

	<p align="center">Specification</p>	<p align="center">Technology</p>
--	--	---

Title:	Technical Specification for Upgrade of Duvha Electric Compressors and Dryers	Unique Identifier:	382-ECM-AABZ28-SP0004-4
		Alternative Reference Number:	N/A
		Area of Applicability:	Engineering
		Documentation Type:	Report
		Revision:	2
		Total Pages:	27
		Next Review Date:	N/A
		Disclosure Classification:	CONTROLLED DISCLOSURE

Compiled by



T. Masethe
System Engineer

Date: 2024/11/06

Functional Responsibility



N. Hlophe
Auxiliary Engineering manager

Date: 2024/11/06

Authorised by



W. Moleka
Engineering Manager

Date: 2024-11-13

CONTENTS

	Page
1. INTRODUCTION	4
2. SUPPORTING CLAUSES	4
2.1 SCOPE	4
2.1.1 Purpose	4
2.1.2 Applicability	4
2.2 NORMATIVE / INFORMATIVE REFERENCES	4
2.2.1 Normative	4
2.2.2 Informative	4
2.3 DEFINITIONS	5
2.3.1 Classification	5
2.4 ABBREVIATIONS	5
2.5 ROLES AND RESPONSIBILITIES	5
2.5.1 Compiler	5
2.5.2 Functional Responsibility	5
2.5.3 Authoriser	5
2.6 PROCESS FOR MONITORING	6
3. TECHNICAL REQUIREMENTS	6
3.1 SUMMARY OF SCOPE	6
3.2 SYSTEM DESCRIPTION-EXISTING SYSTEM	6
3.3 SITE CONDITIONS	7
3.4 PLANT REQUIREMENTS	7
3.5 EQUIPMENT SPECIFICATIONS	8
3.5.1 Air Dryers	8
3.5.2 Pressure vessels requirements	9
3.5.3 Corrosion protection	10
3.5.4 Operating and control	11
3.5.5 Internal Interfaces	11
3.5.6 Quality and Inspection Requirements	11
3.5.7 Material	11
3.5.8 Tools and Spares	11
3.5.9 Commissioning	12
3.5.9.1 General Requirements	12
3.5.9.2 OEM Requirements for Commissioning	12
3.5.9.3 Cold Commissioning	12
3.5.9.4 Functional Tests	12
3.5.10 Document Requirements and Configuration Management	12
3.5.10.1 Document Identification	12
3.5.10.2 Document Submission	13
3.5.10.3 Electronic Submission	13
3.5.10.4 Project Engineering Change Management	13
3.5.10.5 DRAWINGS FORMAT AND LAYOUT	13
3.5.10.6 PLANT CODING AND LABELLING	13
3.5.10.7 CONFIGURATION MANAGEMENT STANDARDS	15
3.5.10.8 Manual Requirements	15
3.5.11 Tender Returnable's	15
3.5.12 Condition monitoring	15
3.5.13 Design Acceptance	15
3.6 C&I REQUIREMENTS	16
3.6.1 SYSTEM OVERVIEW	16
3.6.2 New Control System Requirements	17
3.6.3 OPERATING PHILOSOPHY	19
3.6.3.1 Operating description for normal operating conditions	19
3.6.3.1.1 Auto mode	19

CONTROLLED DISCLOSURE

3.6.3.1.2 Manual mode.....	19
3.6.3.1.3 Start-up sequence	20
3.6.3.1.4 Shut-down sequence	20
3.6.3.1.5 Maintenance Mode.....	20
3.6.3.1.6 Operating Concept.....	20
3.6.4 C&I SPECIFICATION	20
3.6.4.1 Field Requirements and Installations	20
3.6.4.2 Transmitters.....	21
3.6.4.3 Cabling & Racking (Cable Installation and Routing).....	21
3.6.4.3.1 The Contractor to take note of the following for cabling design.....	21
3.6.4.4 Junction Box.....	22
3.6.4.5 Impulse Piping	22
3.6.4.6 Slave and Master Controllers.....	22
3.6.5 SYSTEMPERFORMANCE	23
3.6.5.1 Life Expectancy	23
3.6.6 GENERAL REQUIREMENTS FOR THE WORKS (C&I WORKS)	23
3.6.7 Tests.....	23
3.6.7.1 FAT.....	23
3.6.7.1 Site Integration Test (SIT).....	23
3.6.7.2 Change over from existing L2 network to new PROFINET network.....	24
3.6.8 Training Requirements.....	24
3.7 CIVIL SCOPE	24
3.7.1 Civil Contractor responsibility.....	24
4. AUTHORISATION	25
5. REVISIONS	26
6. DEVELOPMENT TEAM.....	26
7. ACKNOWLEDGEMENTS.....	26

CONTROLLED DISCLOSURE

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the Authorized Version on the database.

1. INTRODUCTION

This document provides the technical specifications for the electric compressor's dryers and the PLC upgrade at Duvha Power Station. The upgrade was initially for replacement and the installation the new electric compressors including dryers and the PLC. The Centac 18MX3 compressor was replaced with electric driven Centac C400 type compressors air. The dryers and the PLC were not replaced.

The dryers through which the compressors supply compressed air are oversized for the size of the compressors the station has, which leads to extensive air loss during the purging process on the dryers. The dryers are also obsolete. The dryers need to be replaced to match the size of the new station's compressors. These dryers combined causes an air loss of about 42m³/min, which almost equates to a single compressor.

The C&I requirements for the electric compressors and dryers are to control, operate and monitor the system. The system is monitored and controlled from the Outside Plant Control Room (SCADA) and locally from the local control panel. The OPCR performs two main functions: displaying data relating to the operation of the compressor plant to the operators and forwarding the data to the station historian (VA). There is a Marshalling PLC that communicates with all control equipment that forms part of the outside plant SCADA network, collecting data from each at regular intervals.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document covers the control and service air compressor dryers' system and the PLC associated components.

2.1.1 Purpose

The purpose of this document is to specify the technical requirements for the replacement of the electric compressors air dryers and the PLC associated equipment.

2.1.2 Applicability

This document is applicable to Duvha Power Station.

2.2 NORMATIVE / INFORMATIVE REFERENCES

2.2.1 Normative

- [1] 40-53113685, Design Review Procedure.
- [2] 382-ECM-AABB-D00139-29ConceptDesignReportforDuvhaPowerStationUpgradeof Compressors and Dryers Project.
- [3] 382-ECM-AABZ28-SP0004-4 rev-1Technical Specification for Upgrade of Duvha Electric Compressors and Dryers.
- [4] 240-105929225 Compressed Air System Standards.

2.2.2 Informative

- [5] 382-ECM-AABZ26-RP000-11-Upgrade of the LPS compressors and dryers ROC.
- [6] 384-CAO-BSSS-D00185-2-Upgradeof Duvha Electric Compressors and Dryers SRD.

