where diesel compressors are used.
- Connection points and pipe routes shall be determined and protected from vehicular and personnel traffic.
- The area surrounding the compressors and dryers shall be barricaded; access shall be restricted to authorised personnel only.
- Temporary fire precautions and fire protection provisions shall be made based on a risk assessment.
- The exact tie-in point(s) should be determined based on the capacity required, isolation available and the number of trains to be installed. An analysis shall be done to confirm the pressure drop, temperature drop and maximum flow that would be possible through the connection would not result in a failure of the system.
- All flexible pipework should be as short as possible and routed to not kink or be exposed to sharp edges.
- Where the temporary system ties into the permanent system it should be provided with an NRV to prevent the temporary system from draining the main compressed air system during ruptures or other failures.

9.2 THE COMPRESSORS

- The compressor may be either diesel or electrically driven.
- The compressor shall be air cooled.
- Sizing of the compressors shall be sized and selected (see Section 7.3) with regards to quality (see Section 4) and redundancy (see Section 7.16), and matched to its specific dryer in the train.

9.3 DRYER

- Sizing of the dryers shall be sized and selected (See Section 7.7) with regards to quality (see Section 4) and redundancy (see Section 7.16), and matched to the compressor in the train.
- Where a temporary compressor and dryer combination is provided, the dryer shall be powered from the compressor.

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10. AUTHORISATION

This document has been seen and accepted by:

Name and Surname	Designation

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11. REVISIONS

Date	Rev.	Compiler	Remarks
February 2016	0.2		To develop a compressed air system standard ensuring consistency on compressed air systems
May 2016	1		Final Document for Authorisation and Publication
March 2016	1.1		Initial rewrite into correct template
March 2017	1.2		Major update with design requirements and parameters for sizing equipment
July 2018	1.3		Incorporated comments from LPS SC review
Oct 2018	2		Final Rev 2 Document for Authorisation and Publication
October 2023	2.1		Updated Sections 7.3, 7.6 and 7.11 of the document.
Dec 2023	2.2		Draft Document for Comments Review
Feb 2024	2.3		Final Draft after Comments Review Process
March 2024	2.4		Additional updates completed
March 2024	2.5		Final Draft after Additional updates completed
March 2024	2.6		Additional updates completed
May 2024	2.7		Final Draft after additional updates completed
May 2024	3		Final Rev 3 Document for Authorisation and Publication

12. DEVELOPMENT TEAM

This standard was reviewed from Rev 2 to Rev 3 by the Compressed Air Forum/Care Group.

13. ACKNOWLEDGEMENTS

Frank Wessels and Keagan Naidoo for the work that was performed with during the compilation of the first revision of standard. The valuable input from all the members of the Compressed Air Forum.

