

 Eskom	Technical Specification	Medupi Power Station
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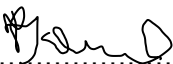
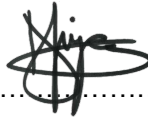
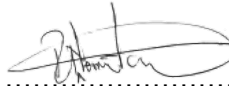
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1. INTRODUCTION

This document provides the scope of works to be executed by ERI via a sole source. The scope of works has gone to open market several times without success necessitating a change in procurement strategy to finalize the works. This document covers the following 14 scopes which have been combined into a single scope:

- a. Clean Laboratory Modifications
- b. Oil Laboratory Modifications
- c. Coal Laboratory Modifications
- d. HCl dosing system
- e. NaOCl fumes
- f. Corroded components replacement
- g. Potable Water Disinfection (ClO₂)
- h. CPP Measuring Tanks Venting
- i. RO pH Control
- j. UF Control Valves
- k. Effluent Neutralization Sump (ENS) pumping system upgrade
- l. WTP Raw Water Clarifier Overflow Pipes
- m. Relocation of polymer and coagulant dosing points
- n. Lowing of Coagulant Dosing Pumps Suction

2. SUPPORTING CLAUSES

2.1 SCOPE

This document covers the applicable work to be performed on the above detailed scopes by ERI.

2.1.1 Purpose

The purpose of this document is to provide ERI with the relevant details required to perform the works as defined in this scope.

2.1.2 Applicability

This document shall apply to Medupi Power Station.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

2.2.1 Normative

- [1] Record of Decision - Modifications at Coal Lab
- [2] Design Change Notice - Dust problem in Coal Sample Preparation Room in the WTPLaboratory

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- [3] 0.84/61041 Water Treatment Plant Clarifier Raw Water Overflow Pipeline (sheets 1 & 2)
- [4] 0.84/25226 Water Treatment Plant Clarifier Polymer Dosing Sections – Piping General Arrangement
- [5] Impact Assessment - Dust problem in Coal Sample Preparation Room in the WTP Laboratory
- [6] 348 – 9954327 Engineering Change Proposal (ECP) Laboratory Modifications
- [7] 348-10032597 Engineering Change Proposal Report for design improvements of the WTP Clarifier and Clarifier chemical dosing
- [8] 240714321-50 – Plant Labelling Standard
- [9] SANS 10400 National Building Regulations
- [10] SANS 241:2015: Drinking water standard.
- [11] SANS 52671:2021: Chemicals used for treatment of water intended for human consumption- Chlorine dioxide.
- [12] OHS Act 85 of 1993: The Occupational Health and Safety Act 85 of 1993.
- [13] 240-10172128 – Specification for the internal Corrosion protection of Water Systems, Tanks, and vessels.
- [14] 200-24289 Medupi Power Station Corrosion Protection Specification.
- [15] RTD/MAT/19/036 Protective Coating Specification – Medupi Power Station Water Treatment Plant Main Building
- [16] RTD/MAT/21/014 Protective Coating Specification – Medupi Power Station Semi-Bulk Chemical Storage Structural Steel Work and Plinths
- [17] RTD/MAT/17/028 Medupi Power Station Water Treatment Plant Sulfuric Acid Bund Corrosion Protection Lining.
- [18] OHSACT Occupational Health and Safety Act of 1993.
- [19] SANS 10108 The Classification of Hazardous Locations and the Selection of Equipment or Use in Such Locations.
- [20] SANS 60079-10-1 Explosive Atmospheres Part 10-1: Classification of Areas – Explosive Gas Atmospheres Conformity Assessment Criteria for all Pressure.
- [21] SANS 10142 Code of practice for wiring of premises.
- [22] SANS 347 Categorization and conformity assessment criteria for all pressure equipment.
- [23] SANS 10227, Criteria for the operation of inspection authorities performing inspection in terms of the Pressure Equipment Regulations.
- [24] SANS 10400 National Building Regulations.
- [25] SANS 10142-1 The wiring of premises part 1: Low voltage installation
- [26] 348-9984115 Medupi PS Required Operational Capability Effluent Neutralisation Sump Pumps Modification Report
- [27] 348-389557 Medupi Contractor Quality Specification
- [28] 0.84 – 4717 ENS P&ID
- [29] 348-10032597 Engineering Change Proposal Report for design improvements of the WTP Clarifier and Clarifier chemical dosing

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2.2.2 Informative

- [1] ISO 9001 Quality Management Systems.
- [2] 240-53113685: Design Review Procedure.
- [3] 240-53114002: Engineering Change Management Procedure.
- [4] 240-53114026: Project Engineering Change Management Procedure.
- [5] ISO 17025:2017 - General requirements for the competence of testing and calibration laboratories.
- [6] 240 – 83138702 – Medupi Power Station Chemistry Quality Management System Manual.
- [7] ISO 10007 Guidelines for Configuration Management
- [8] Occupational Health and Safety Management Systems Requirements (OHSAS 18001)
- [9] 240-82410629 – Environmental Management Strategy
- [10] 240-60490979 – OHS Operational Plan
- [11] 200-53810 - Documentation Handover List
- [12] 200-46362 - Site Inspections Procedure
- [13] 200-38425 - Procedure for Hazard Identification and Risk Assessment
- [14] 200-16817 - Excavation Permit Application Procedure
- [15] 200-15406 - Issue Takeover Certificate
- [16] 200-11303 - Medupi Occupational Health, Safety and Management Policy
- [17] 200-1680 - Document and Record Management Procedure
- [18] 200-1679 - Project Quality Plan
- [19] 32-421 - Eskom Life Saving Rules
- [20] 32-245 - Eskom Waste Management Standard
- [21] 200 16714 - Medupi Commissioning procedure
- [22] 200-45965 - Manufacturing Inspection and Testing

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2.3 DEFINITIONS

Stakeholder	Is anyone that has an interest in the outcome of the project.
Inspection	Activities, which through examination, observation, or measurement, determine the conformance of material, parts, components, etc., to predetermined specifications and quality requirements.
Maintenance	All activities required retaining an item of plant in, or to restore it to an acceptable condition, including the examination and evaluation of the actual condition.
Maintenance Philosophy	The principal approach is decided upon for performing maintenance, such as proactive or reactive maintenance.
Maintenance Strategy	The type of maintenance selected for specific plant and equipment, such as time or condition-based maintenance, corrective or preventative maintenance
System	An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective.
Testing	All activities required determining the actual performance or condition of an item.
Automatic	is a mode of operation in which a particular function of a piece/s of equipment is performed automatically by the DCS rather than manually.
Remote Manual	is the remote operation of the plant from the DCS by the operator of a normally automated system
Local Manual	is the manual operation of the plant from a nearby proximate location relative to the equipment by an operator.
Local Maintenance	is the process of preserving a condition or situation of equipment in the plant.

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2.3.1 Classification

Controlled disclosure: controlled disclosure to external parties.

2.4 ABBREVIATIONS

Abbreviation	Description
A	amps
Auto	Automatic
AAS	Atomic absorption spectrometer
ASME	American Society of Mechanical Engineers
BoP	Balance of Plant
CAR	Corrective Action Request
C&I	Control & Instrumentation
CEB	Chemically Enhanced Backwash
CEDI	Continuous Electro Deionisation
CIP	Cleaning in Place
CIO ₂	Chlorine Dioxide
CPP	Condensed Polishing Plant
CM	Configuration Management
CQMP	Coal Quality Management Procedure
DB	Distribution Box
DCS	Distributed Control System
ECP	Engineering Change Proposal
ECSA	Engineering Council of South Africa
ENS	Effluent Neutralization Sump
FAT	Factory Acceptance Test
FMCA	Failure mode and criticality analysis
GA	General Arrangement
HAZOP	Hazard and Operability
HCl	Hydrochloric Acid
HMI	Human Machine Interface
HVAC	Heating Ventilation Air Conditioning
Hz	Hertz
ICP - OES	Induced Coupled Plasma - optical emission spectrometry
ITP	Inspection and Test Plan
JB	Junction Box
Kg	Kilogram
KKS	Kraftwerk-Kennzeichensystem
LDE	Lead Design Engineer

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LOSS	Limit of supply and services
MDL	Master Document List
MSDS	Material Safety Data Sheet
NaOH	Sodium Hydroxide
NaOCl	Sodium Hypochlorite
NCR	Non Conformance Report
OEM	Original Equipment Manufacturer
OHS Act	Occupational Health and Safety Act
PDRT	Process Drains Recovery Tank/s
P&ID	Piping and instrumentation Diagram
PBS	Plant Break Structure
PC	Personal Computer
PEC	Professional Engineering Certificate
PPE	Personal Protective Equipment
PSR	Plant Safety Regulation
PSV	Pressure Safety Valve
PER	Pressure Equipment Regulations
PLC	Programmable Logic Controller
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Procedures
QMS	Quality Management System
RAM	Reliability, Availability and Maintainability
RO	Reverse Osmosis
ROC	Required Operational Capability
ROD	Record of Decisions
RP	Responsible Person
SABS	South African Bureau of Standards
SANS	South African National Standard
SHE	Safety Health and Environmental
SIT	Site Integration Testing
SOW	Scope of Work
SRD	Stakeholder Requirements Definition
THMs	Trihalomethanes
HAAs	Haloacetic acids
TM	Team Medupi
TOC	Take Over Certificate
UF	Ultra-filtration
UPS	Uninterrupted power supply
V	Volts

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VAC	Volts alternating current
VDSS	Vendor Document Submittal Schedule
WTP	Water Treatment Plant

2.5 ROLES AND RESPONSIBILITIES

The following roles and responsibilities apply:

Person	Responsibility
Contractor	The <i>Contractor</i> shall design (to the extent specified in the Contract), procure, supply to site, construct, commission, conduct acceptance test execute the Works in accordance with the Contract and with the Project Manager's instructions, and shall remedy any defects in the Works.
Engineering Design Work Lead (EDWL)	He/she co-ordinates the design work provided by the discipline Design Engineering roles and integrates this work into a final integrated design product. He/she is the custodian of the requirements set and the interface register between packages and part of his/her role is to maintain this information. He/she remains responsible for the integrity of the engineering product and is accountable for the overall management of interfaces and delivery of an integrated product.
Lead Discipline Engineer (LDE)	The role of the Lead Discipline Engineering role is to manage the technical integrity of the design and be accountable for the management of the interfaces within their specific engineering domain
Site Construction Engineering Practitioner	The Site Construction Engineering role is part of the project engineering team and participates in conjunction with other team members of all disciplines in order to assure the technical integrity of a fully functional and operational plant that meets the user requirement and Eskom Engineering expectations and requirements. The Site Construction Engineering role is a key link to facilitate and ensure that the plant, is built and commissioned, is fully aligned with the Design Base, Operating Technical Specifications and the Maintenance Base. The role provides an assurance function. Quality inspections, Final acceptance, sign-off and approval

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Designer	As per Construction regulations: Designer means a) a competent person who: i) prepares a design ii) checks and approves a design iii) arranges for a person at work under his or her control to prepare a design, including an employee of that person where he or she is the employer; or b) engineer contributing to or having overall responsibility for a design. c) a contractor carrying out design work as part of a design and building project;
Architect	“The architect is responsible for the concept, layout of a building, the specification of finishes, the submission an approval of architectural plans, ensuring compliance with planning requirements and national building regulations and similar activities. “ From ECSA The role, responsibilities and conduct of persons registered with ECSA appointed for small building works
Project manager	The Project manager coordinates the execution of the Works to achieve the required cost, schedule and quality objectives. The Project manager is delegated authority from the Eskom Employer Representative to manage the defined scope of work.
Quality Management	Quality ensures Contractors build plant according to contractual specifications, and user requirements and codes. Quality is the custodian of the Quality Management System and quality records and facilitates the work of the Approved Inspection Authority (AIA). The Quality Function’s responsibility is to ensure Contractors have a sound quality system in place. Quality checks these systems on behalf of the Employer.

3. SCOPE OF WORK

The *Contractor* shall take full professional accountability for all of the Works in their scope and shall provide the following for review and acceptance:

- a) Updated/marked-up and signed P&ID’s, GA drawings and Isometric drawings.
- b) The *Contractor* shall submit as-built data and drawings of the completed Works upon handover.
- c) All drawings shall comply with the Eskom standards listed in Appendix D.
- d) Design calculations and/or detailed information for all equipment sizing.
- e) List of all interfaces.
- f) Updated operating philosophy, maintenance philosophy and control narratives.
- g) Equipment schedules.
- h) Mechanical design calculations and drawings for the tanks and piping signed

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- by a registered engineering professional.
- i) Where simulation software's are used, it is expected that all model input files and results will be included in the design report.
 - j) The *Contractor* shall perform acceptance tests on all the works.

3.1 CLEAN LABORATORY MODIFICATIONS

The clean laboratory is used to receive and analyse water samples for low concentration level of impurities. The clean laboratory is equipped with the Induced Coupled Plasma - optical emission spectrometry (ICP-OES), for analysis of metals in water. The ICP-OES is not capable of analysing low levels of metals in water due to the combustion method utilised. To address the above deficiency, a more sensitive instrument was procured, atomic absorption spectroscopy (AAS) analyser that utilises a graphite furnace.

For the AAS to function, compressed air, acetylene and argon gases are required as ancillaries. AAS instrument utilises a combustion method for analysis. Therefore, a gas extraction system is required to extract all gas combustion products from the clean laboratory. In addition to the above requirements, as part of the scope, a two-tier table with chemical resistant work surfaces, and lockable wheels that prevent it from moving if so desired is required. The table will be used to house the AAS instrument, and its load capacity (static and dynamic) shall be at least 200kg.

The AAS extraction system shall have audible and visible alarm system. Power supply will be required to power the extraction system alarm system, the extraction fans and the AAS instrument.

The changes on the clean lab are highlighted in RED in figure 1 and summarised as follows:

- a) A gas extraction system with a fume hood, audible and visible alarm system.
- b) Power supply to power the extraction system, its alarm systems and the AAS instrument.
- c) Gas reticulation system for the supply of compressed air, acetylene and argon gases from the gas storage area to the clean laboratory.
- d) Supply a two-tier table with chemical resistant surfaces and lockable wheels, the load capacity shall be 200kg.