CONTROLLED DISCLOSURE

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the Authorized Version on the database.

2.3 DEFINITIONS

2.3.1 Classification

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

2.4 ABBREVIATIONS

HMI	Human Machine Interface
kPa	Kilo Pascal
kPag	Kilo Pascal Gauge
LDE	Lead Discipline Engineer
LPS	Low Pressure Services
m ³ /hr	Cubic metres per hour
mamsl	Metres above mean sea level
Nm ³	Normal cubic metres
Nm ³ /min	Normal cubic metres per minute
OPCR	Outside Plant Control Room
ppm	Parts per Million
PBS	Plant Breakdown Structure
PDP	Pressure Dew Point
SANS	South African National Standards
SCADA	Supervisory Control and Data Acquisition
SIT	Site Integration Test
LV	Low Voltage
MV	Medium Voltage
CFS	Combined Fuse Switch
MCB	Miniature Circuit Breaker
VA	Visual Assist

2.5 ROLES AND RESPONSIBILITIES

2.5.1 Compiler

The document compiler is responsible for ensuring that this document is up-to-date and that this document is not a duplication of an existing documentation, regarding the document's objectives and content.

2.5.2 Functional Responsibility

The Functional Responsible Person shall determine if the document is fit for purpose before the document is submitted for authorisation.

2.5.3 Authoriser

The document authoriser is a duly delegated person with the responsibility to review the document for alignment to business strategy, policy, objectives, and requirements. He/she shall authorise the release and application of the document.

CONTROLLED DISCLOSURE

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the Authorized Version on the database.

2.6 PROCESS FOR MONITORING

This document will be approved following a Multidisciplinary Design Review that will be performed as per the Design Review Procedure 240-53113685.

3. TECHNICAL REQUIREMENTS

3.1 SUMMARY OF SCOPE

Table 1: Summary of Scope of Work

Discipline	Scope
Mechanical	Replacement of air dryers from Electric compressor number one to electrical compressor number four.
Electrical	None
C&I	<p>The Contractor shall design, engineer, supply, install and commission the following:</p> <ul style="list-style-type: none"> • Four new PLC (Slave Controllers) for the four electric compressors for control and protection of the electric compressor, dryer and auxiliaries. • Program to fetch all information from the black box controller • New PLC (Master Controller) • Master HMI to be upgraded to KP700 Comfort • Programming of Marshalling PLC to accommodate new electric compressors. • Electric compressor controller (Compressor onboard controller provided by the Contractor) interface to the Slave Controller • Dryer controller (onboard controller provided by the Contractor) interface for each compressor to the Slave Controller • Field instrumentation for the auxiliaries as per the Instrument Schedule • Installation of moisture trap. • Field instrumentation interface to the Slave Controller. • Drives interface to the Slave Controller as per the Drive Schedule. • New junction boxes • New tapping points for additional instrumentation • New impulse piping for additional instrumentation • Cabling, racking and power distribution. • Bus communication link (PROFINET) between the Master Controller and the Outside plant SCADA for compressor status and monitoring HMI and VA changes.
Civil	Ensuring adequacy of existing equipment supports

3.2 SYSTEM DESCRIPTION-EXISTING SYSTEM

Duvha Power Station Compressed air system comprises of four electric centrifugal compressors for the production of control and service air. Each compressor has its own desiccant heatless twin dryer for moisture removal.

CONTROLLED DISCLOSURE

Table 2: Existing Electric Compressors

Machine	Make& Model	Compressor capacity (Nm ³ /min)	Discharge Pressure (kPag)	Compressor type	Dryer
Electric Compressor1	Ingersoll-Rand Centac C400	52	700	Electrical Centrifugal	Heatless Desiccant
Electric Compressor2	Ingersoll-Rand Centac C400	52	700	Electrical Centrifugal	Heatless Desiccant
Electric Compressor3	Ingersoll-Rand Centac C400	52	700	Electrical Centrifugal	Heatless Desiccant
Electric Compressor4	Ingersoll-Rand Centac C400	52	700	Electrical Centrifugal	Heatless Desiccant

3.3 SITE CONDITIONS

The Altitude of the low pressure services building at Duvha PowerStation is 1600 metres above sea level. Atmospheric pressure at the elevation is 85 kPa. Other site characteristics at Duvha PowerStation which shall be used for sizing equipment are listed on the table below:

Table 3: Ambient site conditions

Ambient condition	Minimum	Average	Maximum
Pressure	80kPa	85kPa	90kPa
Temperature	-10°C	35°C	40°C
Relative Humidity	20%	60%	80%

3.4 PLANT REQUIREMENTS

The new upgraded plant should provide clean, dry, oil-free air to air users at Duvha Power Station to meet the following quality requirements:

Table 4: Dryer specification

Specification	Details
Quality Requirement	Clean, dry, oil-free air
Discharge Pressure	620-820 kPa (g)
Dew Point	-40°C PDP
Max Oil Content	<0.1 mg/m ³
Max Particle Size	<1 micron
Capacity at the Outlet	52 m ³ /min
Machine Make & Model	Ingersoll Rand Centac C400, Centac C18-MX3
Compressor Capacity	52 Nm ³ /min
Discharge Pressure (kPag)	700
Compressor Type	Electrical Centrifugal
Dryer Type	Heatless Desiccant

CONTROLLED DISCLOSURE

The following equipment must be replaced with completely new equipment. The AKZ codes of the equipment referred to are listed in Table 4 below:

- AirDryersforcompressor1,2,3and4

Reusable pipes and fittings may be reused, provided they can perform the required function.

Table 5: AKZ codes of equipment to be modified:

Equipment	AKZ code
AirDryer1	00US11G001
AirDryer2	00US12G001
AirDryer3	00US13G001
AirDryer4	00US15G001

3.5 EQUIPMENT SPECIFICATIONS

3.5.1 Air Dryers

Each compressor shall be fitted with a dedicated desiccant heatless dryer. The dryers shall have the following features:

- The dryers shall always deliver air with a pressure dew point of at least -40°C.
- The size of the dryers shall be in accordance with the capacity of the compressors (52 m³/min).
- The dryer performance characteristics shall be based on sizing with an inlet air pressure of 700 kPa (g), inlet temperature of 35°C, and an inlet air relative humidity of up to 100%.
- The compressed air pressure drop across the dryers shall not exceed 30 kPa based on an inlet pressure of 700 kPa (g).
- Each dryer shall be a packaged unit including an on-board controller. The controllers shall control the individual dryer discharge pressure dewpoint at the set-point.
- The dryer shall have a variable purge discharge control function to economize the dryer air consumption.
- If the noise from a dryer in operation exceeds 85 dB, this shall be clearly stated.
- The pressure vessels of the dryer shall meet all the requirements of OHS Act, Pressure Equipment Regulations.
- Each dryer shall be fitted with at least three filters: the water separator, the oil filter, and the after filter. These shall meet specific requirements (to be detailed separately).
 - The after filter shall have a filter element that removes particles down to 0.1 micron.
 - The oil filter shall have a filter element that removes oil aerosols down to 0.01 micron.
 - The water separator shall have a filter element that removes particles down to 3 microns.
 - The pressure drop across each filter shall not exceed 30 kPa(g), at which point a filter replacement signal shall be generated.
 - Each filter shall be fitted with a digital pressure transmitter which will have a local display and transmit a signal to the C&I system.
 - Each filter shall have a zero loss water trap. The water separator condensate drain shall have the capacity to remove all the water that condenses within the compressor, under all operating conditions.
- All dryers shall have a permanently fixed stainless steel/trifoliolate data plate in a conspicuous place with the following minimum particulars:

CONTROLLED DISCLOSURE

- Name of manufacturer.
- Dryer model and size.
- Year of manufacture.
- Input voltage and frequency in units of volts and hertz.
- Power and current in units of watts and ampere.
- Pressure dewpoint.
- Dryer AKZ identification number.