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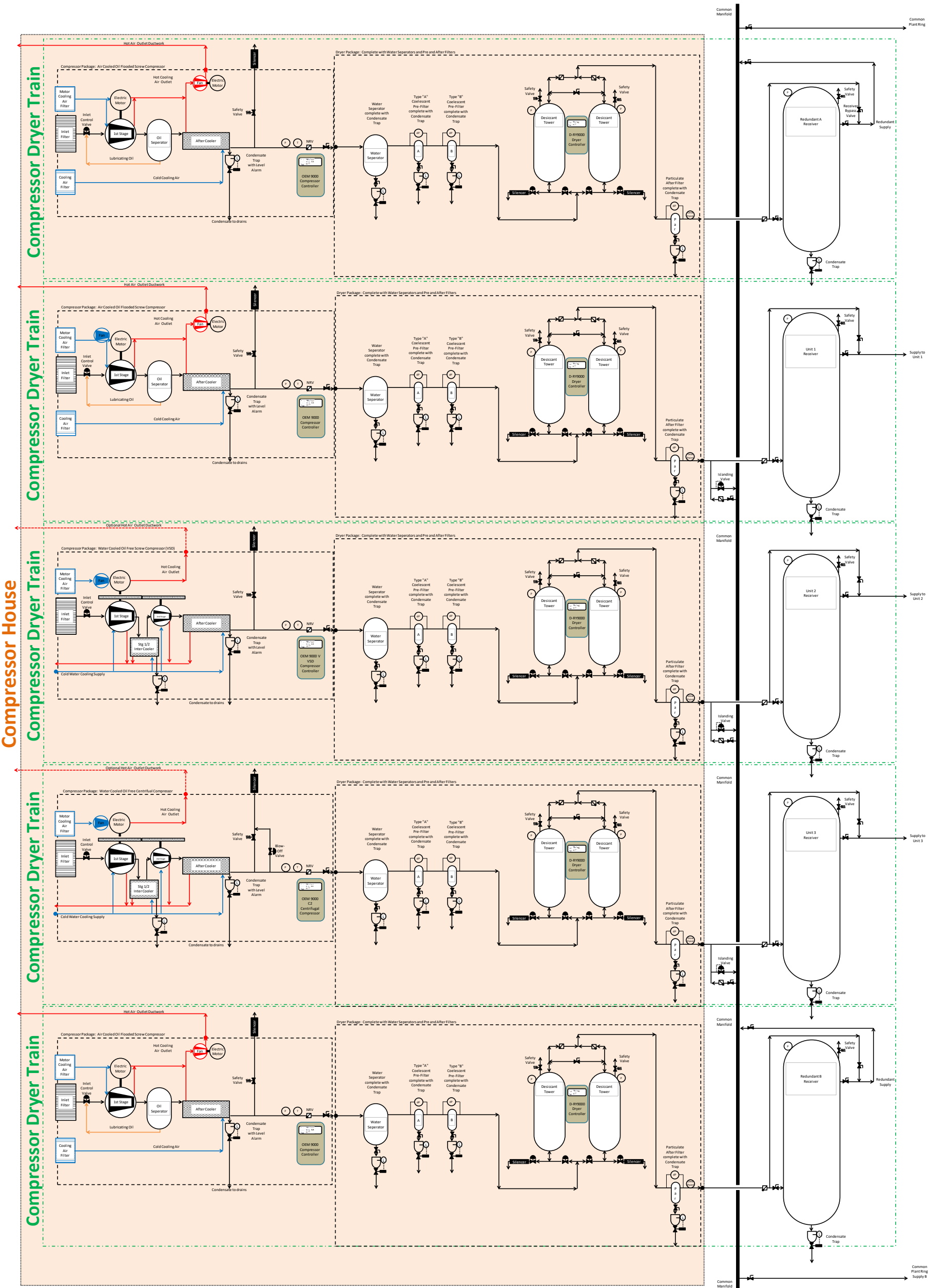
APPENDIX A: AMBIENT REFERENCE CONDITIONS FOR ALL THE ESKOM COAL FIRED POWER STATIONS**Table 6: Ambient reference conditions for all the Eskom Coal Fired Power Stations**

Station	Elevation	Atmospheric Pressure			Dry-Bulb Temperature			Relative Humidity		
	MASL	Minimum	Expected	Maximum	Minimum	Expected	Maximum	Minimum	Expected	Maximum
		kPa(abs)	kPa(abs)	kPa(abs)	°C	°C	°C	%	%	%
Arnot	1688	77.95	82.947	87.95	-10	25	35	20%	60%	80%
Camden	1662	78.20	83.203	88.20	-10	25	35	20%	60%	80%
Duvha	1610	78.72	83.718	88.72	-10	25	35	20%	60%	80%
Grootvlei	1567	79.15	84.146	89.15	-10	25	35	20%	60%	80%
Hendrina	1646	78.36	83.361	88.36	-10	25	35	20%	60%	80%
Komati	1638	78.44	83.441	88.44	-10	25	35	20%	60%	80%
Kriel	1629	78.53	83.530	88.53	-10	25	35	20%	60%	80%
Kendal	1641	78.41	83.411	88.41	-10	25	35	20%	60%	80%
Kusile	1515	79.67	84.666	89.67	-10	25	35	20%	60%	80%
Majuba	1718	77.65	82.653	87.65	-10	25	35	20%	60%	80%
Matla	1635	78.47	83.470	88.47	-10	25	35	20%	60%	80%
Matimba	877	86.32	91.319	96.32	0	25	45	20%	60%	80%
Medupi	904	86.03	91.027	96.03	0	25	45	20%	60%	80%
Lethabo	1460	80.22	85.220	90.22	-10	25	35	20%	60%	80%
Tutuka	1654	78.28	83.282	88.28	-10	25	35	20%	60%	80%

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APPENDIX B: TYPICAL CONFIGURATION OF A COMPRESSED AIR PLANT



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