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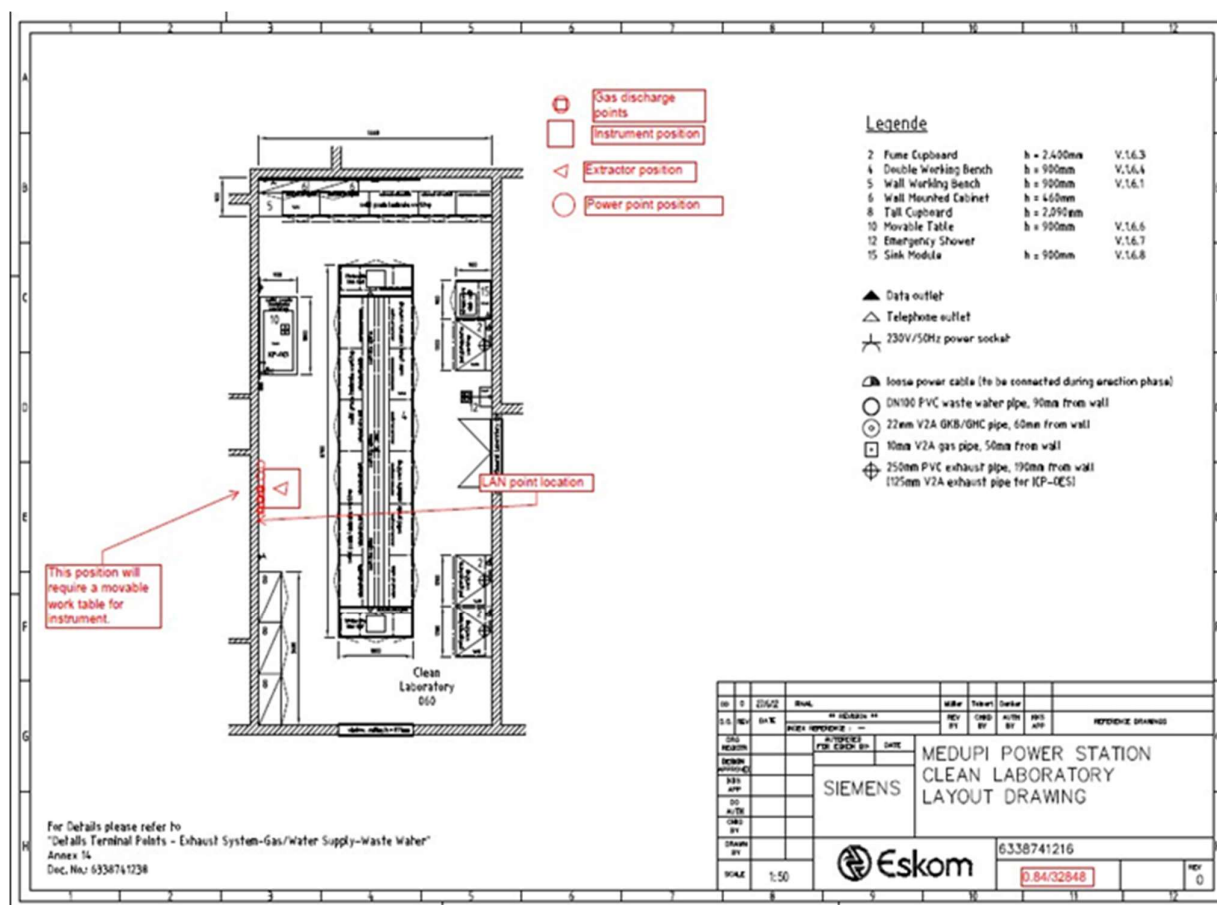


Figure 1: Clean Laboratory modifications

The clean lab process gas requirements are tabulated in Table 1 below:

Table 1: Clean Laboratory gas requirements

Gas	Flow rate	Pressure
Argon	7 L/min	90-120 kPa
Acetylene	10 L/min	90-120 kPa
Compressed air	30 L/min	350-450kPa

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3.2 OIL LABORATORY MODIFICATIONS

The oil laboratory is used to receive and analyse oils used at the power plant. The oil lab is equipped with a carbon and ash instrument that utilises a combustion method. A gas extraction system will be required to enable extraction of gasses produced by the instruments. The instruments will also require the supply of synthetic air and nitrogen gas lines to operate. The oil lab is also equipped with a Bomb calorimeter that analyses calorific value of heavy fuel oil. A bomb calorimeter requires oxygen, nitrogen, and synthetic air to operate. A modification of gas reticulation system from the gas storage area for the supply of oxygen, nitrogen, and synthetic air to the oil lab is therefore required.

The oil lab modifications shall be such that the carbon and ash analyser instrument can be fully functional, and the gas/fumes emitted are extracted out of the Laboratory. The changes on the oil lab are highlighted in RED in figure 7 below and summarised as follows:

- A gas extraction system with a fume hood and visible alarm system.
- Power supply to power the extraction system and alarm systems.
- Gas reticulation system from the gas storage area for the supply of oxygen, nitrogen, and synthetic air to the Oil Laboratory.

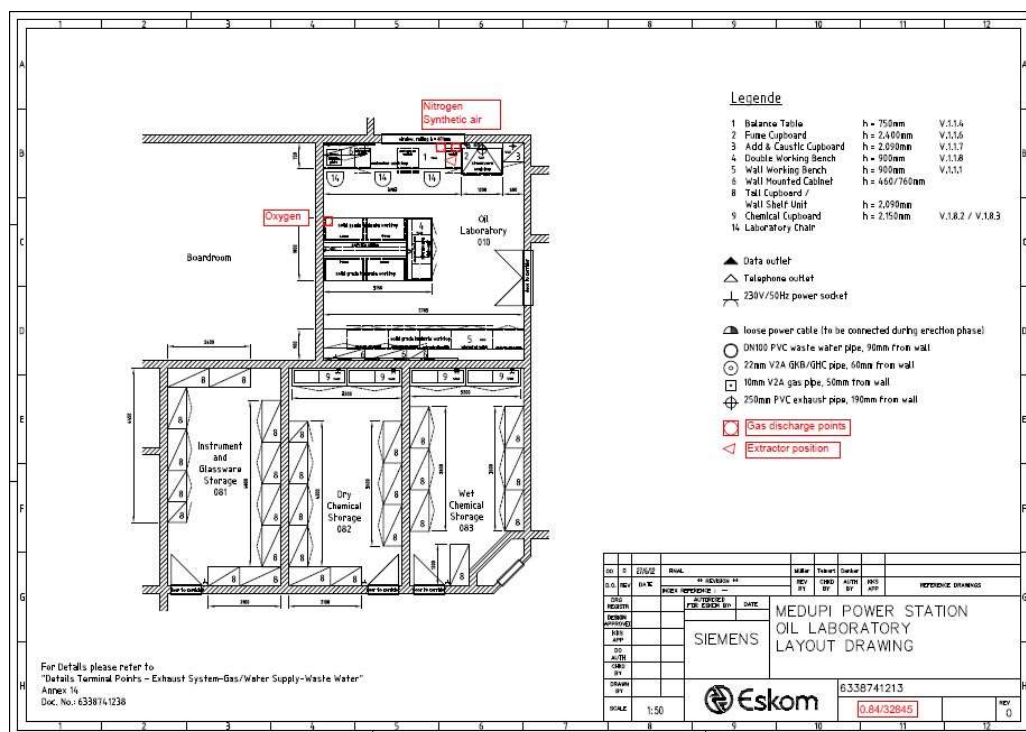


Figure 2:Oil Lab Layout Drawing

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The oil lab process gasses requirements are given in Table 2 below:

Table 2: Oil Laboratory gas requirements

Gas	Velocity	Pressure at terminal point
Oxygen	150 – 600 m/min @2.5 bar	At least 100 kPa, at most 300kPa
Nitrogen	150 – 600 m/min @2.5 bar	At least 100 kPa, at most 300kPa
Synthetic air	150 – 600 m/min @2.5 bar	At least 100 kPa, at most 300kPa

3.3 COAL LABORATORY

The coal laboratory is used to receive and analyse the coal samples. The current set-up of the coal sample preparation room does not make it possible to achieve accreditation as it deviates from clause 6.3 Facilities and environmental conditions of ISO 17025:2017. There is no effective separation of incompatible activities such as the preparation equipment separated from the ovens and furnaces which can adversely affect the validity of the results.

The coal laboratory therefore requires modifications to provide a contamination-free room to perform coal analysis and to provide a dust free safe room for personnel performing coal analysis. The required modifications will be detailed in this document.

The following modifications are therefore required in the coal lab to enable accreditation and to ensure that the required analysis are done:

- a) The passage next to the coal lab shall be used to create a new room.
- b) A new entry/exit double door shall be fitted on the newly created room.
- c) A new countertop shall be fitted for oven and furnace samples for coal analysis.
- d) a dust extraction system.
- e) Fire detection system.
- f) Access control system.
- g) Installation of 2 hour rated fire doors.
- h) Power and lighting on the new room.
- i) Ceiling on both the coal preparation room and the new room.
- j) Flooring on the new room compatible with coal.

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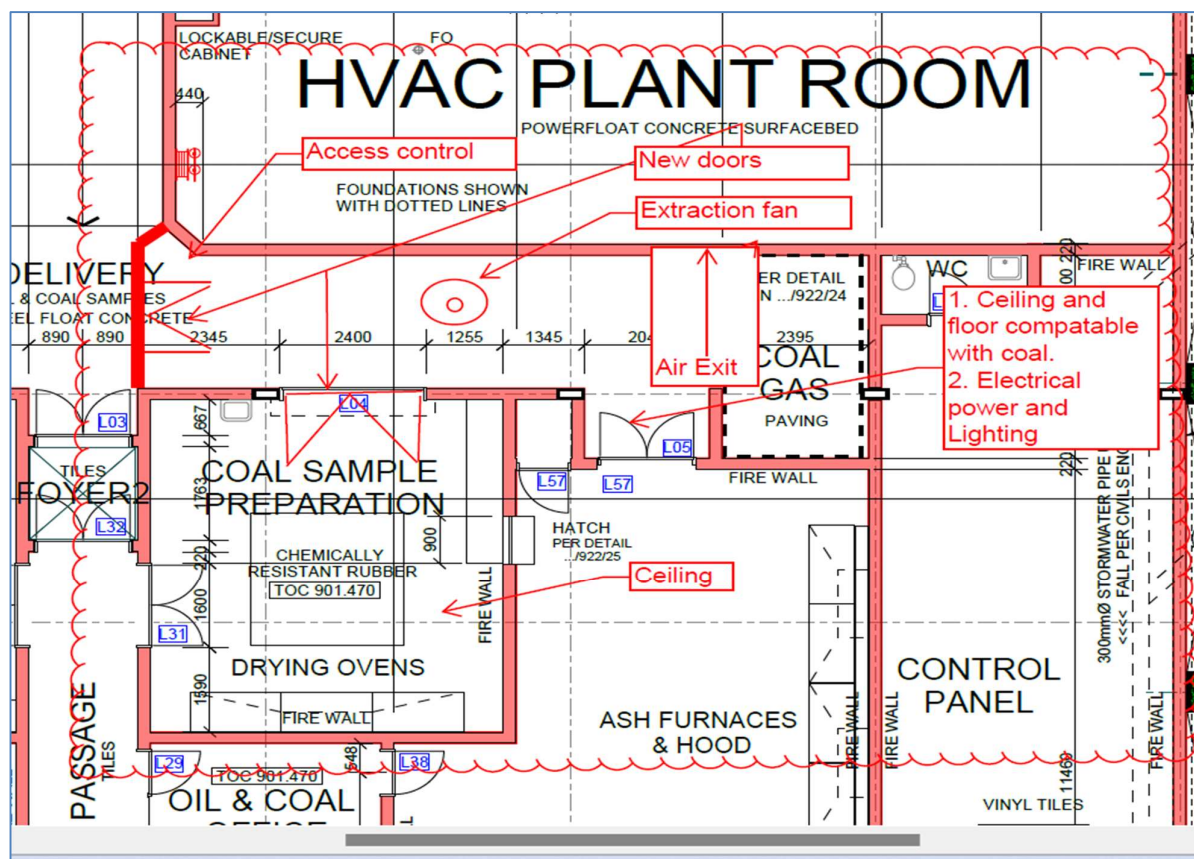


Figure 3: Coal lab concept drawing

The equipment that are placed on either room are listed in Table 3 below.

Table 3: Coal Preparation Room Equipment

Equipment	Coal Grinding Room	Coal Drying Room
1x Abrasiveness Index ¹	√	-
1x Hardgrove Index	√	-
1x Test Sieve and Sieve shaker	√	-
1x Jaw Crusher	√	-
1x Cone and quartering sampler	√	-
2x Drying Oven ²	-	√
1x Ash Fusion furnace with camera	-	√
1x High temperature furnace 1000°C	-	√
1x volatiles matter furnace	-	√

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3.4 MECHANICAL REQUIREMENTS FOR LABORATORY MODIFICATIONS

The *Contractor* shall provide in the enquiry a detailed method statement describing how the process requirements will be achieved by means of the mechanical plant. Within this method statement the *Contractor* shall provide detailed calculation for the selection and sizing of all mechanical equipment such the equipment is optimised for the performance requirement set out by the project.

The *Contractor* is responsible to carry out a detailed set of calculations accompanied by a Hydraulic Analysis. This hydraulic analysis results and model is required to be verified and approved by an ECSA Professional Registered Engineer/Technologist as part of the enquiry submission.

The *Contractor* is to comply with all Acts of Parliament and all regulations and bylaws of local and or other authorities having jurisdiction regarding the execution of the works in particular the following:

- a) Occupational Health and Safety Act as amended.
- b) Government, Provincial and Local Authorities Ordinances, Regulations, By-Laws, Rules and other statutory requirements.
- c) Specifications and Codes of Practice issued by the South African Bureau of Standards and British Standards Institute. The former has precedence over the latter where both bodies have issued conflicting specifications or codes of practice.
- d) The Mechanical requirement follows the process requirement and ensures that all components are within acceptable limits.

3.4.1 Terminal Points

The Laboratory boundaries of the scope are:

- a) The fumes/gases dust extraction systems to be installed and the ducting to discharge outside on the Southern and Northern walls of the WTP Building respectively.
- b) The tie-in into the gas bottles and the analysers/instrument tie-in.

3.4.2 Air and Gas Reticulation System

- a) The *Contractor* shall supply compressed air to the five coal lab instruments that require instrument air namely, caloric value (AC 600 and IKA C200), sulphur (SC832 and Eltra CS 580) and AF 700 Ash Fusion. The instrument air shall be supplied from a stand-alone compressor capable of operating in an outside environment and suitable for the process and explained in this document.
- b) From drawing 0.84/922 sheet 7 (Appendix C), the gas cages for these gases already exist. A competent gas installing *Contractor*, certified by the South African Qualification and Certification Committee for Gas (SAQCC Gas) will utilise the existing gas storage area, and make all necessary modifications to ensure compliance with SANS 10263; SANS 10263-2- 2015; SANS 10087, and all OHS regulations (Act 85 of 1993), especially Pressure Equipment Regulations (PER)

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published in Government Gazette 32395 as Regulation 734 and the accompanying SANS 347.

- c) Each bank shall supply the system through its own pressure reducer. A master pressure reducer shall ensure the correct line pressure no matter which bank is in operation. Each pressure reducer shall be fitted with a safety valve set to operate at 1,5 times the working pressure and be vented to atmosphere. Pressure gauges indicating the cylinder and supply line pressure shall be incorporated in the manifold and on all pressure reducers. Pigtails for connecting the manifold to the cylinders shall be long and flexible enough to allow easy connection to the cylinders without having strain the tube. Each outlet for connecting the manifold to the pigtail shall have a header valve. Pigtails shall be connected to these valves with high-pressure gas connections and shall have a bull nose cylinder valve connection for cylinder coupling.
- d) The reticulation gas supply tubing from the gas storage area to the laboratories shall be standard, metric, seamless, stainless-steel grade 304, 304 L, 316 or 316 L as scheduled for the specific gases and shall be suitable to weld or connecting with proprietary manufactured, two ferrule, threaded connectors.
- e) The tubing shall be supported to ensure that no strain is imposed on any component in the system. Vibration isolation mountings shall be provided for all vibration inducing equipment and associated pipework. Isolators shall be selected to give both horizontal and vertical flexibility (compression and shear). All nuts and bolts shall be either hot dip galvanised or stainless steel, unless otherwise specified. Care must be taken to prevent or mitigate the corrosion caused by dissimilar metal contact on tubing by electrically insulating junctions where possible. Preferably, the tubing routed outside of the building shall be in covered cable trays or pipe ducts up to the perimeter where it enters the building. The routing inside the building should be as such that the gas lines are not routed through the 2-hour fire rated compartments within the building. Refer to the fire rating drawing 0.84/926 in Appendix C for details.
- f) As the gas lines will enter the building through the fire rated brick wall, and likely to be routed below the building ceiling, parallel to the existing gas pipes, the contractor shall identify entrance points (wall opening locations) and specify the required wall opening sizes. The contractor shall repair and fix all modifications made to existing and new infrastructure. The contractor shall ensure that the fire rating for all walls is maintained. Space between pipe and sleeves shall be filled with fiberglass and covered with stainless steel sheet metal plates fixed to the wall. The contractor shall repair and fix all modifications made to existing and new infrastructure. The contractor shall ensure that the fire rating for all walls is maintained.
- g) The *Contractor* shall also be accountable for integration of the new works with the existing work and ensure compliance with the gas regulations such as SANS 10260-1-2004, SANS 10260-3-2004 and SANS 10140. The pressure drop shall be limited to ensure that the pressures detailed in Table 1 and Table 2 are attained at

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- the terminal points.
- h) Preferably, the gas tubing terminal points should be above the Laboratory benches in outlet assemblies, either against the wall or against a fixed vertical cable tray. The terminal points shall be equipped with a main isolation valve for each gas line, and pressure regulators where “room” regulators are required for gases in the Laboratory. As the modification triggers review of zoning of the Laboratories, the *Contractor* shall be accountable for hazardous classification of the areas in terms of SANS 10108.
 - i) All dial pressure gauges shall be glycerine filled to prevent pointer vibrations and shall have accuracy of 2%. The range shall extend to 150% of the maximum operating pressure. Where air/gas flow needs to be measured, it shall be by means of an in-line orifice, or venturi tube and differential pressure gauge normally calibrated in litres/min with 5% accuracy.