3.5.2 Pressure vessels requirements

Dryers will comprise of pressure vessels which shall meet all the requirements of Occupational Health and Safety Act Pressure Equipment Regulations.

- These pressure vessels shall meet the requirements of the OHS Act Pressure Equipment Regulations and 474-10327
- If the dryers are newly manufactured the pressure vessel design code shall be the latest version of Specification for unfired fusion welded pressure vessels (PD5500).
- The welding of the pressure vessels shall meet the requirements of Control of plant construction repair and maintenance welding standard. (240-56241933)
- The personnel doing the welding work must meet the requirements of Qualification certification and accreditation requirements for personnel and entities performing welding related work on Employer plant (240-56246601)
- Dryer NDT testing shall meet the Requirements for NDT on Employer plant standard. (240-83540088)
- The personnel doing the NDT tests must meet the requirements of Employer NDT personnel approval for quality related special processes on Employer plant (240-83539994)
- The specification of the flanges shall meet that of the interfacing piping (existing or new).
- Each dryer and filter vessel shall have a separate permanently fixed data plate in a conspicuous place on the vessel with the following minimum particulars in accordance OHS Act PER.
- Transport and storage shall conform to the following requirements:
 - On delivery the equipment shall be dry externally and internally and ready for installation.
 - The equipment shall be protected from any damage during transportation.
 - Each flange nozzle shall be protected by a wooden blank to protect against damage.
 - The equipment shall be stored inside the building or in ventilated covers. The storage area shall be clean, dry, and dust-free.
 - Piping design
- The piping on the compressor discharge side shall be new to accommodate the new dryer design.
- The following requirements must be met for air piping:
 - Pipes of diameters smaller than 150NB shall meet the requirements of SANS 62.
 - Pipes larger than 150NB shall meet the requirements of SANS 719.
 - Flanges connecting to the equipment shall meet the requirements of the interfacing equipment flanges.
 - Flanges connecting adjoining pipes shall meet the requirements of SANS 1123: Pipe flanges.
 - All piping shall slope in the direction of air flow.
 - Interface with users shall be positioned on the top of the pipe in order to prevent moisture carry-over.
 - The piping and fittings for the air dryers supply and distribution shall be designed according to the latest version of the OHS Act PER and the approved international standard EN 13480 (All parts).

CONTROLLED DISCLOSURE

- Fittings (elbows, bends, tees and reducers) between 15NB and 50NB are suited for socket welding as far as possible and are in accordance with ASME B16.11, "Forged Fittings, Socket-welded and Threaded" or BS EN equivalents.
- Fittings of 65NB and larger are suited for butt welding and are in accordance with ASME B16.9, "Factory Made Wrought Butt-welded Fittings" or BS EN equivalents.
- Mixing of codes (ASME or BS EN) is not permitted. One Code must be selected and used through the system until terminal points. As Duvha is an existing power station, the codes used for the existing design will be considered during modifications.
- Screwed fittings shall only be allowed for 25NB and smaller.
- All valves have a minimum pressure rating of 1000kPa.
- Valves are in accordance with ASME B16.34, "Valves – Flanged, Threaded and Welding End" or BS EN equivalents.

3.5.3 Corrosion protection

- The dryer components shall be externally coated in accordance with the coating system listed in table below or the Supplier's equivalent coating standard. The Supplier's standard colours may be used.
- All internal components shall be suitable protected against corrosion, considering the environmental conditions.
- All piping shall be galvanized, except for small bore tubing which shall be stainless steel.
- All piping, fittings, and flanges shall be hot-dip galvanized in accordance with SANS 121: Hot-dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.
- Pipes shall be painted according to Duvha Power Station colour coding standard.

PROCESS:	ACTIVITY	DFT
SURFACE PREPARATION:	Abrasive blast-clean to Grade Sa2,5 (ISO 8501-1).	
PRIMER COAT	Apply by brush, airless spray or dipping, one coat Single Pack Etch Primer.	15 to 25 micrometres
UNDERCOAT:	After allowing sufficient time for the primer coat to dry, apply by brush or airless spray, one coat of Alkyd Universal Undercoat.	20 to 30 micrometres
FINAL COAT:	After allowing sufficient time for the undercoat coat to dry, apply one coat of High Gloss Alkyd Enamel.	25 to 30 micrometres
Total	Total dry film thickness of coating system:	60 to 85 micrometres
GENERAL:	After installation, lining up, grouting etc., all damage shall be repaired, and coatings made good to the Engineer's approval.	

CONTROLLED DISCLOSURE

Table 6: Corrosion protection specification for compressors and dryers

3.5.4 Operating and control

- Equipment in the compressor plant, i.e. compressors, and filters, dryers, cooling towers, flow meters and dew point meters shall be interfaced and monitored on the OPCR.

3.5.5 Internal Interfaces

- C&I- Control and Monitoring of the electric and diesel compressors.

3.5.6 Quality and Inspection Requirements

- The Contractor shall exercise strict and adequate quality control during all phases of the work.
- The Contractor shall prepare suitable quality control plans (QCP's) and Inspection and Test Plans (ITP's) for all work carried out.
- The Employer, the Inspection Authority, the Employer QC Representative, and the Contractor shall review these QCP's/ITP's jointly and the actual scope of quality control and inspection required for the Contract agreed upon.
- The QCP's/ITP's shall be subject to the Employer's approval and shall indicate all inspection and test points, the methods and procedures to be used and the acceptance criteria to be applied.