3.4.3 Gas Fumes Extraction System

The gas extraction systems of the clean, oil and clean laboratory that will be installed under this project.

scope of work shall consist of a typical gas extraction canopy illustrated in Figure 5 below, equipped with ducting to enable disposal of the gases to the atmosphere, extraction fans, isolation valves and all other necessary components.

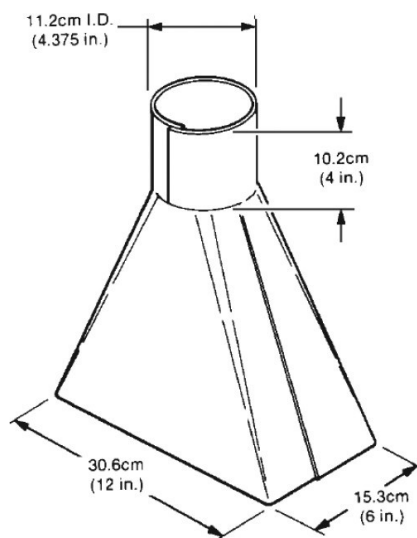


Figure 4: Dimensions for the extraction canopy.

The canopy must be able to extend up and down by at least 200mm. The installation shall be such that the operator of the system can lower and raise the canopy without injury.

Typical gas extraction rates for both extraction canopies are detailed in Table 4 below. Exhaust systems are to be chemically resistant.

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Table 4: Typical Gas fumes extraction rates

Fume extraction system	
Extraction rate	7000-9000L/min
Working exhaust temperature	Capable to handling fumes up to 85 degrees Celsius
Fume general composition	Combustion gases

The gas fumes extraction systems shall also be equipped with low flow alarm. Flow alarm shall be triggered when the flow drops below 6900 L/min. To re-enable the system, the flow needs to return to above 7000L/min and only resume once the alarm is manually reset by a laboratory operator.

In addition to the above requirements, the extraction system shall have an ON/OFF switch to allow the laboratory personnel to turn off the extraction system when desired. A visible signal shall indicate to the operator of the system whether it is in the ON or OFF state.

The ducting materials and construction shall be in a way that it can operate safely and efficiently. The extraction fans shall be located outside on top of the building. Refer to drawing No: 0.84/925 sheet 8.

3.4.4 Dust Extraction and HVAC design

The water treatment Plant building has an existing HVAC system providing cooling, ventilation, and pressurization to both the Coal Sample Preparation Room and Oil Lab. The *Contractor* shall ensure that any modifications comply with Eskom standards 240-70164623: Design Guideline for HVAC in the Eskom Coal Fired Power Stations and 240-102547991: General Technical Specification for HVAC Systems.

The *Contractor* is required to carry out detail design and installation based on the *Employer's* Concept Design (below) for acceptance. The *Contractor* is to carry out this work in accordance with the requirements and standards indicated in the document and with the required legal and statutory requirements. The contractor is permitted to use best practice engineering solution and make reasonable assumptions to complete the *Works*. The *Contractor* may supply alternatives from the *Employer's* Concept Design provided the main option is also provided.

1. The detailed design report including the following:
 - a. Detailed design report signed off by ECSA professional registered engineer/technologist.
 - b. Hydraulic Analysis of the system (dust extraction system)
 - c. Operating and Control Philosophy
 - d. Design drawings: Piping and Instrumentations, isometrics, general arrangement, ducting and layout drawings, as built drawings.

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2. The installation includes:

- a. Construction management
- b. Engineering
- c. Supply (All equipment for the design at worst case condition)
- d. Workshop fabrication and assembly
- e. Testing
- f. Signage
- g. All the consumables required for commissioning.
- h. Cold Commissioning
- i. Hot Commissioning

3.4.5 Employer's Concept Design

Refer to the concept drawings Figure 7, Figure 8 and Figure 9.

- a) The Mechanical concept is an independent dust extraction system.
- b) Power supply to extraction system shall be from the existing supplies.
- c) The *Contractor* is responsible for all other systems that are required but are not listed above to achieve a fully functional dust extraction system.

3.4.6 Air Compressor

The compressed air shall be supplied from a stand-alone compressor capable of operating in an outside environment and suitable for the process and explained in this document. The routing of the compressed air piping must be determined by the *Contractor* and submitted to the *Employer* for *Employer's* approval before carrying out detailed design calculations. The *Contractor's* design must include sizing of all proposed equipment (piping, valves, and other necessary mechanical equipment) as well as a hydraulic analysis for the system demonstrating necessary calculations.

All work part of the *Contractor's* compressed air design must comply with the latest revision of the standards listed section on section 5 and under appendix D.

3.4.7 Mechanical Technical Requirements

- a) Gas tubing, flow and pressure regulations shall be supplied and met according to the specified instrument requirements and listed in Table 1 and Table 2.
- b) Air compressor shall supply dry instrument air in accordance with Eskom compressed air standard 240-105929225.
- c) The gas fumes Extraction Systems shall extract fumes at the coal, clean and oil lab created by the AAS, carbon and ash instruments and spectra oil instruments.
- d) The Dust Extraction System shall extract all the coal dust created in the coal

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grinding room by the Abrasiveness and Hardgrove Index.

3.5 ELECTRICAL REQUIREMENTS FOR LABORATORY MODIFICATIONS

The Contractor shall as part of the scope, design and supply the electrical works required for the efficient, safe, and cost-effective usage thereof.

3.5.1 Terminal Boundary

The scope of the *Contractor* is from the switchgear, cabling and up to the tie-in and/or plug points.

The coal lab has an existing Distribution Box to be re-mounted in the coal drying room from the coal grinding room. The electrical supplies are to be split.

3.5.2 Clean and Oil Lab electrical scope of work

- a) Based on the 2 × fume extractor sizes, the *Contractor* shall size the power requirement. The *Contractor* shall supply all cabling and cable racking including all associated tools and equipment to mount and install the supply cable to the instruments and the switchgear as per the Medupi Power Station Cabling and Racking Standard 200-11768.
- b) Power requirements for the fume extraction system should be from the essential power supply. Therefore, a normal 230 V switch for the alarm system can be considered.
- c) All power supply requirements for the equipment will be supplied by means of an Aux Power Schedule to be submitted by the *Contractor* to the *Project Manager* and for *Employer's* review and acceptance.
- d) The *Contractor* shall provide normal household (three-point plug) electrical supply for the AAS instrument, and the computer associated to the instrument.
- e) Two (2x 230V), three-point electrical switches supplied from the UPS system shall be provided in the clean laboratory to enable powering of the PC's that come with AAS instrument. Additionally, one (1 X 207-253 VAC, 30A 47-63 Hz, Single phase electrical point) supplied from the UPS shall be provided.

3.5.3 Coal Lab electrical scope of work

Power supply and lighting on the new room.

The existing power supply points are to be extended to provide connection points for all equipment listed in Table 5 below.

The power requirements are tabulated on Table 5 below:

Table 5: Coal Preparation Equipment Power Demand

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Equipment ³	Voltage	W
2x Abrasiveness Index ⁴	380V, 5.9A	-
1x Hardgrove Index	220V	300
1x Test Sieve and Sieve shaker	220V	200
1x Jaw Crusher	220V	1500
1x Cone and quartering sampler	220V	200
1x Cross Beta Mill ⁵	220V	1100

3.5.4 Electrical Equipment Rating

All coal lab electrical connections are in accordance with risk classification for hazardous locations. Ex-rated (explosion proof) electrical equipment connections requirements will be determined by the *Contractor* and the scope is to be executed by the *Contractor*.

3.5.5 Compliance to electrical standards

The *Contractor* shall comply to the following electrical standards for execution of the electrical works, or any international standard stipulated in deviation schedule:

- The electrical designs, manufacturing, construction, and installations are done in accordance with SANS 10142-1 (The wiring of premises part 1: Low voltage installation).
- Selection of electrical apparatus to be installed in the stator coolant plant is done in accordance with SANS 10108.
- The power cables and cable racks are done in accordance with 240-56227443 (Requirements for Control and Power Cables for Power Stations Standard).
- Earthing and lightning protection is done in accordance with the Earthing and Lightning Protection Standard (240-56356396).
- Test the motors and provided certificates as per the procurement of power station low voltage motors specification 240-57617975.
- Conduct an earth continuity test and provide certification for quality controls.
- Conduct insulation resistance and provide certification for quality records.
- Produce all documentation and drawings for approval by the *Employer*.

3.5.6 General Requirements for Electrical Works

- The *Contractor* reuses the existing cable racking as far as possible. New cable racks will only be considered where the existing cable racks cannot be utilised. The *Contractor* informs the *Employer* where new racks are required for approval before implementation.
- Ensure new equipment is interfacing with all the other system requirements of

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- the plant/installation.
- c) Test the cables and provided certificate.
- d) Develop, finalise, and implement the optimised cable routing.
- e) Produce exact cable routing designs of all the cables.
- f) Cater for cable servitudes and cable racking.
- g) Implement all cable routing designs as approved.
- h) Implement all cable terminations.
- i) Conduct an earth continuity test and provide certification for quality controls.
- j) Produce all documentation and drawings for approval by the *Employer*.

3.6 CONTROL AND INSTRUMENTATION REQUIREMENTS FOR LAB MODIFICATION

The fire detection is installed in the current lab and additional fire detection shall be installed and linked to the current system and shall be done by the *Contractor*. The access control is installed in the current lab and an additional access control shall be installed on the new door; the works shall be done by the *Contractor*. The *Contractor* is to ensure the designed and installed double door can be fitted with magnetic locking devices. The dust extraction systems are installed with control panel for local operation.

The Contractor shall be responsible for updating the below documentation as a minimum:

- a) Operating philosophy
- b) Drive and actuator schedule
- c) LoSS Diagrams
- d) IO function Blocks
- e) Wiring/Termination drawings
- f) Proposed or redlined MIMIC diagrams
- g) Loop drawings
- h) Cable schedules
- i) IO configuration
- j) IO Functional Distribution and expandability reports
- k) Signal mapping and logics
- l) Splitter box/Junction box GA and Location Drawings

3.6.1 General Requirements for the C&I Works

- a) The *Contractor* provides all equipment and services and executes all *works*

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- to fulfil all requirements specified in this Works Information.
- b) The *works* complies with professional engineering practice and standards for fossil fuel power plants and is designed for the environmental conditions prevailing at Medupi Power Station Site.
 - c) The documentation requirements which form part of the *works* are defined with the *Contractor* in line with Documentation requirements in section 6.5 at the inception of the project.
 - d) The Contractor shall comply to the Employer's Control and Instrumentation Standards and guidelines listed under section 5 Table.8 in all aspects of the works listed on this work specification.
 - e) All C&I and CBMS Works required shall be implemented by an ECSA professionally registered C&I Engineer(s)/Technologist(s).

3.7 CIVIL REQUIREMENTS FOR LABORATORY MODIFICATIONS

3.7.1 Clean and Oil laboratories scope of work

The identified gas line routing with the proposed mounting positions and hardware (detailed calculations pertaining to forces acting on the existing structure where applicable) as well as the required wall opening size and locations shall be submitted to *Employer* for review and approval. This shall be accompanied with a method statement for closing of all openings and all the relevant product specifications and technical data sheets. All external walls of the buildings are 2-hour fire rated, which will be a requirement for the proposed product to seal the openings.

The *Contractor* shall ensure that all work executed complies with the related gas regulations such as SANS 10260-1-2004, SANS 10260-3-2004 and SANS 10140.

3.7.2 Coal Laboratory scope of work

- a) The passage next to the coal laboratory shall be changed into a room.
- b) The new created room shall be fixed with flooring and the ceiling to prevent any dust ingress into the nearby rooms and instruments including the furnaces and ovens.
- c) The ceiling shall be provided on both the existing preparation room and the newly created room to prevent coal dust ingress into the HVAC ducting and the nearby room.
- d) The floor shall be stripped of the carpet and be coated with concrete protective coat that is suitable for coal and coal dust. The floor shall be non-slippery.
- e) The walls and ceiling shall be coated with dark colours such as grey or similar paint colour that will also prevent the coal dust sticking on the walls.
- f) The wall opening for ducting shall be sealed for coal dust ingress.
- g) The new double door to be opened and installed for the coal grinding room after removal of the glass for re-use.
- h) All doors of the coal grinding and coal drying rooms to be 2-hour fire rated

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doors. Any opening to the coal laboratory to be 2-hour fire rated as well. The existing fire protection layout drawing 0.84/926 sheet 1 to be updated to reflect the changes as implemented as per the requirement of this Technical Specification.

3.8 HCL DOSING SYSTEM

The existing hydrochloric acid (HCl) dosing system utilises a removable flowbin as a dosing tank unlike the other semi-bulk chemicals. During operation, the flow bin lid is loosened by the operator to keep the flowbins/dosing tank at atmospheric pressure to prevent flow bin implosion. When the flow bin lid is loosened, concentrated hydrochloric acid fumes are released into the surrounding area.

The HCl system requires modification by adding a dosing tank that will have all necessary equipment and accessories to enable automatic operation of the system. The HCl flow bin offloading is elevated for gravity feed into a dosing tank. Both the HCl dosing tank vent and offloading bin should be routed to a scrubbing system to mitigate a risk of releasing corrosive fumes into the atmosphere.

In addition to the venting and scrubbing of the system, the following is required:

- A junction box for the purpose of the HCl dosing tank level instrument
- A tank level transmitter
- Cables between the instrument and the JB and the DCS
- Commission the signal from the level transmitter to the DCS

The dosing tank shall meet the following requirements:

- Thermoplastic tanks code DVS 2205-2
- The tank's flange nozzles shall be designed to comply with SABS 1123, Table 1000
- A drain valve and instrument nozzle for level transmitter
- Lifting lugs for the tanks must be adequate for the application
- One inspection hatch or manhole

3.9 NAOCL FUMES

The Sodium hypochlorite (NaOCl) system is located next to the HCl and utilises a flowbins as well. The contents of the flowbins are then transferred into a mixing/solution dosing tank. During the transfers from the flowbins, the lid is loosened to prevent implosion of the flowbin. Fumes are then released both on the flowbins and the dosing tank.

Both the NaOCl dosing tank vent and offloading flowbin should be routed to a scrubbing system to mitigate a risk of releasing corrosive fumes into the atmosphere. The bund wall

between the HCl and NaOCl systems must be raised by 1m to prevent possible mixing of the two chemicals in case of spillage.

A NaOCl scrubbing system that can be fitted onto the flowbin and the dosing tank. The design of the system shall be fitted within or near the exiting semi-bulk chemicals bundled areas. The associated interconnecting piping and valves. The pipework shall comply with the standards stipulated in the OHS Act for piping carrying hazardous chemicals.