3.5.7 Material

- All materials and apparatus that is used for the erection of the installation shall be new and of a good quality. The Contractor shall present technical information and brochures for equipment and finishes.
- All materials shall be new, undamaged, free of rust or other defects and shall be of the best quality.
- The Contractor shall upon the request of the Employer, furnish him with documentary proof to his satisfaction that the materials are of the quality specified. Samples of materials for testing, if required, shall be supplied by the Contractor, free of charge.
- Where applicable the material and apparatus shall in terms of quality, manufacture testing and performance comply with the relevant specifications of the following:
 - The South African Bureau of Standards (SANS)
 - Employer Standards and procedures
- Where material or apparatus that are used comply with the standard of any other recognised standards organisation, this should be clearly stated to avoid any ambiguity.
- The Contractor shall provide a certificate from a recognised bureau of standards for material that is used in the contract.
- All exposed equipment and finishes shall be submitted to the Employer for approval in sample form. Samples of all equipment or material shall on request be made available to the Employer before they are installed.

3.5.8 Tools and Spares

- The Contractor shall provide tools and spares as required for installation.
- The Contractor shall handover any special tools, equipment, software, and commissioning manuals to the Employer as required for maintaining or re-commissioning the compressed air system, if necessary, on completion of the project.
- The Contractor shall handover any special tools, equipment, software, and commissioning manualstotheEmployerasrequiredformaintainingorre-commissioningthecompressedair system, if necessary, on completion of the project.

CONTROLLED DISCLOSURE

3.5.9 Commissioning

3.5.9.1 General Requirements

Commissioning is defined as bringing into service all items of the works as specified, meeting the requirements of the functional Works Information, as well as the control system and Plant and Materials performance including all necessary testing and verification of the stated performance.

The works covered by the Works Information is installed and complete in all respects by the date stated in the Accepted Programme. The Contractor provides sufficient personnel for the satisfactory and timely commissioning of the equipment.

Before Plant and Materials is placed in service, the Contractor certifies that it is in a suitable and safe condition.

The Contractor develops a commissioning procedure that is submitted to the Employer for acceptance.

Commissioning shall be done in accordance with 240-56356376 On-Site Commissioning for Low Pressure Systems Standard.

3.5.9.2 OEM Requirements for Commissioning

1. The OEM plans, co-ordinate and execute all commissioning activities for the electric compressor plant.
2. For all electric compressor dryers, the OEM approves and signs of on:
 - i. All commissioning check sheets and tests.
 - ii. The Operational Acceptance Test report.

3.5.9.3 Cold Commissioning

As a minimum, the cold commissioning activities conducted by the Contractor shall consist of:

- Electrical and instrumentation loop check activities defined in IEC 62381
- All field equipment checks.
- Loop checks
- Drive interface checks
- Testing of system functionality.

3.5.9.4 Functional Tests

The functional tests form part of the cold commissioning of the control system and are to include the checking of all measurement loops, interlocks, sequence controls, and analogue controls.

3.5.10 Document Requirements and Configuration Management

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

3.5.10.1 Document Identification

The Contractor is required to submit the Vendor Document Submission Schedule (VDSS) and 240-85521112 C&I Documentation Requirements from Vendors as per agreed dates to the delegated Employer. Employer will pre-allocate document numbers on the VDSS and send back to the Contractor through the delegated Employer. The VDSS is revisable, and changes must be discussed and agreed upon by all parties. Changes in the VDSS can be additional documentation to be submitted, changes in submission dates or corrections in documentation

CONTROLLED DISCLOSURE

descriptions, document numbers, etc. The *Contractor's* VDSS shall indicate the format of documents to be submitted.

3.5.10.2 Document Submission

All project documents must be submitted to the delegated *Employer* with transmittal note. To portray a consistent image, it is important that all documents used within the project follow the same standards of layout, style and formatting as described in the Work Instruction. The *Contractor* is required to submit documents as electronic and hard copies and both copies must be delivered to the *Employer* with a transmittal note.

3.5.10.3 Electronic Submission

Electronic submissions shall be done using the ZendTo Larger File Transmittal Site functionality and route. The submission we use the following link can be used <https://zendto.eskom.co.za/>.

Emails and other submission methods

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

3.5.10.4 Project Engineering Change Management

All Design change management shall be performed in accordance with the latest revision of the Eskom Project Engineering Change Management Procedure (240-53114026) and the *Employer* shall ensure that *Contractor* is provided with latest revisions of this procedure. Any uncertainty regarding this procedure should be clarified with the *Employer*. All design reviews will be conducted according to the Design Review Procedure (240-53113685).

3.5.10.5 DRAWINGS FORMAT AND LAYOUT

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

3.5.10.6 PLANT CODING AND LABELLING

Plant Coding

Coding of the design shall be based on the latest revision of Station AKZ Coding Standard and the *Employer* shall undertake the coding in line with its standards. The AKZ coding shall be applied during the design review stage(s) and cross referenced to all arrangement drawings, schematics, instructions, and manuals and where practical to spare parts list/manuals. The *Contractor* shall be required to include allocated coding to the electronic design drawings.

Plant coding generation shall be undertaken by the *Employer* and manufacturing and installation of the plant labels shall be undertaken by the *Contractor*. The *Contractor* shall make available the following documentation to code:

- Mechanical
- Piping and Instrumentation Diagrams (P&IDs)
- interface list
- process flow diagrams (PFDs)

CONTROLLED DISCLOSURE

- Detailed layout drawing.
- Detail design drawing of the burner modifications.
 - Electrical
- single line diagrams
- electrical board general arrangements (GA)
- cable schedule
- C&I
- C&I architecture drawings
- C&I Cubicle GA
- cable block diagrams
- remote control station lists
- cable schedules
- Civil
- site layouts
- building layouts
- building sectional layouts
- building floor plans per level
- underground services layouts
- cable rack & support
- building lists (including room equipment lists)

Employer will only code the AKZ code defining Documentation listed above. The *Employer* will assign an *Employee* to interact with the *Contractor* in coding the plant as listed above. The *Contractor* will then be required to include allocated codes to all other designs and related documentation. It is also the responsibility of the *Contractor* to consistently apply the AKZ codes throughout the rest of the technical documentation which shall include, but not limited to:

- load schedules
- board parts lists
- cable block diagram
- termination diagram
- drive & actuator schedules
- instrument schedules
- alarm lists, loop diagrams
- signal lists
- schematic diagrams
- termination diagrams
- logic diagrams, etc.

The *Contractor* shall ensure that all documentation is coded (as per the codes assigned by the technician) prior submission to *Employer* for review.

CONTROLLED DISCLOSURE

Plant Labelling

The *Contractor* shall also manufacture and install AKZ labels to the new installed system. Labels shall be manufactured and installed according to the *Employer* 's Plant Labelling Standard 240-71432150. The labelling standard shall be supplied as part of the enquiry documents. *Contractor* shall provide a label sample to be inspected and provided prior to bulk manufacturing of labels.

3.5.10.7 CONFIGURATION MANAGEMENT STANDARDS

240-109607332 Eskom Plant Labelling Abbreviation Standard

240-71432150 Plant Labelling Standard

240-86973501 Engineering Drawing Standard

ENS0002_AKZX PLANT LOCATION CODING

ETS0004 AKZX PLANT LOCATION LABELLING

3.5.10.8 Manual Requirements

1. The operating and maintenance instruction manuals shall be prepared in accordance with the latest edition of the VGB-R171e "Guideline for the supply of technical documentation for fossil-fired and regenerative power stations" including Appendixes 1-8. The instruction manuals are required to give a full technical description of the equipment concerned and to cover all aspects of erection, operation and maintenance.
2. Before the operation and maintenance manuals are handed over, the Contractor must present a training course to the Employer's staff. Any concerns / omissions that are listed during such a training session must be incorporated before final submission.
3. The maintenance manual should contain procedures for hydrostatic pressure tests for pressure equipment including drawings and instructions.
4. The maintenance manual should include a list of suggested critical spares for stock keeping.

3.5.11 Tender Returnable's

1. The Contractor shall be responsible for executing the required work in accordance with this tender specification and shall remain responsible for any discrepancies, errors or omissions of any sort on the submitted data, program, layouts or shop drawings, whether it has been approved or not approved.
2. When the standards of the equipment specified cannot be met in terms of specific design requirements, substitution or alternative equipment may be considered provided that the substituted equipment does not reduce the intended performance, operation, duty-rate, redundancy and reliability requirements of the specification.
3. Deviations or substituted equipment not clearly shown and detailed in the Deviation Schedule shall not be considered or accepted and shall not limit the Contractor's responsibility to provide equipment in terms of the specification.
4. Should approval for the revised equipment not be obtained from the Employer, the Contractor shall be liable for all costs associated with providing equipment in terms of the specification.

3.5.12 Condition monitoring

Local monitoring for the compressor must be available by a local instrument panel which shall display critical system parameters.

3.5.13 Design Acceptance

The *Contractor* is the Design Authority as defined in the Design Review Procedure (240-53113685). The *Contractor* is responsible for following this design procedure and conducts all the design reviews as specified in this procedure.

CONTROLLED DISCLOSURE

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the Authorized Version on the database.

All designs to be submitted for acceptance to the *Employer* and the Employers Inspection Authority prior to manufacture. Manufacturing and material procurement may only start after these acceptances are obtained.

3.6 C&I REQUIREMENTS

3.6.1 SYSTEM OVERVIEW

The C&I requirements for the electric compressors and dryers is to control, operate and monitor the system. The system is monitored and controlled from the Outside Plant Control Room (SCADA) and locally from the local control panel. The OPCR performs two main functions that of displaying data relating to the operation of the compressor plant to the operators, as well as the forwarding the data to the station historian (VA). There is a Marshalling PLC which communicates with all the control equipment that forms part of the outside plant SCADA network, collecting data from each at regular intervals.

The new electric compressors installed came with an on-board controller and its instrumentation. The on-board controller didn't cater for the electric compressor auxiliary therefore an additional PLC with a Local Control Panel per compressor was added for control, monitoring and protection of the auxiliaries. (As shown in figure below)