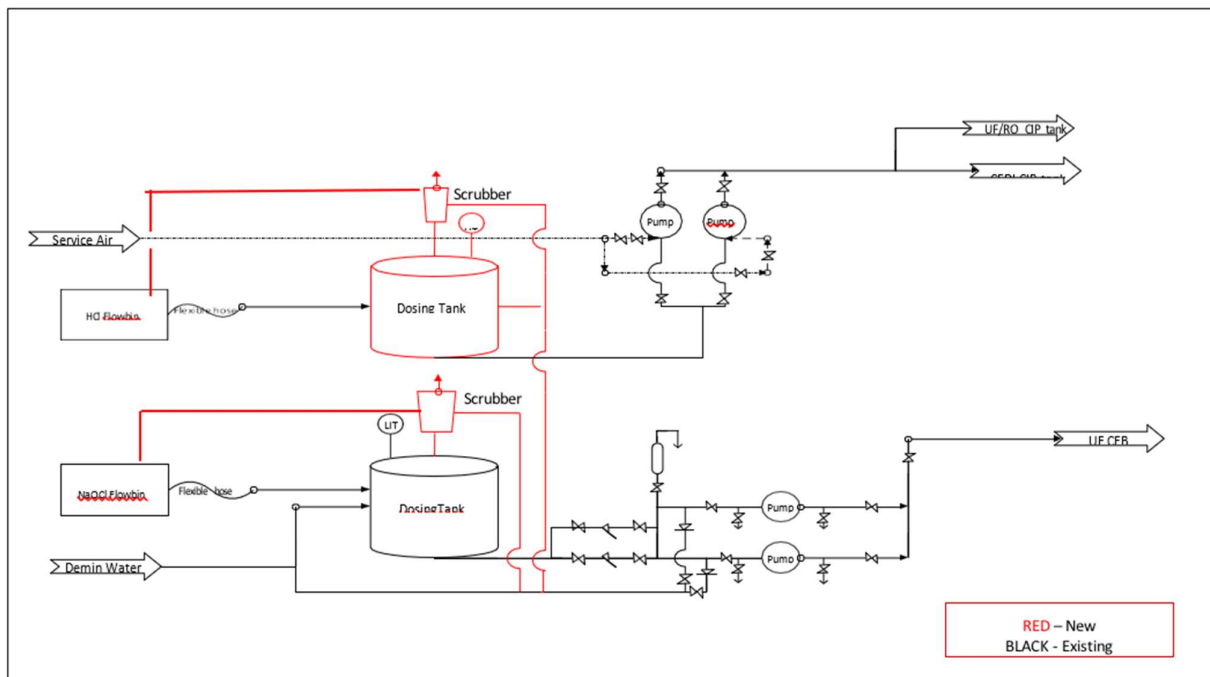


Figure 5: HCL and NaOCl systems concept.

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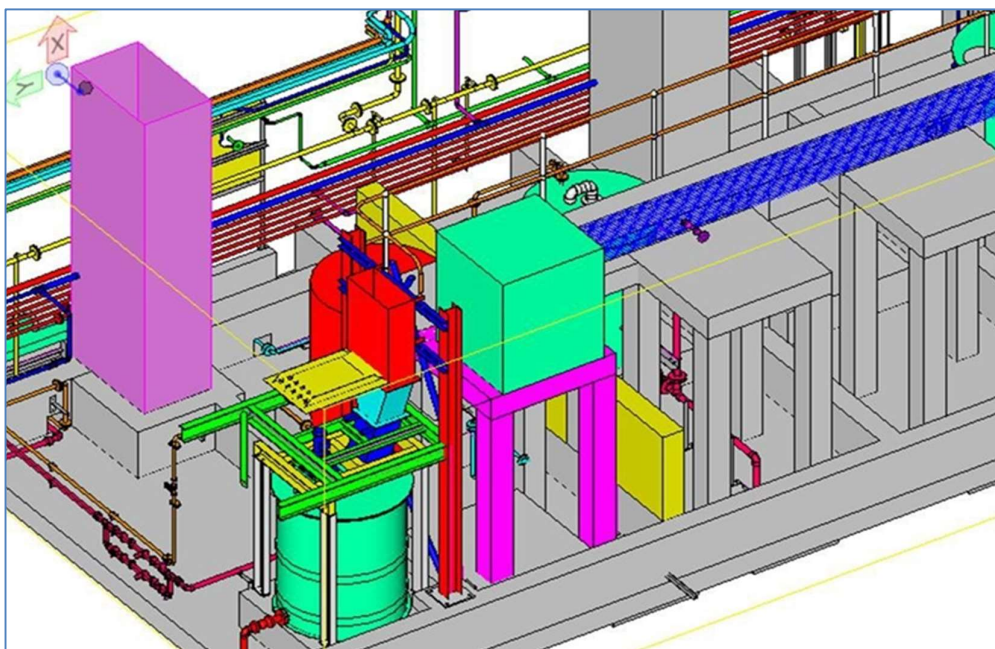


Figure 6: Concept model of civil requirements (platform and diving wall)

3.10 HCL AND NAOCL SCOPE OF WORK

The semi-bulk chemical systems are situated outside the WTP building. The *Contractor* shall design the HCl and NaOCl chemical system that consists of:

HCl system

- HCl dosing tank with a useable/pumpable volume of 2m³ (2000L). The system shall have transfer pipework from the HCl flow bin to the dosing tank. The tank shall have an inspection hole, overflow line, drain line. The tanks shall comply with thermoplastic tanks code; DVS 2205-2 code. The tank flange nozzles shall be designed to comply with SABS 1123, Table 1000. The tank shall also have a drain valve and an instrument nozzle for the level transmitter. Lifting lugs for the tank shall be adequate for application. The tank shall have at least one inspection Hatch/1 Manhole.
- The HCl dosing tank shall be equipped with a level measurement transmitter that will be used to monitor the level in the tank. The level transmitter shall be displayed on the WTP DCS.
- A HCl scrubbing system that can be fitted onto the flowbin and the dosing tank. The design of the system shall be fitted within or near the exiting semi-bulk chemicals bundled areas.
- The associated interconnecting piping and valves. The pipework shall comply with the standards stipulated in the OHS Act for piping carrying hazardous chemicals.
- All equipment such as tank, scrubber, valves, and piping shall be compatible with 35 % HCl. Suitable Material of construction to be considered which is compatible

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- with 35% HCl.
- f) The HCl tank and scrubbing system will be located within in the existing HCl bund. A civil guide drawing is made available in Appendix E for the bund details.
 - g) The control philosophy for the HCl dosing system shall be such that when the low level of 10-30% has been reached, the DCS will prompt the operator to initiate topping up the tank. The operator can then manually connect a full flow bin and empty its contents into the dosing tank. Topping up of the dosing tank will be done until the high level of 90% is reached.

NaOCl system

- a) A NaOCl scrubbing system that can be fitted onto the flowbin and the dosing tank. The design of the system shall be fitted within or near the exiting semi-bulk chemicals bunded areas.
- b) The associated interconnecting piping and valves. The pipework shall comply with the standards stipulated in the OHS Act for piping carrying hazardous chemicals.

3.10.1 Control and Instrumentation Specifications

The existing infrastructure is limited to accommodate additional signals. The *Contractor* shall:

- a) Procure and supply a junction box (JB) for the purposes of the HCl dosing tank level instrument.
- b) The *Contractor* shall design, procure, supply and shall install a tank level transmitter.
- c) *Contractor* to pull cables between the instrumentation to the JB and to the DCS.
- d) *Contractor* shall commission the signal from the level transmitter to the DCS.
- e) The Contractor shall comply to the Employer's Control and Instrumentation Standards and guidelines listed under section 5 Table.8 in all aspects of the works listed under on this work specification.
- f) All C&I Works required in this technical specification document shall be implemented by an ECSA professionally registered C&I Engineer(s)/Technologist(s).

3.10.2 Civil and Structural Specifications

- a) Any supporting infrastructure and/or plinths required for the tanks, scrubbers, pipes, C&I and Electrical Equipment etc.
- b) The *Contractor* shall build a 1m bund wall between the HCl and NaOCl systems.
- c) Structural changes shall consider existing infrastructure and relevant plant drawings are available from the *Employer* under Confidentiality and non-disclosure agreement.

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3.11 CORRODED COMPONENTS REPLACEMENT

Due to the operation of the HCl and NaOCl systems as mentioned above, when the flow bin lids are loosened, concentrated hydrochloric acid and sodium hypochlorite fumes are released into the surrounding area. The HCl and NaOCl fumes are hazardous and if inhaled, they can be detrimental to human health. They have also resulted in extensive corrosion in the vicinity of these tanks.

The corroded components scope addresses the observed external corrosion and damage on the plant and equipment. The scope boundary is:

- a) All the carbon steel equipment/piping situated in the semi-bulk chemical storage bund areas (inside and outside the WTP Building) is to be replaced with materials of construction that are compatible with chloride (HCl or NaOCl). The contractor may consider suitable materials of construction which are “plastic” in nature”, i.e. polypropylene or HDPE or PVC. The selected materials are to be readily available in RSA market, replaceable by maintenance personnel (does not required expert skills) and long-life (consider longevity of the plant for a lifetime of 50 years). The list of carbon steel pipelines with piping accessories, and isometric drawings of the pipelines are included in Appendix I.
- b) All Stainless-steel piping and tubing need to be pickled and passivated (externally or outside surface of the piping and tubing) to mitigate the impact of external corrosion. The list of stainless-steel pipelines with piping accessories, and isometric drawings of the pipelines are included in Appendix I. Data sheet for the valves is provided in Appendix K.
- c) KKS labels in the semi-bulk area to be replaced by graflux type material. The list of KKS labels that need to be replaced are listed in Table 7. All KKS tags shall comply with the KKS coding standard/specification 200-3340 KKS Coding and Labelling KKS01 Rev 4.
- d) Cable racks, conduits and pipe supports in and around the semi-bulk area are to be replaced.
- e) Impulse piping to the pressure transmitters, supports and conduits in and around the semi- bulk area are to be replaced.

New equipment is required as detailed below:

SMBS storage, transfer, and dosing pumps:

All the mechanical equipment situated in and around the SMBS system chemical bund (inside and outside the WTP Building) is to be replaced with new ones excluding the storage tanks, the dissolving/dilution tanks, HDPE piping, the SMBS analyser and its canopy and junction/distribution box and control panels for the pumps. The flanges, washers, nuts, and bolts on the HDPE piping need to be replaced. The piping from the discharge of the SMBS transfer pumps as highlighted in Figures 17 and 18 in Appendix I are to be replaced. The demin water piping is to be pickled and passivated and the demin water piping accessories such as valves, pumps, flanges, washers, nuts, and bolts in this bund are to be replaced. The air distribution manifold for the semi-bulk chemicals 0 0QFL64 AT001 including the associated valves, situated inside the SMBS chemical bund are to be replaced as well. The SMBS dissolving tank mixer motor 0 0GDN70 AM001-M01, safety shower and eye washer next to the SMBS bund, 0 0GKC10AT045/59 and

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their associated piping and valves need to be replaced. The pipe supports also need to be replaced. The datasheet for the valves is included in Appendix K and that for the mixer motor is included in Appendix L.

NaCl dosing system

All the mechanical equipment situated in and around the NaCl system chemical bund (inside and outside the WTP Building) is to be replaced with new ones excluding the mixing tank, HDPE piping, junction/distribution box and control panel for the pumps. The flanges, washers, nuts, and bolts on the HDPE piping also need to be replaced. The demin water piping is to be pickled and passivated and the demin water piping accessories such as valves, flanges, washers, nuts, and bolts in these bunds also needs to be replaced. Sodium chloride mix tank mixer motor 0 0GDN65 AM001-M01 and all the pipe supports in the bund also need to be replaced. The datasheet for the valves is included in Appendix K and that for the mixer motor is included in Appendix L.

NaOCl dosing system

All the mechanical equipment situated in the NaOCl system chemical bund (inside and outside the WTP Building) is to be replaced with new ones excluding the storage tank, the dilution tank and PVC piping. The flanges, washers nuts and bolts on the PVC piping also need to be replaced. The demin water piping is to be pickled and passivated and the demin water piping accessories such as valves, flanges, washers, nuts, and bolts in these bunds also needs to be replaced. The handrail (Galvanised) and pipe supports (galvanised and compatible with equipment) also need to be replaced.

TTA dosing system

The nuts and bolts on the mixing tanks, piping, pipe clamps, flanges, washers, nuts, and bolts on the HDPE piping are to be replaced. The demin water piping is to be pickled and passivated and the

demin water piping accessories such as valves, flanges, washers, nuts, and bolts also need to be replaced. The datasheet for the valves is included in Appendix K.

TSP dosing system

The nuts and bolts on the mixing tanks, piping, pipe clamps, flanges, nuts, and bolts on the HDPE piping are to be replaced. The demin water piping is to be pickled and passivated and the demin water piping accessories such as valves, flanges, washers, nuts and bolts also need to be replaced. The datasheet for the valves is included in Appendix K.

Coagulant dosing system

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The demin water piping is to be pickled and passivated and the demin water line pipe supports and its accessories such as valves, flanges, washers, nuts, and bolts are to be replaced.

Antiscalant

The demin water piping is to be pickled and passivated and the demin water line accessories such as valves, flanges, washers, nuts are to be replaced.

3.11.1 Electrical Requirements for corroded components

The Contractor shall be responsible for the procurement, delivery to Medupi Site, storage and installation of the electrical equipment required for the plant process. This will include the supports required for the equipment.

The Contractor shall be responsible for all the electrical construction activities. This excludes the feed source supply boards as supplied by Eskom.

The Contractor shall supply all cabling and cable racking including all associated tools and equipment to mount and install the supply cable to the pumps and instruments as per the Medupi Power Station Cabling and Racking Standard 200-11768. This includes, but is not limited to, the following sections of the works:

- a) All required electrical cabling from equipment to the power source. The current installed cables will be cut back by 10m from the equipment side and be joined on the existing cable racks in the water treatment plant. Table 6 shows the electrical supplies affected by the corrosion on the area.
- b) Conduit supports and cable rack design for all the electrical cabling are to be replaced. Due to the high chemical corrosion in the area the cable conduit, racking and supports shall be fabricated with a chemical resistant material.
- c) Cable routing from the source to all supplied equipment, will be supplied by Eskom.

Table 6: Current installed electrical cables

Equipment KKS	Description	Supply cable size
=0 0GDN20 AP021 -M01	CUSTIC TRF PUMP 2 MOTOR	3x6 mm ² + 1x6 mm ² (BVX04FCM) 2x2.5 mm ² (BVX02DCM)
=0 0GDN60 AP061 -M01	HYPOCHLORITE DSG PUMP 2 MOTOR	3x4.0 mm ² + 1x4.0 mm ² (BVX04ECM)
=0 0GDN65 AP041 -M01	SODIUM CHLORIDE TRF PUMP 2 MOTOR	3x4 mm ² + 1x4 mm ² (BVX04ECM) 2x4 mm ² (BVX02ECM)

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=0 0GDN20 AP001 -M01	CAUSTIC TRF PUMP 1 MOTOR	3x6 mm ² + 1x6 mm ² (BVX04FCM) 2x2.5 mm ² (BVX02DCM)
=0 0GDN60 AP051 -M01	HYPOCHLORITE DSG PUMP 1 MOTOR	3x4.0 mm ² + 1x4.0 mm ² (BVX04ECM)
=0 0GDN65 AP031 -M01	SODIUM CHLORIDE TRF PUMP 1 MOTOR	3x4 mm ² + 1x4 mm ² (BVX04ECM) 2x4 mm ² (BVX02ECM)

The Contractor shall supply and install new earthing to all the pumps, instruments, and structures in the semi-bulk area within specification of the Medupi Earthing and Lightning Protection Standard 200-11757. The Contractor shall provide earthing certificates for these works.

Eskom as well as the Contractor shall measure compliance of the construction as per accepted inspections and testing procedures under the Eskom Quality management system as outlined in section 3.5 of this document.

3.11.1.1 Earthing and lightning protection

- The *Contractor* implements the correct earthing concept for reliable operation as per 240-56356396.
- The *Contractor* correctly earths the metal casings of instruments to the earth mat to avoid any electromagnetic interference which may arise from such things as portable FM transmitters, cell phones and other equipment used on site in the vicinity of the plant.
- All C&I and electrical system equipment shall be earthed to the station earth point (clean earth).
- All metal instrument casings shall be properly earthed (grounded) to the earth mat to avoid any electromagnetic interference which may arise from portable RF transmitters, cell phones and other equipment used on the plant.
- All earthing required to eliminate any interference shall be provided by the *Contractor* within the Works.