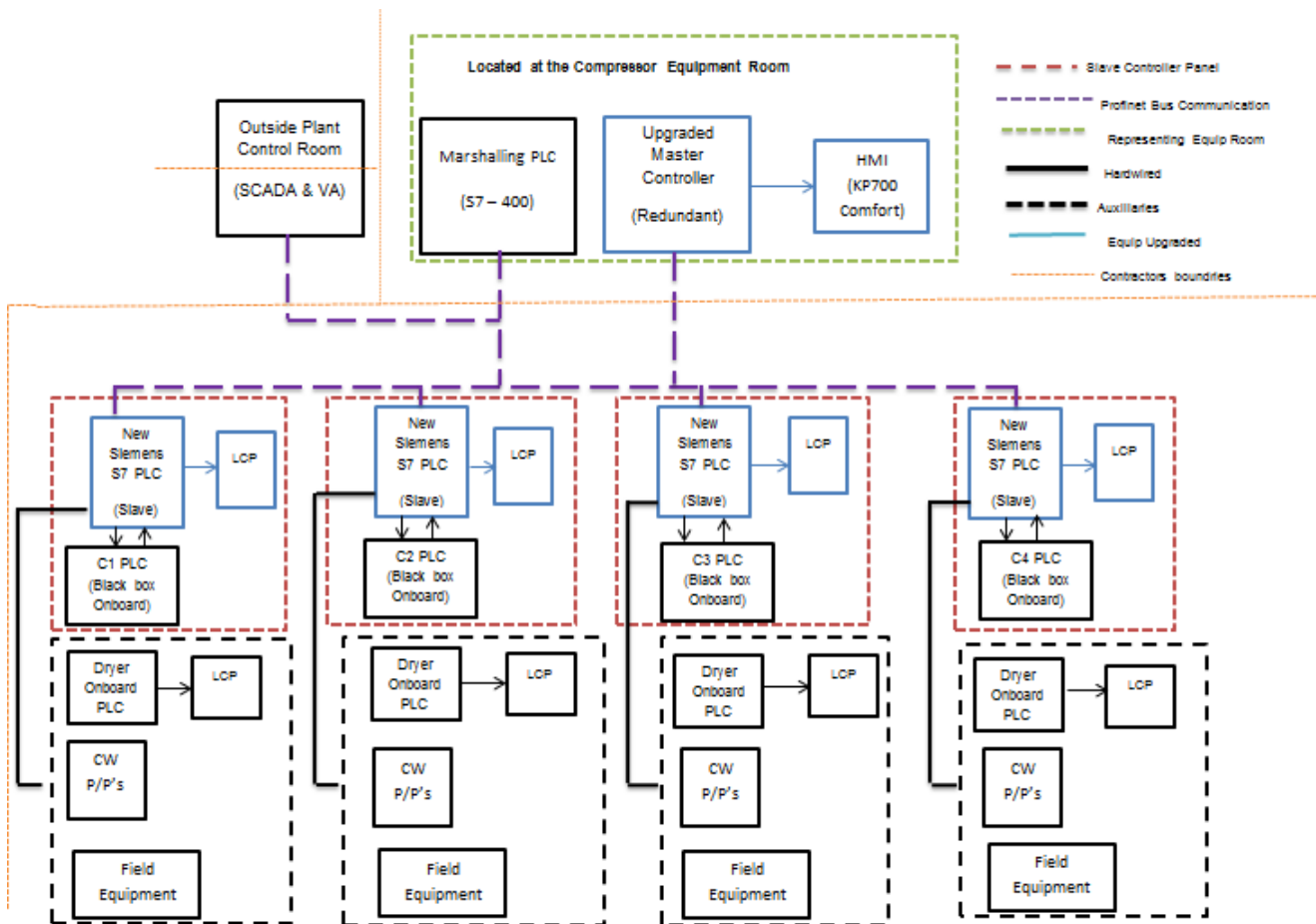


Figure 1: As Built Electrical Compressor Configuration

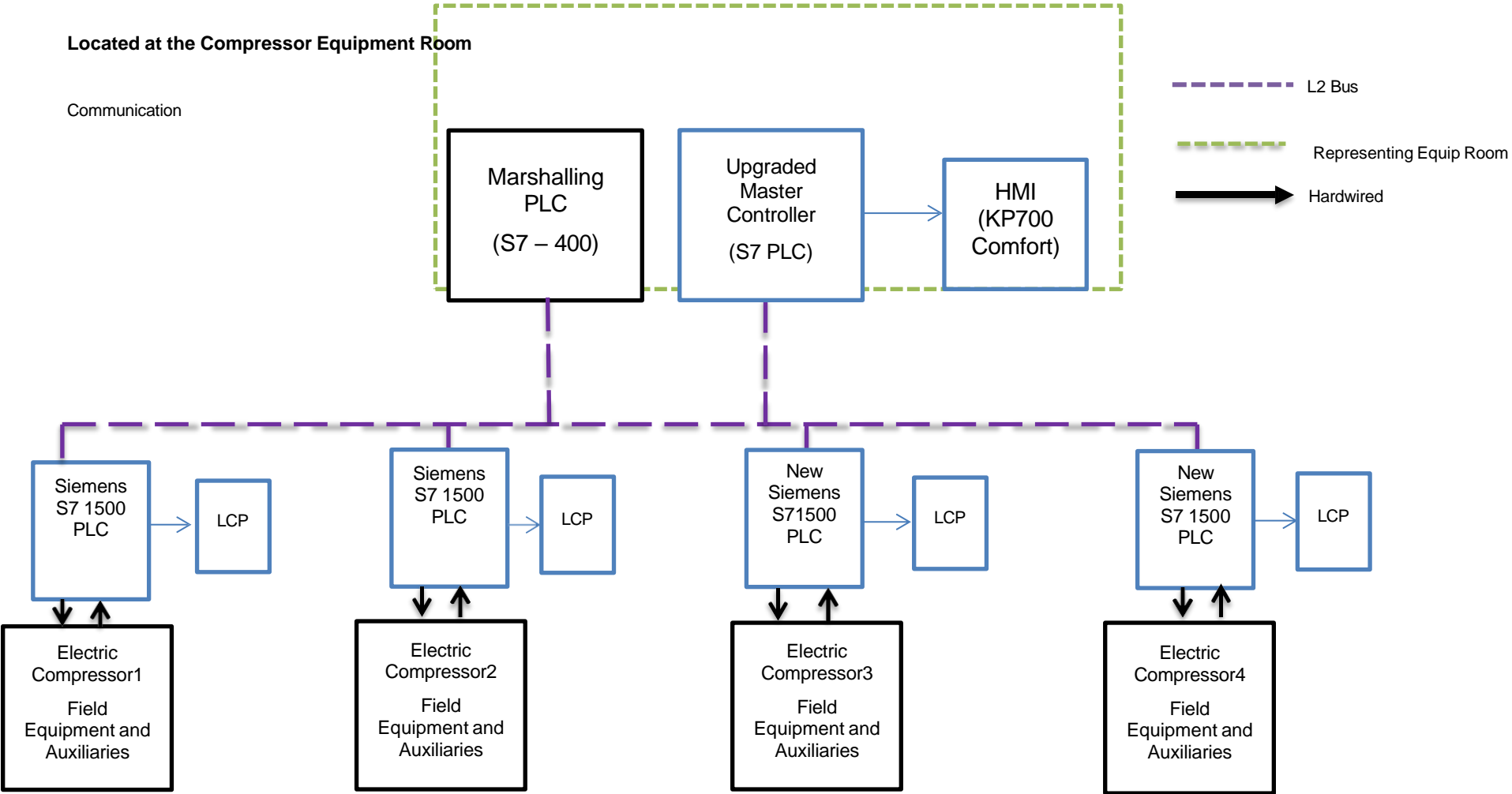
CONTROLLED DISCLOSURE

When downloaded from the EDS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the Authorized Version on the database.

3.6.2 New Control System Requirements

- IR controller and Siemens S7 1200 to be replaced with new PLC (Latest Technology) for all newly installed compressors as shown in figure 3.
- Siemens S7 1500 PLC is for control, operating, monitoring and protection of the entire compressor system.
- Local Control Panel per compressor is required.
- Interface all compressor instrumentation and auxiliaries (including driers) to the Siemens S7 1500
- Each dryer unit should be fitted with dew point measurement.
- Upgrade the existing master controller with new PLC (latest technology)
- Master HMI to be upgraded to KP700 Comfort
- Interface all electric compressor to the master controller for sequencing purposes
- Master Controller location will remain in the compressor plant equipment room.
- Programming of Marshalling PLC to accommodate new electric compressors.
- Field instrumentation for the compressor as per the instrument schedule.
- Installation of moisture trap
- All compressors should be program to accommodate the operating philosophy as stated.

CONTROLLED DISCLOSURE



3.6.3 OPERATING PHILOSOPHY

Four electrical compressors reinstalled in the compressor house. Each compressor is installed with a respective dryer, and two cooling water pumps. This set of equipment shall be referred to as a compressor train. Four compressors shall be operational with one compressor on standby. The compressor shall keep the system pressure between 450 kPa and 750 kPa. The system protections shall be sufficiently specified in the detailed design phase. If a substation board is lost the diesel compressors shall kick in to supplement air supply.

Each dryer shall be supplied by the Contractor as a fully packaged unit with its own standard on-board controller and on board instrumentation. Each compressor train shall have a slave controller which interfaces with the cooling water pump drives, the compressor controller and the dryer controller. This slave controller will be integrated to communicate with the master controller in the compressor house. The compressor house will have one master controller for all four compressors.

The compressor plant shall be fitted with the following measurements for control and local and remote indications as a minimum:

- Each air filter shall be fitted with differential pressure measurement device to signal when filter replacement is required.
- Each compressor shall be able to receive a signal from the discharge pressure transmitter to enable the automatic stopping/starting of the compressor.
- Each dryer unit will be fitted with dew point measurement instrumentation.
- Each dryer unit outlet pipe will be fitted with flow measurement instrumentation.
- The cooling water supply and return pipelines shall have temperature measurement.

3.6.3.1 Operating description for normal operating conditions.

3.6.3.1.1 Auto mode

The compressors will be operated from the Master Controller in Auto mode, and from the Slave Controller in Manual mode. Sufficient compressors will be controlled (i.e. stopped or started) so that the required system air pressure is ensured. Should the duty selected compressor fail to start or not be able to supply sufficient air, the Master Controller will start the next duty selected compressor in the duty sequence. Auto-rotation duty cycling determines the sequences in which the stand-by compressor shall operate. In the auto mode compressors will stop/start without operator intervention.

3.6.3.1.2 Manual mode

The manual mode is initiated by the operator after which the control resides with the operator. The master controller can be set to the local control mode which means that control is transferred to the slave controller. Drives can then only be started or stopped from the slave controller and not from the master controller. The operator will sequentially start the compressors in sequence to put the plant in a fully operational state. The slave controller will, however, control all respective compressors' auxiliary sequence interlocking and protection. Similarly to the remote mode, the slave controller will continuously signal to the Slave HMI the status of the plant and generate all alarms. In the event of midstream equipment failing to start or tripping due to a fault condition, the slave controller will inhibit any further starting of subsequent equipment until the fault is cleared.

CONTROLLED DISCLOSURE

3.6.3.1.3 Start-up sequence

After the running compressor has been selected and the sequencing controller has been set to auto mode, the system will start automatically in a logical sequence with all protections and interlocks activated. The Slave Controller in the low pressure services will control all sequences. In the event of equipment failing to start or tripping during the run up, the slave controller will automatically trip the faulty equipment and inhibit any further sequential starting of equipment. The Slave Controller will always signal to the Slave HMI the status of all drives and transmit alarms for any equipment or primary device which is in a fault or abnormal state. The following start up sequence shall be followed:

- The dryer shall start-up.
- The cooling water pumps shall start up.
- The compressor shall start-up.

3.6.3.1.4 Shut-down sequence.

Should a fault condition occur in the compressor train (any operating component) whilst the train is in a fully operational/running state, all equipment in the train will stop in the required sequence to ensure a safe shut-down. The controlled shut-down of the system will be in sequence to ensure there isn't a compressor trip. The following sequence shall be followed:

- The compressor shall stop running.
- The dryer shall stop running.
- The cooling water pumps shall stop running.

3.6.3.1.5 Maintenance Mode

The purpose of this selection is to run individual items of the plant out of sequence. The operator will direct the slave controller to release the plant drives (to be repaired) from any sequence interlocks with adjacent equipment, i.e., the equipment in question may be started and run up without interfacing with the upstream or downstream equipment. All plant and personnel safety protection systems will be fully operational in the maintenance mode.

3.6.3.1.6 Operating Concept

The plant shall allow the following controls from the master controller as a minimum:

- Stopping/starting of each compressor.
- To be able to be switched to automatic/manual mode. In the manual mode, the compressors shall be able to be stopped/started manually from the Slave Controller.
- System start button which will be used in the automatic mode.
- Compressor duty selector.

3.6.4 C&I SPECIFICATION

3.6.4.1 Field Requirements and Installations

The *Contractor* shall ensure that field installation, inclusive of instrumentation, junction boxes, cabling, and racking, is properly labelled with permanent labels that will not be easily removed. All labelling shall be consistent throughout the compressor plant.

Field device labels must be made of stainless steel, with text on labelling engraved as per the 240-563554: "Field Installation Standard", while also adhering to SANS 10108 Hazardous Area Classifications. All equipment shall be installed in accordance with the manufacturer's

CONTROLLED DISCLOSURE

instructions, listed standards in Section 7, and industry best practices. The equipment layout is such that when mechanical work is performed, no C&I equipment is damaged. Where harsh environmental conditions are not avoidable, the field equipment is designed for operation in that environment must be used (i.e. all field equipment is selected according to the environment in which they will operate in). All field equipment is to be 24VDC powered and signal transferred to the local control panel, master control panel for control and monitoring and to the Outside plant control room (SCADA) for monitoring purposes only. All field equipment excluding junction/splitter boxes and their electrical connections is rated IP 66 and operates over an ambient temperature range of: -10°C to 70°C.

3.6.4.2 Transmitters

All transmitters supplied as part of the Works are compatible with the relevant primary measuring element. All transmitters have built-in diagnostics that constantly monitor and alarm any faults on the transmitter. The transmitter and its installation position are labelled such that if the transmitter is removed, the label is still visible in the plant. The labels are provided as per the labelling requirements defined in ETS004 Rev 4 – AKZX Plant Location Labelling.

Transmitters are suited and adequate to fulfil the following function and accuracy requirements:

- All digital transmitters have built in local digital indicators that can be programmed to indicate the range and specified engineering units for the process. All transmitters provided have a high turn down ratio so that the minimum possible different types of transmitters can be used for all the applications.
- All transmitters conform to a minimum accuracy of span of 0.05%. All transmitters are supplied with a drift free guarantee period of 10 years or better.
- It is ensured that the installation of the transmitters:
 - Allows for safe and easy access for maintenance and calibration.
 - Accounts for the environmental conditions
 - Allows for the removal of equipment for maintenance in the vicinity of the transducer.

3.6.4.3 Cabling & Racking (Cable Installation and Routing)

All cable installation and instrumentation cables shall be flame retardant, low smoke type, and comply with 240-56227443: Requirements for Control and Power Cables for Power Stations Standard. Instrument cabling is to be installed with due respect for safety, reliability, access, maintenance, environmental conditions, and best practices. All cabling must be suitably protected against mechanical damage, chemicals, dust build-up, and heat

3.6.4.3.1 The Contractor to take note of the following for cabling design:

- a. Instrument cabling is defined as cabling between field instrumentation and junction boxes.
- b. Power supply cabling is defined as being cabling required to power field equipment.
- c. Cables shall only be terminated in instruments and junction boxes. No intermediate cable joints are permitted.
- d. Cables connected to instruments are installed with a loop of cable to provide sufficient slack for re-making the cable connection if the instrument is removed and to allow for removing the instrument without electrical disconnection.

CONTROLLED DISCLOSURE

- e. Instrument cables are routed separately from electrical power cables, and crossovers that bring signal and power cables into close proximity are made at right angles.
- f. The routes for power supply cabling and the racking are of a consistent and integrated design taking into account different cabling and racking routes for common modes of failure, and the redundancy concepts of the mechanical plant design.
- g. The Contractor provides 20% spare installed capacity in all multi-core cables, rounded up.
- h. The terminal blocks for the junction box terminations shall comply with SANS 60947-7-1 and 60947-7-2.

UVG cable and Field/Trunk Cable installations will be used to transfer signals from the field equipment to the Slave Controller according to 240-56355815: Cabling standards.

3.6.4.4 Junction Box

New junction box is to be provided to terminate all instrumentation. Junction boxes shall be properly labelled with permanent labels that will not be effortlessly removed and to also have enclosure material of 3CR12 stainless steel grade or higher and will be powder coated using RAL7035. Junction boxes are rated IP 65. The Contractor to comply with this standard 240-563555: Junction box and cable termination.

3.6.4.5 Impulse Piping

Non-destructive testing is conducted on all impulse piping welds. The results of all non-destructive testing on impulse piping welds must be accepted by the Employer's representative. All pipe work provided is inclusive of supports, transition pieces to primary isolating valves and drains to provide complete impulse, equalising and blow-down lines for all instruments. The drains impulse piping provided is 1.3 meters from the manifold with tips facing away from the transmitter face.