3.11.2 Control and Instrumentation Requirements

The Contractor shall be responsible for the design, procurement, delivery to Medupi Site, storage and installation of the C&I equipment required for the plant process. This will include the supports required for the equipment.

The contract shall replace the following C&I equipment:

- Impulse and capillary tubes around the semi-bulk chemical systems including

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those to the pressure and level transmitters 0 0GDN70 CL001, 0 0GDN70 CP001, 0 0GDN70 CP005, 0 0GDN70 CL011, 0 0GDN70 CF541, 0 0GDN70 CP08 and 0 0GDN70 CP083.

- b) Racking and conduits around the semi-bulk chemical systems.
- c) Structural support of all C&I equipment's around the semi-bulk chemical systems.
- d) The Contractor shall comply to the Employer's Control and Instrumentation Standards and guidelines listed under section 5 Table.8 in all aspects of the works listed under section 3.
- e) All C&I Works required should be implemented by an ECSA professionally registered C&I Engineer(s)/Technologist(s).

3.11.3 Configuration Management Requirements

The KKS tags for the equipment and instruments in the table below in are to be replaced. The new KKS tags are to be made of graflux material of construction. All KKS tags shall comply with the KKS coding standard/specification 200-3340 KKS Coding and Labelling KKS01 Rev 4.

Table 7: KKS labels for replacement

KKS	Long Description	Short Description
Instrument Air		
0 0QFL64 AA501	SODIUM CHLORIDE MIX TANK DISWTR INLET IV IA IV	Na MIX TNK DWTR INLV IA IV
0 0QFL64 AA502	HYDROCHLORIC ACID PUMP 1 SERVICE AIR IV IA IV	HCL PMP 1 S/A V U IA IV
0 0QFL64 AA503	HYDROCHLORIC ACID PUMP 2 SERVICE AIR VALVE UNIT IA IV	HCL PMP 2 S/A V U IA IV
0 0QFL64 AA504	SMBS DISSOLVING TANK DISWTR INLET IV IA IV	SMBS DSLV TNK DWTR INLV IA IV
0 0QFL64 AA505	SMBS DISSOLVING TANK 1 OUTLET IV IA IV	SMBS DSLV TNK 1 OUT IV IA IV
0 0QFL64 AA506	SMBS TO RO FLUSHING IV 1 UNIT IA IV	SMBS RO FLSH IV 1 U IA IV
0 0QFL64 AA507	SMBS STORAGE TANK 1 INLET IV IA IV	SMBS STRG TNK 1 INLV U IA IV
0 0QFL64 AT001	SEMI BULK CHEMICAL DSG IA WTR TRAP	CHEM DSG IA WTR TRAP
0 0QFL64 AA401	SEMI BULK CHEMICAL DSG IA DV	CHEM DSG IA DV
SMBS		

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0 0GDK45 AA481	SMBS DISSOLVING TANK DISWTR INLET DV	SMBS DSLV TNK DISWTR INL DV
0 0GDN70 CL001	SMBS DISSOLVING TANK LEVEL TRANSMITTER	SMBS DSLV TNK LTX
0 0GDN70 AA201	SMBS DISSOLVING TANK OUTLET IV UNIT	SMBS DSLV TNK IV OUT U
0 0GDN70 AA501	SMBS TRF PUMP 1 SUCTION IV	SMSB TRF 1 SUC IV
0 0GDN70 AA303	SMBS TRF PUMP 1 DELIVERY PTX IV	SMBS TRF 1 PTX IV
0 0GDN70 AA601	SMSB TRF PUMP 1 DELIVERY PTX IV	SMBS TRF MPM 1 PTX IV
0 0GDN70 AA601	SMBS TRF PUMP 1 DELIVERY NRV	SMBS TRF PMP 1 DELY NRV
0 0GDN70 AA503	SMBS TRF PUMP1 DELIVERY IV	SMSBS TRF PMP 1 DELY IV
0 0GDN70 AA505	SMBS TRF PUMP 2 SUCTION IV	SMBS TRF PMP 2 SUC IV
0 0GDN70 AA605	SMBS TRF PUMP 2 DELIVERY NRV	SMBS TRF PMP 2 DELY NRV
0 0GDN70 AA507	SMBS TRF PUMP 2 DELIVERY IV	SMBS TRF PMP 2 DELY IV
0 0GDN70 AA411	SMBS STORAGE TANK DV	SMBS STOR TNK DV
0 0GDN70 AA291	SMBS TO RO FLUSHING IV 1 UNIT	SMBS RO FLSH IV 1 U
0 0GDN70 BR001	SMBS DISSOLVING TANK BAG LOADER	SMBS DSLV TNK BAG LD
0 0GKC10 AA545	SMBS DSG PUMP AREA SAFETY SHOWER 1 WTR IV	SMBS SFTY SHWR 1 WTR IV
0 0GKC10 AT045	SMBS DSG PUMP AREA SAFETY SHOWER 1	SMBS SFTY SHWR 1
0 0GKC10 AA559	SMBS DSG PUMP AREA SAFETY SHOWER 2 WTR IV	SMBS SFTY SHWR 2 WTR IV
0 0GKC10 AT059	SMBS DSG PUMP AREA SAFETY SHOWER 2	SMBS SFTY SHWR 2
NaCl		
0 0GDK45 AA478	SODIUM CHLORIDE MIX TANK DISWTR INLET DV	NaCL MIX TNK DISWTR INL DV
0 0GDK45 AA278	SODIUM CHLORIDE MIX TANK DISWTR INLET IV	NaCL MIX TNK DISWTR INL IV
0 0GDN65 CL001	SODIUM CHLORIDE MIX TANK LEVEL TRANSMITTER	SODIUM CL MIX TNK LTX
0 0GDN65 BR001	SODIUM CHLORIDE MIX TANK BAG LOADER	SODIUM CL MIX TNK BAG LD

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0 0GDN65 AA511	SODIUM CHLORIDE MIX TANK OUTLET IV 1	SODIUM CL MIX TNK IV 1
0 0GDN65 AA521	SODIUM CHLORIDE MIX TANK OUTLET IV 3	SODIUM CL MIX TNK IV 3
0 0GDN65 AT021	SODIUM CHLORIDE MIX TANK OUTLET STRAINER 2	SODIUM CL MIX TNK STNR 2
0 0GDN65 AA523	SODIUM CHLORIDE MIX TANK OUTLET IV 4	SODIUM CL MIX TNK IV 4
TTA		
0 0GDN51 AA503	TOLYLTRIAZOLE MIX TANK INLET IV	TTA MIX TNK INL IV
TSP		
0 0GDN50 AA503	TRI-SODIUM PHOSPHATE MIX TANK INLET IV	TSP MIX TNK INL IV
Antiscalant		
0 0GDN55 AA501	ANTISCALANT FLOW BIN OUTLET IV	AS FLOW BIN OUT IV
0 0GDN55 AM011	ANTISCALANT MIX TANK MIXER	AS MIX TNK 1 MIX
0 0GDN55 AM011 - M01	ANTISCALANT MIX TANK MIXER MOTOR	AS MIX TNK 1 MIX MTR

3.12 POTABLE WATER DISINFECTION (CLO2)

Chlorine gas was initially chosen as a preferred disinfectant for the potable water production system. However, the continuation of disinfecting with Chlorine gas could lead to formation of carcinogenic Trihalomethanes (THMs), and Haloacetic acids (HAAs) when reacting with natural organic matter in water that is consistently high in the reclaimed station drains water and Crocodile-west stream. Chlorine dioxide gas was thereafter selected as the preferred disinfectant.

Potable water is produced from 55% Ultrafiltration permeate and 45% Reverse Osmosis 1st permeate. The combined water will then be disinfected with chlorine dioxide and mixed to ensure uniform composition of potable water. The water is then sent to the potable water tanks 00GDK11 BB001/011.

The chlorine dioxide for potable water disinfection system is to be designed and installed for potable water flow of 538 m³/hr such that, automatic dosing of chlorine maintains a 0.7 to 3 mg/L as residual chlorine in the potable water distribution system. The existing chlorine building is to be used for potable disinfection system, chlorine dioxide.

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The chlorine demand of the water needs to be confirmed. Water analyses must be performed to determine the chlorine demand seasonal fluctuations and impact by the power station's effluent water that is recovered into the water treatment plant. The chlorine dioxide sizing must be based on the worst-case scenario.

The following specifications are required for the potable water disinfection system:

- a) A chlorine dioxide purity of greater than 95%.
- b) The conversion of the input raw materials should be greater than 96%, to ensure that low waste generated, and the unreacted materials are recycled.
- c) The chlorine dioxide system shall be in the existing chlorine building. Chlorine dioxide in potable water shall be monitored using the existing analyser.
- d) A handheld portable residual chlorine analyser shall also be supplied to measure the chlorine concentration in the disinfected water on terminal point TP 06-21-270 and a grab sample shall be provided for alternative sampling. Sampling system for the chlorine dioxide shall be in accordance with SANS52671:2021.

The Contractor shall assess for chlorine dioxide demand on the water quality. The Contractor is responsible for the confirmation of the chlorine demand. The Contractor will perform water analysis and accommodate seasonal changes to finalise the chlorine demand. The basis of design shall take into consideration the chlorine dioxide demands seasonal variability of the stream, as the Crocodile-west water quality changes seasonally and the stations effluent water. The size of the chlorine dioxide system shall be based on a worst-case scenario demand test obtained.

The desired typical process drawing for the system is given in appendix E. The 25NB piping from the flanged terminal point TP 06-XX-01 inside the chlorine building to the dosing point has already been installed by Others. The Contractor is to tie into this terminal point pipe from the chlorine dioxide system.

The potable disinfection system scope is:

- a) The existing chlorine room is designated for chlorine dioxide (partitioned into two rooms).
- b) The dosing point connection is in the room.

3.12.1 Mechanical Requirements

- a) The scope is to design, supply and install piping, pressure gauges, valves, supports, vessels/storage tanks, pump, reactor, filters, and all associated mechanical equipment.
- b) All pipework, vessels/storage tanks, reactor shall be of appropriate material of construction for the chemicals that will be used in this system.

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3.12.2 Control and Instrumentation Requirements

- a) The *Contractor* shall be responsible for the C&I works within the scope of work.
- b) The control and automation functionality, alarm indication, human machine interface, information system for the system shall be engineered and provided in the Programmable Logic Controller (PLC) by the *Contractor*.
- c) The residual chlorine analyser will be displayed on the HMI in the WTP DCS as shown in Appendix G.
- d) *Contractor* shall pull the cable/s from the *Contractor's* PLC to the DCS.
- e) The *Contractor* shall make use of the existing signal for the potable water tanks outlet free chlorine analyser (00GDK08CQ001) to send milli Amp (mA) signal to and display the residual chlorine analyser concentration on the WTP DCS. Refer to Appendix F for the limit of scope and supply (LOSS).
- f) The earthing applied by the *Contractor* shall be based on recognised best engineering practices and shall ensure the safe and reliable operation of the C&I systems and the protection of the electronic equipment against damaging transients.
- g) The Contractor shall comply to the Employer's Control and Instrumentation Standards and guidelines listed under section 5 Table.8 in all aspects of the works listed under section 3.
- h) All C&I Works required in this technical specification document shall be implemented by an ECSA professionally registered C&I Engineer(s)/Technologist(s).

3.12.3 Electrical Requirements

The *Contractor* shall as part of the scope, design and supply the electrical works required for the efficient, safe, and cost-effective usage thereof.

- a) The current power supply in the building is a 230V, 25A feeding the chlorine system thermal shut off valve control panel.
- b) The *Contractor* shall specify the electrical requirements for the chlorine dioxide system by means of an Auxiliary power schedule if any new equipment will be used. A typical template for the auxiliary power schedule is given in Appendix H.
- c) The *Contractor* shall be responsible for all the electrical works including earthing.

3.12.4 Civil and Structural Requirements

The *Contractor* shall be responsible for all civil and structural works. The existing chlorine building was constructed by *Others* and available information is listed in Appendix E.

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Any changes that impact the installed civil works (including HVAC in the building), the *Contractor* shall inform the *Employer* and accordingly, the Medupi Project engineering change processes shall apply.

3.13 CPP MEASURING TANKS VENTING

The CPP regeneration measure tanks for the sodium hydroxide and sulfuric acid are used to transfer both chemicals to the CPP regeneration station for the purpose of regeneration of the CPP resin. The vent lines for both above-mentioned tanks are connected back to their respective bulk supply tanks in the WTP. During overflow of these tanks the chemicals move to the vent piping and tend to stop on the low points of the vents pipeline as the piping is channelled through the trenches before it reaches the bulk supply tanks. The chemical sitting on the low points on the vent line prevent proper venting on both measure tanks as a result over pressurisation is experienced during filling, which can cause significant damage, compromising the integrity of the tank, and incurring potentially costly repairs. The inadequate venting system also affect the measure tank level. Incorrect measure tank level can lead to inefficient cation resin regeneration, which will lead to poor cycle chemistry and chemistry induced plant failures consequently.



Figure 7: Sulfuric acid measure tank vent line to the sulfuric acid bulk storage tank.

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Figure 8: CPP regen caustic measure tank, vent line connected back to the caustic bulk storage tank.

3.14 RO PH CONTROL

Medupi Power Station receives bulk sulfuric acid at 98% concentration and dilutes it to 30%. The diluted sulfuric acid is pumped to the Reverse Osmosis stage 1 (RO1) feed pump common suction header pipe. Sodium hydroxide is received at 45% concentration and stored on the bulk storage tank and diluted to 30% concentration. The diluted sodium hydroxide is pumped to Reverse Osmosis stage 2 (RO2) feed pump common header line. Reverse Osmosis (RO) requires sulfuric acid and caustic dosing for pH control to dissolve Carbon Dioxide (CO_2) gas to bicarbonate (HCO_3). The existing RO dosing pumps are oversized and results in overdosing of the chemicals into the system, and the desired and optimum pH required by operations not being met. To achieve the desired pH on RO – using the existing pumps, two extra dilution tanks will be required to further dilute both the caustic and acid to (3 – 10 %) concentration depending on the quality of the feed.

- a) To achieve the desired pH on RO the caustic and sulfuric acid will require further dilution from 30% concentration to approximately (3 – 10%) concentration for both chemicals. Therefore, both chemicals will require their own dilution tanks to achieve this.
- b) For sulfuric acid, provision shall be made to pump 30% diluted sulfuric acid from any of the two existing 30%, 10m³ dilution tanks, to the envisioned 1.5m³ sulfuric acid tank. Therefore, there should be a demin water supply line to the new dilution tanks. The dilution tank shall be equipped with a mixer, a level and temperature transmitter and a conductivity meter to measure the strength of the chemical after mixing. The dilution tank shall be supplied with two dosing pumps (one duty and one stand by). The dosing pumps shall be used to pump acid from the existing dilution tank to the 1.5m³ dilution tank. The system should be controlled on the DCS.

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- c) For caustic, provision shall be made to pump 30% diluted sulfuric acid from any of the two existing 10m³ dilution tanks, to the envisioned 1.5m³ sulfuric acid tank. Therefore, there should be a demin water supply line to the new dilution tank. The dilution tank shall be equipped with a mixer, a level, and a conductivity meter to measure the strength of the chemical after mixing. The dilution tank shall be supplied with two dosing pumps (one duty and one stand by). The dosing pumps shall be used to pump acid from the existing dilution tank to the 1.5m³ dilution tank. The system should be controlled on the DCS.
- d) Both tanks shall be sized in a way that they will both fit in the available chemical bund area. A properly constructed platform and access shall be provided to safely access the tanks if required. A suitable material of construction shall be selected for both tanks considering both chemicals.
- e) All equipment such as tanks, scrubbers, valves, and piping shall be compatible with 3-10% Sulfuric acid and 3-10% caustic. Suitable Material of construction to be considered which is compatible with both chemicals.
- f) The control philosophies for both dilution systems shall be such that when the low level of 10-30% has been reached, the DCS will prompt the operator to initiate automatic topping up the tank.
- g) The selected materials are to be readily available in RSA market, replaceable by maintenance personnel (does not required expert skills) and long-life (consider longevity of the plant for a lifetime of 50 years).
- h) The design as well as the works are to be overseen by a Contractor's Professional process/mechanical engineer/technologist and reviewed by Employer for acceptance.