3.6.4.6 Slave and Master Controllers

The Controllers provided by the Contractor meet the following requirements:

- a. Siemens S7 PLC technology.
- b. Accept analogue input measurements from the field based on two-wire 24VDC, 4-20mA signals.
- c. 20% spare I/O capacity at handover.
- d. The Processors are configured to be dual modular redundant.
- e. Redundant processors are capable of being replaced online with no effect on the operating plant.
- f. All analogue and digital signals used for operator information, control, protection, interlocking, calculations, or plant history are continuously monitored for validity.

CONTROLLED DISCLOSURE

3.6.5 SYSTEM PERFORMANCE

3.6.5.1 Life Expectancy

All equipment and control components are supported and maintainable until the end of the year 2039.

3.6.6 GENERAL REQUIREMENTS FOR THE WORKS (C&I WORKS)

The Contractor is required to provide the following Engineering Documentation (C&I Design), accordingly:

- Wiring diagrams
- Cable Schedules and Cable Routing
- Termination Schedule
- Functional Logic Diagrams
- Drive & Actuator Schedule
- Instrument Schedule
- Panel Interface List
- I/O Block Diagram
- Limits of Supply and Services
- Operating and control philosophy of the upgraded system to be provided
- PLC diagrams and P&IDs to be provided of the upgraded system
- Standard equipment operating manuals
- Maintenance Manuals & Procedures
- Datasheets
- Mechanical hook-ups drawings
- Training manuals
- Network architecture and configuration drawings
- Spare capacity report
- PLCs internal equipment connection and wiring drawings
- PLCs configuration settings

3.6.7 Tests

3.6.7.1 FAT

Testing shall adhere to at least the minimum requirements set by IEC 62381. The Contractor is to conduct a pre-factory acceptance test at the Contractor's factory in preparation for the FAT. The Contractor is to completely test and verify the performance of the Duvha Electric Compressor Control System. During FAT, the Contractor demonstrates that the Duvha Electric Compressor System meets the requirements of this Technical Specification.

3.6.7.1 Site Integration Test (SIT)

The SIT only begins once the following has occurred:

CONTROLLED DISCLOSURE

- All electric compressor control equipment has been installed in the final locations and connected to permanent power supplies.
- All interfaces to 3rd party systems (OPCR and VA) have been implemented.
- The SIT is carried out before plant commissioning commences to ensure:
 - Correct performance of the Electric Compressor Control System
 - Safety of plant and personnel
 - Compliance with the Technical Specification
- As a minimum, the SIT testing and inspection activities provided by the Contractor consist of:
 - Site integration and site acceptance activities defined in IEC 62381
- In the event of an error in any test (hardware or software), the fault is logged, analysed, and resolved.
- The Contractor is allowed to rectify the fault and retest for the full duration on condition that the Project Manager finds the fault to be minor.
- Major faults may lead to the termination of the SIT.
- The Contractor rectifies the fault and re-starts the SIT after proving the compliance and performance of the rectified piece of equipment by carrying out the appropriate diagnostic tests.

3.6.7.2 Change over from existing L2 network to new PROFINET network.

- Existing PROFINET network: Currently this network consists of the bunker level PLCs, the Marshalling PLC, and the Driefontein Dam PLC.
- The Marshalling PLC (located at the LP Services building) has two existing ports. The existing ports are for the L2 network and the PROFINET network. The changeover from L2 network to new PROFINET network will be accessed via the Marshalling PLC on the PROFINET network.
- The fibre optic cables used for the L2 are still in good condition and they can be reused for PROFINET.
- Currently, only two old electric compressors are running and are operated locally from their individual slave controllers. Therefore, the Marshalling PLC will be programmed to cater for the new electric compressors. These changes are to ensure that the process data sent to the Marshalling PLC is sent to the OPCR SCADA.
- The Contractor should be able to roll back to the existing L2 if the changeover is not successful.
- A detailed risk assessment must be conducted by the Contractor before a changeover to the new PROFINET is done.
- The detailed risk assessment must be reviewed and accepted by the Employer.

3.6.8 Training Requirements

The intensity of the training will be dependent on the changes implemented.

3.7 CIVIL SCOPE

The new Hankison PSA dryers have similar weight as the older dryers and can be placed on the same plinths. The base dimensions for the Hankison PSA dryers are larger and modifications shall be made. The other proposed dryers have increased weights of 34% and more. These dryer's base footprint is also significantly larger than the current dryer plinths and the Contractor shall be required to design a modification for the supports or replace the support with new structures.

3.7.1 Civil Contractor responsibility

Should the supports not have sufficient capacity, the *Contractor* shall be required to design a modification for the supports or replace the supports with new structures that meet the load

CONTROLLED DISCLOSURE

requirements. The supports to be assessed include the compressor plinths, supporting ground slab and the dryer plinths.

Design

The design process shall follow the Structural Design and Engineering Standard 240-56364545, the steps below shall outline the deliverables specified:

1. The *Contractor* shall perform adequate calculations and design checks to show that the existing compressor plinths have the capacity for the new compressors. Vibrations must be taken into account.
2. The *Contractor* shall perform adequate calculations and design checks to show that the existing dryer plinths have the capacity for the new dryers and that the dryers fit on the plinths.
3. The concrete strength of the plinths must be checked by the *Contractor* if deemed necessary.
4. The *Contractor's* professional structural engineer who is registered with the Engineering Council of South Africa provides design certification in accordance with SANS 10400-A, declaring the design "fit for purpose" in terms of the relevant design codes and the OHS Act.
5. For modifications of the plinth, the *Contractor* submits editable electronic drawings in Micro Station (DGN/DWG) format and in PDF format. Drawings issued to the *Employer* are not "Right Protected" or encrypted.

Construction

1. Demolition the current concrete plinths to suit the new installation.
2. Concrete grade to be 35Mpa/19mm.
3. Reinforcement shall not be damaged during demolition for reuse
4. Dowell bars shall be used were necessary.

4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Lucky Mtembu	Manager Mechanical Maintenance Turbine
Octavia Mohale	Manager Risk and Safety
Mary Maunye	Senior Technologist Engineer
Sibonokuhle Tapala	Senior Engineer Prof Engineer
Nsizwa Mhlongo	C&I System Engineer
Vero Masuku	C&I Engineering Manager
Elliot Mamba	Electrical Technician Engineering
Alisha Surjoobhalee	Technician Configuration

CONTROLLED DISCLOSURE

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2016	1	G. Magagula	First Issue
September 2024	2	T. Masethe	Removed The Compressor replacement and the electrical scope of work.

6. DEVELOPMENT TEAM

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

- Thabiso Masethe
- Nsizwa Mhlongo
- Vusi Chirwa

7. ACKNOWLEDGEMENTS

N/A.

CONTROLLED DISCLOSURE

When downloaded from the EDMS database, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised Version on the database.