3.15 UF CONTROL VALVES

The Ultra Filtration (UF) is used to remove suspended solids, colloidal matter, bacteria, some viruses, and some macromolecules by filtration, using membranes. The flow to the UF Skids from the feed pumps need to be regulated depending on the number of Skids and pumps in operation. The current system relies on the UF flow control valves per skid (00GDB01/02/03/04 AA001), however the control valves are not correctly sized which leads to excessive back pressure on the UF skids. The required design feed flow per skid is 410m³/h.

The Contractor shall correctly size and install the UF control valves to meet the operational inlet flow of 410m³/h per skid. The design as well as the works are to be overseen by the Contractor's Professional process/mechanical engineer/technologist and reviewed by Employer for acceptance.

3.15.1 Control and Instrumentation Requirements

The existing infrastructure is limited to accommodate additional signals. The *Contractor* shall:

- a) Procure and supply a junction box (JB) for the purpose of both sulfuric acid and caustic dilution tanks level, temperature instruments and conductivity analysers.
- b) Procure, supply, and install a tank level, temperature transmitters and conductivity analysers.
- c) *Contractor* shall pull cables between the instrumentation to the JB and to the DCS.
- d) *Contractor* commission the signal from the level, temperature transmitter and the conductivity signal to the DCS.
- e) Procure and install impulse and capillary tubes around the caustic and sulfuric chemical bund area for the new instruments.
- f) Racking and conduits around the caustic and sulfuric chemical bund area.
- g) Structural support of all C&I equipment's around the caustic and sulfuric chemical bund area.
- h) Interface to the DCS.
- i) The Contractor shall comply to the Employer's Control and Instrumentation Standards and guidelines listed under section 5 Table.8 in all aspects of the works listed under section 3.
- j) All C&I Works required in this technical specification document shall be implemented by an ECSA professionally registered C&I Engineer(s)/Technologist(s).

The Contractor shall be responsible for updating the below documentation as a minimum:

- Operating philosophy
- Drive and actuator schedule
- LoSS Diagrams
- IO function Blocks
- Wiring/Termination drawings
- Proposed or redlined MIMIC diagrams
- Loop drawings
- Cable schedules
- IO configuration
- IO Functional Distribution and expandability reports
- Signal mapping and logics
- Splitter box/Junction box GA and Location Drawings

The Contractor shall implement the DCS interfaces using the above input documentation. Design, construction, and commissioning of the DCS interfaces shall be based on the relevant LoSS diagrams.

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The Control and Instrumentation (C&I) interfaces shall comply to the standards and guidelines listed on table 8.

C& I Safety Requirements:

- a) No individual C&I fault shall endanger the safety of the people or plant or jeopardise the integrity of major plant.
- b) The earthing concept applied by the Contractor shall be based on recognised best engineering practices and shall ensure the safe and reliable operation of the C&I systems and the protection of the electronic equipment against damaging transients.

3.16 ELECTRICAL REQUIREMENTS FOR RO PH CONTROL, CPP MEASURE TANKS AND UF CONTROL VALVES

- a) The Contractor shall be responsible for procurement, delivery to Medupi Site, storage and installation of the electrical equipment required for the plant process. This will include the supports required for the equipment, transportation of motors and storage shall adhere Storage of power station electric motors (240-56360387) and transport of power station electric motors (240-56361435).
- b) The contractor shall design, supply, and install correct size cables to feed all the pump motors, with additional E-stop cables. All cables accessories shall be included. Cable selection, testing, routing, and cable racking shall be done in accordance with Eskom requirement for Control and Power cables for power station (240-56227443).
- c) The contractor shall determine the best cable route to the loads by making use of existing racks where applicable.
- d) Upon installation of cables, contractor shall reseal any fire sealing damage by installation of cables.
- e) The contractor shall design, supply and install correct size buckets for the switchgear that will power up all the pumps, all design and installation shall adhere to LV Switchgear control gear assembly associated equipment for voltage 1000V and 1500V standard (240-56227516). Bucket must include interface for Emergency stopping and DCS connection. All protection elements of design must adhere to MV and LV Protection standard (240-56357424) and IEC 255 for protection relays.
- f) The *Contractor* shall supply and install new earthing to all the pumps, instruments and structures adhering to the Medupi Earthing and Lightning Protection Standard (240-56356396) The *Contractor* shall provide earthing certificates for these works. Eskom as well as the *Contractor* shall measure compliance of the construction as per accepted inspections and testing procedures under the Eskom Quality management system.
- g) The contract shall update labels on the switchgear where installation occurred following the Eskom KKS Standard.
- h) Electrical power supply allocation will be done by the employer, contractor shall have to use the allocated point for supply to design and install their buckets.
- i) The contractor shall develop termination schedules that will be incorporated with the existing schedules. Templates to be used for termination schedules (240-

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77302094).

- j) The contractors shall be responsible for all electrical construction activities, and they shall ensure that all outdoor electrical equipment is weatherproof with the correct IP Rating.
- k) The plant shall be designed using and system approach to ensure satisfactory performance of all its system, all electrical equipment necessary for safe operation and efficient working.

3.16.1 General Electrical requirements

- a) Ensure new equipment is interfacing with all the other system requirements of the plant/installation.
- b) The electrical designs, manufacturing, construction and installations are done in accordance with SANS 10142-1 (The wiring of premises part 1: Low voltage installation).
- c) Test the motors and provided certificates as per the procurement of power station low voltage motors specification 240-57617975
- d) Conduct an earth continuity test and provide certification for quality controls.
- e) Conduct insulation resistance and provide certification for quality records.
- f) Produce all documentation and drawings for approval by the *Employer*.
- g) The selected equipment must be able to withstand harsh and environment.

3.16.2 Earthing, Lightning, and Electrical Protection

- a) All C&I system equipment shall be earthed to the station earth point.
- b) All metal instrument casings shall be properly earthed (grounded) to the earth mat to avoid any electromagnetic interference which may arise from portable RF transmitters, cell phones and other equipment used on the plant.
- c) All earthing required to eliminate any interference shall be provided.
- d) All field cables and network cables shall be earthed (grounded). The cables shall be earthed at one end or both ends depending on the interference signal and shall comply with an overall recognized earthing arrangement.
- e) Lightning and Surge protection shall be included in all the circuits where there is exposure to potential lightning.
- f) All earthing and surge protection shall as a minimum be in accordance with the following standards and specifications:
 - SANS 10142-Part 1 - The Wiring of Premises Part 1: Low-voltage installations.
 - 240-55714363 - Coal Fired Power Stations Lighting and Small Power Installation Standard.
 - 240-56356396 – Earthing and Lightning Standard

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3.16.3 Requirements Related to Maintainability

- a) The components installed shall be protected from the harsh or hazardous power plant environment.
- b) The Contractor shall ensure that the installation of the transmitters:
 - Allow for safe and easy access for maintenance and calibration.
 - Allow for the environmental conditions.
 - Allow for the removal of equipment for maintenance in the vicinity of the transducer.
- c) Emergency plans shall be provided for system failures and faults such that appropriate measures can be taken immediately without having to first analyse the cause of the failure.

3.17 CIVIL REQUIREMENTS FOR THE RO, PH CONTROL, CPP MEASURE TANKS, AND UF CONTROL VALVES

- Any supporting infrastructure and/or plinths required for scrubbers, tanks, pumps, pipes, C&I and Electrical Equipment etc.
- Structural changes shall consider existing infrastructure and relevant plant drawings are available from the *Employer* under Confidentiality and non-disclosure agreement.

3.18 EFFLUENT NEUTRALISATION SUMP PUMPING SYSTEM UPGRADE

The ENS system currently receives all effluent from the WTP, including process streams that were designed to be recovered back. This includes the low conductivity effluent from the CPP regeneration plant which was designed to be recycled for reprocessing through the PDRT system and UF backwash which should be recycled through clarifiers. The process drains recovery water and the CPP low conductivity regeneration flush are supposed to be directed to the PDRT for further processing. The PDRT system is undergoing modifications and is currently not available. These two streams present additional effluent routed to the ENS which was not considered in the design of the ENS. The UF backwash which is recoverable to the clarifier is being diverted to the ENS whilst the clarifier is being commissioned.

There are frequent cleans on the RO and CEDI units due to the deteriorating feedwater quality further impacting the volumetric inflow into the system.

The ENS system currently takes ± 6 hours to neutralize the sump and further 8 hours to discharge. Given the higher than design volume of liquid effluent being sent to the ENS, there is an increase in the risk of spilling effluent from the ENS, resulting in a possible Water Use License condition violation. Ideally, the neutralization of the sump contents and the emptying of the sump must take a maximum of 2,5 hours each.

The *Works* include the decommissioning, removal of the current ENS system, the installation of the temporary pumping system to keep the sumps operational, the design,

manufacture, construction, commissioning, and testing of the new piping system and pumping required for the Water Treatment Plant Effluent Neutralisation System (ENS).

The scope includes, as a minimum:

1. Provision of a temporary effluent sump mixing (neutralization) and discharge system that will be utilized during the decommissioning of the currently installed system, as well as during the installation and commissioning of the new system.
2. The sizing and selection of the pumping and piping system that can meet the requirements of mixing and emptying the effluent pump contents to the designated discharge point in the required time.
3. The mechanical design of the system must take into consideration available space in the sump pump pit, all pipe routing, and flows.
4. The mechanical connections necessary for the interfacing with the existing plant, for the sump discharge, including the tie-ins at the designated discharge.
5. The tie-ins to the existing plant must be designed with double isolations to prevent contamination as well as ensure compliance with Eskom Permit to Work System.
6. The electrical design of the plant includes load schedules, cabling, and associated protections.
7. The loading of the proposed pumps and motors (*Contractor* takes into cognizance that the sump pump pit is equipped with a 1.5-ton crawl beam).
8. A civil design inclusive of pipe support details, pump bases, etc.
9. Documentation including detailed drawings, design calculations, operating manuals, maintenance manuals, test certificates, signed quality control plans, equipment specifications, and commissioning procedures.

The *Contractor* completes the detailed design for all areas of the *Works* as specified above. All drawings provided with this *Employer's Works* Information are for information only and any validation required will be the responsibility of the *Contractor*. Wherever changes are made to the existing infrastructure, it remains the responsibility of the *Contractor* to update all the existing drawings of those areas to an as-built status.

3.18.1 BATTERY LIMITS

3.18.1.1 CIVIL BATTERY LIMITS

The *Contractor* makes use of existing pipe racks and pipe trenches for laying discharge lines, where possible. The pipe supports are included in the *Contractor's* scope as well as new plinths if required.

3.18.1.2 CONTROL AND INSTRUMENTATION BATTERY LIMITS

The *Contractor* installs all actuators and instrumentation, with associated cabling installed from the field to the control system. This includes the provision of junction boxes, etc. as

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may be required to fulfil the scope requirements for both new and existing instruments and drives that will be re-used.

3.18.1.3 ELECTRICAL BATTERY LIMITS

The *Contractor* will be responsible for the provision of the electrical interface. The *Contractor* will also be responsible for cable route identification and termination. All fieldwork will be the responsibility of the *Contractor*, up to and including cabling to the switchgear room at a location/source provided by the *Employer*.

3.18.1.4 MECHANICAL BATTERY LIMITS

The *Contractor* will be responsible for the installation of the mechanical equipment for the system. The *Contractor* shall also be responsible for interfacing with the existing plant to do the tie-ins that are required as part of the *Work*.

- a. Terminal Point A - Upstream of the Inlet to the ENS (refer to drawing number 0.84/4717)
- b. Terminal Point B - Downstream of the Outlet from the ENS (refer to drawing number 0.84/4717)

Where any ambiguities on the battery limits exist, clarification should be sort during the tender phase.

3.18.2 EMPLOYER'S ENGINEERING DESIGN

The design of the water balance and effluent from the WTP was originally conceptualised as a small volume of effluent of 40,72m³/hr. The original design catered for 2x50 m³/hr pumps with a 3rd pump added later for the CPP regen effluent. The WTP effluent was originally designed to be neutralized in a 2x 1000m³ sump.

The design was then changed to a 2x 500m³ sump with a 1200m³ tank (brine concentrate) as a buffer. This tank has never been interconnected and has never been used. The effluent is currently discharged to the dirty water tank 2.

The ENS has no moving parts and is a large sump. Any potential upgrade on the pumping systems should cater for the currently installed plant and limit any additional equipment to maintain or increase the frequency of shutting down of the plant.

The WTP has experienced numerous challenges and downtime because of the issues/challenges on the ENS system. The pumping out of the effluent is limiting operations, and thus, a change of the pumps is required in:

1. Providing a high pumping capacity to empty a compartment of the sump once neutralized in a time of 2,5 hrs or less.
2. Providing a redundant system such that not all pumps are required to be in operation at the same time.

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3. Providing an efficient neutralization system that will be completed in 2,5 hrs or less as the other compartment is emptied.

The design required is:

- New 3×200 m³/hr pumps to replace the 3×50 m³/hr pumps. 2 x pumps in operation (one operating in recirculation/neutralization and one discharging from the sump) and 1x pump on standby.
- Utilize the existing pump's location and installation as per Appendix M.

3.18.3 WORKS FUNCTION AND PERFORMANCE REQUIREMENTS

The design life of the *Works* shall be a minimum of 50 years from the commissioning of the *Works*.

- (1) The system must require minimum operator intervention.
- (2) The following modes of operation are available; automatic, remote manual, local manual and local maintenance.
- (3) The normal mode of operation of the pumps will be the automatic mode.
- (4) The process(s) shall have requisite alarms and protections to ensure that the pumps are neutralizing at a rate sufficient to ensure the pH requirements of the contents are met and that the pumps are discharging at the rates necessary to ensure the sump doesn't overflow.
- (5) The system is equipped with redundancy to cater for maintenance on the plant.
- (6) The contents of the sump are neutralized in one compartment in less than 2.5 hours and the discharging in the second compartment is done within 2.5 hours from full (100%) to empty (5%).
- (7) Neither sump compartments overflow during the operations outlined above.

3.18.4 CONTRACTOR'S DESIGN

The *Contractor* shall be responsible for the design, manufacture, procurement, factory acceptance testing, delivery to site, off-loading, erection, installation, site testing and commissioning of all Plant and Materials required for ensuring a fully functional system.

The *Contractor* takes into consideration the Employer's concept design and functional requirements as stated in Section 3.2 during the design of the new pumping and piping system. It remains the *Contractor's* responsibility to provide a design and installed system that can neutralize the contents of the effluent sump in ≤ 2.5 hours or better and discharge the sump in ≤ 2.5 hours without exceeding the capacity of the sump and subsequently overflowing the sump. Thus, the Contractor ensures that his design fulfils the stated requirements.

- (1) The *Contractor* shall be responsible for decommissioning the existing ENS pumping system. The *Works* shall include the removal of existing pumps and all equipment around (C&I cable, power, instrument, etc.) for the construction of

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- new plinths (if required) and the installation of new pumps with their piping and support structures.
- (2) The *Contractor* shall be responsible to provide a temporary pumping system (pumps and piping) required to be used during the construction and commissioning phases of the new ENS pumping and piping system. The systems must empty the sump in 2.5 hours. The *Contractor* is responsible for emptying the sump and ensuring that no spillages of the effluent occurs.
 - (3) The *Contractor* shall be responsible for new pumps, piping and its support structures design, manufacturing, supply, installation, quality assurance, commissioning, and handover of this project.
 - (4) The *Contractor* shall be responsible for permanently relocating the existing ENS pH analysers from the pit to a safe and accessible location on ground level. Please refer to Appendix D for flow specifications.
 - (5) The *Contractor* shall be responsible for the design, installation, commissioning, and testing of all equipment (cable, cable racks, supports, and canopy) required for the protection and operation of pH analysers in a new location.
 - (6) The *Contractor* shall be responsible for the design, supply, installation, and commissioning of the power cables necessary to power up the newly selected pumps.
 - (7) All designs are to be reviewed and accepted by the *Employer* before any installations/construction.
 - (8) The *Contractor's* site establishment is to commence once the design is accepted, and the project is ready for execution.
 - (9) The *Contractor* will ensure that all waste generated during the execution phase of the project will be managed following Medupi Power Station's existing waste management process.
 - (10) The *Contractor* shall be responsible alongside the *Employer's* representatives for, Factory Acceptance Testing (FAT), Site Integration Testing (SIT) and Commissioning of the new plant installations. Contractor provides a minimum of 7 days' notice to ensure that the relevant representatives are available.
 - a. The *Contractor* conducts a FAT for the pumps to fulfil the *works*. The FAT shall be conducted before installation in the presence of the *Employer's* representatives.
 - b. The *Contractor* conducts an SIT (upon successful completion of the FAT) at Medupi Power Station to prove the plant provided before connecting to the process. The *Contractor* provides an SIT procedure (including all tests to be performed) to the *Employer* for acceptance before the SIT.
 - c. The *Contractor* continues with commissioning after the successful completion of the SIT.
 - d. The *Contractor* provides all procedures, test/commissioning reports and certificates.
 - e. The *Contractor* shall provide commissioning procedures for all disciplines (C&I, electrical and mechanical).
 - (11) The *Contractor* shall provide the *Employer* with all relevant documentation applicable to the new installations as stated in this document. A vendor document

submittal schedule (VDSS) is presented and agreed with the Employer at the kick-off meeting to ensure that the expectations of documents to be produced during the project is understood by both parties.

The *Contractor* is to design the system as per the design criteria listed below:

- a. Install 3×200m³/hr discharge pumps on the ENS as determined by the Employer's concept design. The *Contractor* does his design and calculations to confirm the pump sizing that fulfils the scope requirements.
- b. Neutralization mixing rate at a level at which overflow will not occur.
- c. Redundancy in the pumping system.
- d. The sump must be emptied in ≤ 2.5 hours.
- e. Existing infrastructure is to be used wherever possible.
- f. The pumps will be interfaced with the existing DCS.
- g. Pumps will be powered by a safe reliable electrical supply.
- h. All monitoring is to be done by the Outside Plant (BOP) DCS.
- i. The pump and piping material of construction must be suitable for pH fluctuating (Ranges from 1 to 14) effluent.
- j. Where-ever possible sample lines are to be routed and sloped gradually downwards from the sample point with a minimum number of bends and joints.
- k. Suitable non-blocking strainers at the suction of the pumps are required.
- l. Design to take into consideration the corrosion specifications listed in the references and added to Appendix B and C

3.18.4.1 MECHANICAL REQUIREMENTS

The scope of work is to replace the existing three (3) pumps with the new bigger pumps whilst using the existing infrastructure. The Works shall include re-designing the current pipes works to accommodate the new pumps.

The works include:

- a. Construction management
- b. Engineering
- c. Supply, delivery, and installation at the site
- d. Workshop fabrication and assembly
- e. Testing
- f. Signage
- g. All the consumables required for commissioning
- h. Cold Commissioning
- i. Hot Commissioning

3.18.4.1.1 Requirements for pumps

The *Contractor* submits the pump data sheets during the tendering phase as well during the design phase. This must be submitted with the design documentation to the *Employer* for acceptance before the construction of the design of the works.

The following minimum requirements apply:

- Pumps are made of materials suitable to handle corrosive materials or lined with a suitable lining as per the Employers' specifications. The corrosion protection of the pumps is to be in line with the Eskom corrosion protection specification GAM/MAT/22/173 which is attached in Appendix C.
- All centrifugal pumps are fitted with mechanical seals.
- All pumps are self-priming, with a proven design and construction suitable for the intended purpose.
- All pump and motor moving parts are adequately guarded in terms of the OHS Act No 85 of 1993. Pumps are complete with all necessary vents, drains, priming valves, foundation bolts and anti-vibration mountings.
- Pressure indicators conditions are to be accessed if replacement is required for the use of the pump discharges after pressure sustaining valves.
- Preference must be given to locally manufactured pumps, to facilitate timeous spares procurement.
- All pumps are capable of running continuously without overheating. The certified performance curves of the pumps are submitted to the *Employer* for acceptance and are provided for use after the commissioning of the works.
- The materials of construction for the pumps must be suitable for the water and environment it is in contact with, the environmental conditions. The contractor should analyse the water quality and the environmental conditions.
- All pumps and motors for the works are numbered for identification purposes.
- Pumping systems shall be designed to be energy efficient.
- A full set of pump characteristics is to be provided for approval by the *Employer*. Pumps shall be selected such that they run within 5% forward and 10% backward from the pumps' best efficiency point (BEP). High-efficiency motor and an IP55 enclosure variable speed drive, which shall be integrated with the motor. Drives shall not be enclosed within the control panel.
- Pumps are to conform to 240-56030558 - Centrifugal Pumps Specification
- The *Contractor* provides the following minimum pump information to the Employer:
 - o Recommended spare list
 - o Part list of the pump and part number
 - o Pump curves and system curves indicate the pump duty point

- o Pump assembly and disassembly procedure
- o Maintenance procedure (including the routine maintenance of the pump)
- o Pressure delivery rate and discharge pressure
- o 100% redundancy of feed pipelines and their pumps

Table 8: Pump piping pressure specifications

System	Velocity Guideline (m/s)	Pressure Drop - Range kPa/100m	Pressure Rating	Material
Suction Pipework	As per pump guideline	5 to 50	As per contractor design	Compatible to ENS
Discharge Pipework	*Up to 2.5m/s	5 to 50	As per contractor design	Compatible to ENS

3.18.4.1.2 Piping and Associated Equipment

The existing piping is to be used. The *Contractor* shall assess the existing piping system, which is currently discharging to the dirty tank storage (tank 2) to accommodate the new pumps, if required re-design/modify the piping system, to accommodate the new pumps. The *Contractor* needs to price for the new pipes if required.

The *Contractor* submits the pipe data sheets and complete design to the *Employer* for acceptance.

- (1) All the pipework supplied in one contract and complying with this specification is designed, manufactured, fabricated, erected, and tested to comply with the contractually defined latest edition of a single national or international code and its associated standards. Mixing codes from different countries of origin is not acceptable.
- (2) Piping to conform to 240-123801640 - Standard for Low-Pressure Pipelines. All pipes are to be sized to ensure that the process requirement is met with an economically viable and energy-efficient solution. Pipe supports must be provided. All pipe joints are flanged for ease of future maintenance. Pipe flanges are as per the standard SANS 1123 (Pipe Flanges) Type 3 Raised Face.
- (3) The pipeline conforms to environmental regulations.
- (4) Pipes are to follow best practices and be generally as per Code BS EN 13480.
- (5) The design should incorporate the provision for meaningful in-service non-destructive testing during periodic overhauls of the pipeline. The provision and installation of the primary measuring elements for the control and instrumentation conditions will be accessed if require replacement or if the existing one can be used. The provision of all isolating valves and the necessary actuators will be required.
- (6) All pipes are required to be suitable material with regards to chemical compatibility, the *Contractor* determines the required pressure rating of the pipe based on the equipment

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- and pumping system selected. Pipes are required to be sloped and include drain valves to cater for drainage during maintenance and includes isolation valves. Pipes are equipped with vent valves for the purging of air during start-up.
- (7) The pipes are required to include all fittings (bends, expansion joints, etc.) and supports where needed.
 - (8) Pipe supports are to be according to manufacturer specifications and design code EN 13480
 - (9) Pipe sizes are to be selected so that the following maximum permitted velocities or pressure differentials are not exceeded by design or maximum upset conditions.
 - (10) The Contractor submits the pipe data sheets and complete design to the Employer for acceptance.
 - (11) The piping used must be suitable for the environment and the process fluid it is in contact with.
 - (12) Data books, to include all necessary material and test certificates maintained as part of the QA documentation and made available for inspection if so, requested by the Employer.
 - (13) Any steel welding is done as per 240-106628253 Standard for Welding Requirements and 240-83539994 Standard for Non-Destructive Testing (NDT) Requirements on Eskom Plant.
 - (14) Where applicable all joints shall be joined through plastic welding i.e., for new piping or in the case where old HDPE piping is to be connected to new HDPE piping or repaired.
 - (15) All welds shall be backed by an electrically conductive material to enable continuity testing by spark testing.
 - (16) During the welding process, suitable measures shall be taken against any negative effects of the environment (e.g., temperature and the possibility of condensation). Welding shall not be permitted when the ambient temperature is less than 10 °C OR the dew point is <3 °C above the substrate temperature OR the relative humidity RH > 75%.
 - (17) All welds shall be pinhole and defect free and tight after completion of assembly and jointing. The contractor/installer shall perform pinhole detection of all welds using "spark" testing equipment at a voltage setting as per the manufacturer's requirements. Defects shall be recorded and repaired.
 - (18) Upon delivery of the new piping shall be accompanied by a 3.1 inspection certificate as per EN 10204: "Metallic products — Types of inspection documents" The test parameters and acceptance criteria shall be as per those as specified in Table 7 of EN 14879-5, an inspection certificate 3.1 according to EN 10204.
 - (19) The welder's qualifications shall be as per EN 13067, Plastics welding personnel — Qualification testing of welders — Thermoplastic welded assemblies – Group of materials 2 and 4 OR MERSETA Manufacturing, Engineering and Related Services Sector Education and Training Authorities accredited training NQF Level 2 and a minimum of 2 years' experience in a thermoplastic fabrication environment. The supervisor's qualification is as per above and if according to MERSETA then NQF Level 2 and a minimum of 5 years' experience in a thermoplastic fabrication environment.
 - (20) The Contractor applies the necessary corrosion protection layers on all pipes, as per:

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- Eskom Standard 240-106365693 (Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings).
- All pipes are to be painted and labelled as per 240-145581571 (Specification for the Identification of the Contents of Pipelines and Vessels) and
- SANS 10140 (Identification of Colour Markings).

3.18.4.1.3 Valves Requirements

As a minimum, the following valves are required:

- Suction and discharge manual isolation valves per pump
- Discharge non-return valve per pump
- Manual isolation valves per sampling point
- Manual isolation valve per analyser, transmitter, and air release valves
- Pneumatic valves supporting the operation of one neutralizing (recycling back to the neutralization sump), one discharging pump and one standby pump. All three pumps must have the capability to operate as either the recycling, discharging, or standby pump.

The *Contractor* produces a valve schedule on completion of the design of the works and submits it to the *Employer* for acceptance.

The following minimum requirements apply:

- (1) Piping to conform to 240-105020315 Standard for Low-Pressure Valves
- (2) All valves are arranged and positioned at accessible locations to ensure safe, efficient and easy operation and maintenance. The Contractor provides clear access to the valve hand wheels and avoids valve hand wheels being tucked behind other valves or components.
- (3) All valves are of approved design and manufacture and those of similar size, make, and duty are interchangeable with one another. The Contractor complies with the *Employer's* specifications.
- (4) The face of each hand wheel is clearly marked with the words "OPEN" and "SHUT" with relevant direction arrows adjacent to it.
- (5) All valves for the works are numbered for identification purposes.
- (6) The Contractor supplies the following minimum valve information to the Employer:
 - recommended spares list
 - valve assembly and dis-assembly procedure

All critical and emergency stop valves have a fail-safe mechanism. During the design stage, the *Contractor* specifies a fail-safe valve mechanism in positions the Employer deems critical.

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Where the *Contractor* specifies valves not preferred by the *Employer*, it may be accepted by the *Employer* if the valves are a locally supplied product. An application for the deviation must be submitted to the *Employer* for approval.

The materials for the construction of the valves should be compatible with the environment in which the valves will operate. Refer to Appendix C for the corrosion protection specification for these valves.

3.18.4.1.4 Other Mechanical equipment

All pipework, valves and pipe hangers, brackets and supports are arranged in such a manner that they do not obscure the view of any instrumentation or obstruct safe and normal access to panels, switches, etc. The materials for the construction of the pipe supports should be compatible with the environment. Refer to Appendix C for the corrosion protection specification.

Pressure and Flow Measurement

Existing pressure measurement device conditions are to be accessed to verify if a replacement is needed or if it can be used.

Vent/Drain lines

It is preferable to use the existing drain and vents. The *Contractor* must assess the existing vent to verify if it will be suitable for the scope that will be implemented.

Where changes are made, the *Contractor* provides routing drawings of pipes and tubes to be installed under this contract before work commences for the acceptance of the *Employer*.

3.18.5 Corrosion Protection Requirements

The documents most applicable to the scope of work set out in this document are:

- 240-101712128 - Eskom Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings
- 240-106365693 Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings
- ISO 9001: Quality Management Systems – Requirements.
- GAM/MAT/22/173: The Corrosion Protection of The Pumps to Be In line With the Eskom Corrosion Protection Specification
- RTD/MAT/17/60: Medupi Power Station Water Treatment Plant Sulphuric Acid Bund Corrosion Protection Lining.

The Contractor shall clarify any concerns relating to the above specifications and not make assumptions when developing the tender submission.

Documentation and information (specific to this project) to be provided by the *Contractor* shall include:

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- A Quality Management System that meets or exceeds the requirements of ISO 9001. Relevant and applicable certification and the quality management policy are to be submitted. A quality control plan (QCP) should be provided by the Contractor that should align with the *Contractor's* Quality Requirements Specification (QM-58). This QCP will be reviewed by the *Employer* for final acceptance before any work can start
- Name of the applicator, facility, web address, e-mail address, contact telephone number and physical address.
- Provide the latest product and material safety data sheets as well as manufacturing batch certificates for each of the products being proposed.
- The contractor must provide service temperatures, and chemical compatibility for all products used as well as materials of construction, to confirm that the correct material has been used for the environment and will provide longevity as stated in this *work*.
- The contractor must provide case studies for materials to confirm material compatibility as well.
- The Product Data Sheet/s shall be signed by the manufacturer, Contractor, and applicator. The signed Product Data Sheet/s shall be deemed to be part of this standard and any further/other subsequent revisions of the Product Data Sheet/s shall be submitted to Eskom for reacceptance clearly stating the variations/deviations. No further use/application of the related product is permitted until acceptance by Eskom.
- The *Contractor* must provide method statements detailing all steps, procedures, and activities of the corrosion protection application process.
- The *Contractor* must provide detailed Quality Control Plans (QCP's) and shall detail all inspections and tests with acceptance criteria during the application of corrosion protection systems. Inspections during application shall at least cover surface preparation, environmental, parameters, dry film thickness, hardness, adhesion, continuity, and visual tests.
- The *Contractor* must provide a detailed programme showing how the works will be carried out and completed within the time constraints of the project.
- The *Contractor* must provide joint guarantees by the *Coating Manufacture and Applicator and Contractor*. This guarantee with proposed terms and conditions shall perform in the given environment for a minimum period of 10 years
- Provide an organogram, specific to this supply, detailing all the positions and individuals responsible for technical expertise and logistic support.
- The Curriculum vitae of these key personnel shall be included with the submission. Suitably qualified applicators, supervisors and inspectors are considered key in the application process. In this regard details of personnel number, qualification type, level and experience are to be provided as part of the organogram.
- Competent site supervisors qualified to SAQCC (Corrosion Protection) Module PS1 'General Painting Supervisors'.
- Coating applicators/painters qualified to SAQCC (Corrosion Protection) Module PA1 'General Heavy Duty Coatings Applicator'.
- Coating inspectors qualified to SAQCC (Corrosion Protection) 'Coating Inspectors' Level 1 (shop inspections) or Level 2 (site inspections) or NACE Coating Inspection Programme (CIP).

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If no exclusions or qualifications are submitted at the time of tender, the requirements as prescribed in this specification shall apply.

The *Contractor* shall ensure that there is always sufficient suitably qualified, experienced, and skilled staff to carry out and supervise all activities.

The *Contractor* shall have a blast profile gauge, holiday detector test, shore hardness tester, and dry film thickness gauge at the shop/site at all times. The *Contractor* shall also have at the shop/site instrumentation to measure the psychrometric conditions and the substrate temperature. All instrumentation required must have a calibration certificate that is not expired. This must be submitted as part of the tender returnable.

3.18.6 CONTROL AD INSTRUMENTATION REQUIREMENTS

General Requirements for the C&I Works

The existing C&I components are to be used. Some components shall be replaced depending on the conditions.

3.18.6.1 DCS scope

- (1) All required process logic updates, in line with the installed DCS update, will be done by the *Contractor*.
- (2) All additional instrumentation required shall be standardized with the currently installed instruments.
- (3) All additional cables required, whether as a result of the currently installed cables not being in a state to be re-used or the solution necessitates extra cables, shall be provided by the Contractor and should be compliant to 240-56227443 – Requirements for control and power cables for power stations
- (4) The person who will be executing the work should be a professionally registered Engineer/Technologist with an understanding of the ALSPA system if there will be modifications on the DCS (logic and/or IO count). If the works will only be the relocation of the field equipment with no modifications on the instrumentation and controls, a technician with an instrumentation trade test will suffice.

3.18.6.2 Power Supplies

- (1) The power source will be supplied by the employer.
- (2) Cabling from the power source to the load will be provided by the *Contractor*.
- (3) The power source circuit/ bucket will be modified by the *Contractor*.

3.18.6.3 Plant Lifecycle

- (1) As part of the works, the *Contractor shall* provide lifecycle information for all hardware provided to fulfil the *works*. As a minimum, the information must include the current lifecycle of the product (where in its lifecycle it is), a plan for

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future obsolescence and an upgrade/migration path if a product is nearing the end of its lifecycle.

- (2) The *Contractor* shall inform the *Employer* of any plant which cannot meet any lifecycle requirement captured in the works information.

3.18.6.4 Plant Locations

- (1) The location of the plant is as follows:
 - a. The existing pumps are located at the WTP ENS dry sump where pumping is affected. The new pumps will replace the existing pumps in the same location.

3.18.7 ELECTRICAL REQUIREMENTS

Description of electrical scope of work

- (1) The electrical power supply allocation will be done by the Employer.
- (2) The *Contractor* is to design and supply electrical motors coupled to the pumps.
- (3) The *Contractor* shall supply and install the correct size buckets for the switchgear that will supply power to the motors.
- (4) The *Contractor* shall update all labels on the switchgear where installation has occurred following the Eskom KKS Standard.
- (5) The *Contractor* shall determine the cable route to the motors by making use of existing cable racks depending on the conditions if they are damaged replacement will be needed.
- (6) The *Contractor* shall install any scaffolding required to run the cables on the correct cable racks.
- (7) The *Contractor* shall reseal any fire sealing (pyrocote) damaged by the installation of cables.
- (8) The *Contractor* shall procure and install the correct size cables to feed the motors. All cables accessories shall be included.
- (9) The *Employer* shall provide all relevant switchgear documentation once the allocation has been done as per the size of the motors.

Electrical equipment rating requirements

The ENS at which the pumps will be installed is not a classified zone.

3.18.7.1 Compliance with Electrical Standards

The *Contractor* shall comply with the following electrical standards for the execution of the electrical works, or any international standard stipulated in the deviation schedule:

- The electrical designs, manufacturing, construction and installations are done as per SANS 10142-1 (The wiring of premises part 1: Low voltage installation).

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- Earthing and lightning protection shall be done as per the Earthing and Lightning Protection Standard (240-56356396).
- The *Contractor shall* correctly earth the metal casings of instruments to the earth mat to avoid any electromagnetic interference which may arise from such things as portable FM transmitters, cell phones and other equipment used on-site in the vicinity of the plant.
- Standards applicable to electrical Motors installed in a Power Station are to be applied (Storage, transportation, and procurement of motors 240-56360387, 240-56361435 and 240-57617975)
- The cable selection, testing and routing are done as per Eskom Requirements for Control and Power Cables for Power Station (240-56227443)

3.18.7.2 General requirements

The high-level general scope of work for electrical includes:

- Ensure new equipment is interfacing with all the other system requirements of the plant/installation.
- Test the motors and provided a certificate as per the Procurement of Power Station Low voltage motors specification (240-57617975)
- Conduct an earth continuity test and provide certification for quality controls.
- Conduct insulation resistance and provide certification for quality records
- Produce all documentation and drawings for approval by the *Employer*.

3.18.8 CIVIL AND STRUCTURAL REQUIREMENTS

The *Contractor* ensures that the structural integrity of the supporting infrastructures (e.g., concrete floor slab) is not impacted by the newly installed equipment across the sumps.

- (1) The *Contractor* shall assess the existing pump plinths to accommodate the new pump set and if required design, demolish, reconstruct or modify the plinths to accommodate the new pump set.
- (2) The *Contractor* must make sure that all new concrete works are protected where necessary by applying an approved protective coating according to the *RTD/MAT/17/60: Medupi Power Station Water Treatment Plant Sulphuric Acid Bund Corrosion Protection Lining Revision 2* (Option 1 - Coating) in Appendix B.

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- (3) In the pump pit after new plinths for the new pump set are constructed the civil structure shall be corrosion protected to cover at least 1m from the bottom of the pit and pipe routing.
- (4) The design, as well as the works, are to be overseen by a *Contractor's* Professional civil engineer/technologist and reviewed by the *Employer* for acceptance.
- (5) The *Contractor* shall compile a consolidated detailed design report for the civil modifications (if modifications are required) signed by a Professional registered Civil Engineer/Technologist.
- (6) PE certificate signed by a Professional registered Civil Engineer/Technologist for the works completed.
- (7) Detailed drawings for construction are to be submitted for approval by the Employer. All submitted drawings are to be signed by a Professional Civil Engineer/Technologist with the ECSA registration number stated on the drawing.
- (8) Any discrepancy or ambiguity between the *Employer's* Specifications or requirements is immediately brought to the attention of the *Employer* for clarification.
- (9) The *Contractor* is mandated in terms of Construction Regulations 2014: Duties of Designer, 6(1) g to fulfil the duties described therein for the detailed designs done by the *Contractor*. Any risk associated with the *Contractor's* design is highlighted to the *Employer* together with mitigation measures.

3.18.9 Performance Testing after completion

The following criteria as a minimum shall be used during the acceptance tests of the upgraded neutralization sump pumping system.

- The neutralization system shall neutralize the sump contents in ≤ 2.5 hours.
- The new pumping system shall reduce each sump level from 100% to less than 5% in ≤ 2.5 hrs.
- The piping shall be tested if it is capable of handling at least 1.5 x Design Pressure and in line with the ASME B31.3
- All instrumentation shall be calibrated
- A signal check will be performed to verify the plan items.
- All parameters, pressure, and flowrates shall be verified if they are within the ranges specified in the latest revision of the approved control narratives.
- All plant logics, alarms and trip conditions shall be verified to confirm their consistency with the latest revision of the approved control narratives.

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3.19 WTP RAW WATER CLARIFIER OVERFLOW PIPELINES

The water treatment plant clarifier was constructed by package 08 as a civil structure. The mechanical overflow pipes were not included in that package nor any other package. Mechanical designs were created (0.84/58781 and 0.84/61041 sheets 1 and 2) including protective coating specifications (RTD/MAT/21/026) but not implemented.

The Contractor is to design, manufacture, install, and commission the clarifier overflow pipes.

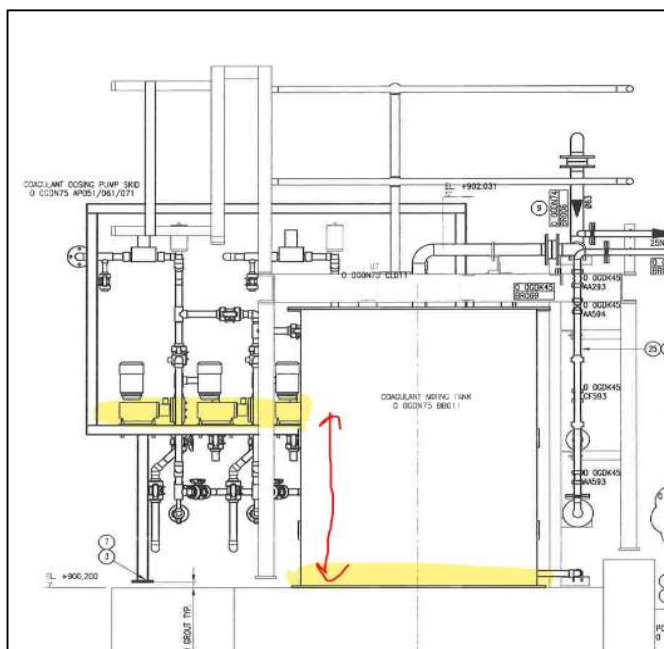
3.20 RELOCATION OF POLYMER AND COAGULANT DOSING POINTS

The dosing pipes of the polymer at the clarifier discharges into the second slow mixing chamber. The Contractor is to extend the polymer dosing points to the first slow mixing chamber and both dosing pipes be fitted with isolation valves. This change will provide an option to increase the polymer residence time and allow for either discharge point to be utilized.

The coagulation dosing point is currently located at the inlet chambers of the clarifiers. The Contractor is to add a dosing point at the common inlet pipe at the base of the inlet chamber.

3.21 LOWERING OF COAGULANT DOSING PUMPS SUCTION

The coagulant dosing pumps suction is placed at approximately 40% of the tank level. Although the pumps are positive displacement pumps, they are unable to pump the coagulant when the level in the tank is below the suction of the pump (see GA figure below). The Employer recommends that the pumps suction is dropped or lowered to below 10% of the tank level to allow for the "Low" 15% alarm and "Low Low" 10% level alarm/interlock to be activated during operation as per the design.



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Figure 9: Coagulant suction pump level

The Contractor is to lower the dosing pumps skid to as closely as possible to the dosing tank discharge pipe level. The Contractor must extend the dosing pumps suction and discharge piping appropriately. The works must be performed without disconnecting any electrical or C&I connections.

The Contractor is responsible for the mechanical, electrical, and C&I integrity of the system after the pumps level has been adjusted.

4. CONFIGURATION MANAGEMENT PLAN

The *Contractor* shall prepare a configuration management (CM) plan utilizing ISO 10007 as a reference guide for the scope of work. The CM plan shall include the following:

- a) A complete and comprehensive description of the Contractor's document numbering conventions and revision schema.
- b) A description of the electronic data management system(s) that the Contractor shall use for the management of documents and/or configuration items.
- c) A description of the configuration management activities which will be undertaken by the Contractor as well as a rough timescale thereof.
- d) A description of the baselines that will be established and the content of these baselines.
- e) The release procedure for product configuration information.
- f) The procedure for the control of changes prior to the establishment of baselines as well as after.
- g) The method for processing changes, emanating both internally and from sub-suppliers.
- h) method for collecting, recording, processing and maintaining the data necessary for producing configuration status accounting records.
- i) The definition of the content and format for all configuration status accounting reports.
- j) A list of audits will be conducted to ensure adherence to the CM plan.

4.1 CONFIGURATION MANAGEMENT

- Drawings shall be submitted in native CAD – and PDF formats.
- Detailed models (where applicable) and calculations pertaining to the design shall be submitted in PDF as well as native format.

As-built drawings shall be submitted in PDF and native CAD formats.

4.2 PLANT DESIGN SYSTEMS

The *Contractor* shall apply the Kraftwerk-Kennzeichensystem (KKS) codification system to uniquely identify the systems, sub-systems and components constituting the Plant.

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The *Contractor* shall apply the following guidelines and standards when codifying plant:

- a) the application of KKS plant coding (NMP 45-7) – 200-4190
- b) KKS Key Part – Fossil power station (NPSZ 45-45) – 200-18202
- c) Issuing of KKS certificate – 200-94660
- d) VGB – B 106 E Part A– KKS Application Commentaries Part A – General
- e) VGB – B 106 E Part B1 – KKS Application Commentaries Part B1_
MechanicalEngineering
- f) VGB – B 106 E Part B2 – KKS Application Commentaries Part B2 - Civil Engineering
- g) VGB – B 106 E Part B3 - KKS Application Commentaries Part
B3_Electrical and C&IEngineering
- h) VGB – B 106 E Part B4 - KKS Application Commentaries Part B4
Identification of C&Iand Control Tasks

The Contractor shall identify all plant indicated or referenced by documentation by the plant's.
unique KKS codes within the documentation itself.

The Contractor shall ensure that the codification assigned to plant is consistently maintained throughout the design cycle, e.g. the KKS codes indicated in the O&M manuals are consistent with the KKS codes indicated in the original process and instrumentation diagram.

The Employer shall supply the Contractor with a system-level plant breakdown structure (PBS) of the existing plant at the Site, as well as a preliminary system-level plant breakdown structure of the plant within the Contractor's scope at contract initiation. The Contractor shall review the PBS to ensure alignment with the Contractor's design philosophy and shall expand the PBS to the complete system level (Fn level of the KKS hierarchy). The Contractor shall provide a complete system-level PBS with the submission of the process flow diagrams of the plant within the Contractor's scope.

The Contractor shall codify all equipment, and any components which are required to be codified as per the guidelines and standards referenced in this document. The Contractor shall indicate equipment and component codification in drawings and documents indicating or referencing such plant.

The Contractor shall submit all KKS codes designated by the Contractor, with the documents in which they were originally designated, to the Employer for review. The Contractor shall remain responsible for ensuring that the codes designated are unique and meet the requirements established by the various standards applicable to the project. Where any ambiguities or doubts with regards to KKS codification exist, the Contractor shall engage the Employer for resolution.

4.3 PLANT LABELLING

The *Contractor* shall manufacture and install labels according to the Medupi Label specification, 200-3340.

Any abbreviations to plant descriptions shall be prepared in accordance to the *Employer's*

abbreviation standard, 200-5343.

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Detailed nameplate or label lists with the service legends and including the KKS Code shall be prepared by the *Contractor* and submitted to the *Employer* for review and comment before commencing the manufacture of the labels. On plant areas where labels do not make ergonomically sense please consult site configuration management for guidance.

4.4 PLANT DESCRIPTION AND DOCUMENTATION

The *Contractor* shall prepare a list of KKS designations allocated to components for each scope of delivery or system (this list will be referred to as equipment list in the rest of this document for simplicity's sake, but includes documents such as cable schedules, valve schedules, etc.). The equipment list shall be submitted with the original implementation documentation describing the design of the system (e.g. process and instrumentation diagram, single line diagram, etc.). The *Contractor* shall ensure that the equipment list accurately represents the implementation documentation which it accompanies. The content of the lists will be agreed to per discipline with the *Employer*. As a minimum, the equipment list shall include:

- a) the KKS designation of all components within the relevant scope or system.
- b) the full verbal description of each component, compiled according to the standards referenced in this document.
- c) the abbreviated description of each component, utilising abbreviations as listed in the referenced project abbreviation list, and abbreviated to a number of characters as required by the project digital control system (DCS) and as per the label requirements in, 200-3340.
- d) the approval status of each component, in alignment with the list of approval statuses specified for document.

4.5 TECHNICAL DOCUMENTATION REQUIREMENTS

On completion of the design work, the *Contractor* shall submit to the *Employer* the following documentation:

- a) The *Contractor* shall compile an integrated design report incorporating the process, mechanical, civil, electrical, and C&I designs. The integrated design report shall be signed by a competent registered engineer/technologist with ECSA.
- b) The *Contractor* shall supply all documented as specified in the Vendor Document Submittal Schedule (VDSS – Document Number 240-85521112).
- c) The following Templates are provided to the *Contractor* and the *Contractor* shall complete the templates as per below and as specified in the VDSS.
- d) 240-72349423 Instrument Schedule
- e) 240-61379755 Drive and Actuator Schedule
- f) 240-72344339 Virtual Signal List
- g) 240-72346360 Load Schedules for UPS Supply
- h) 240-72346591 C&I Defects Check sheet.
- i) 240-72350241 Panel Interface List

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Design and Drawings signed by a competent ECSA registered engineer in line with ECSA requirements, to ensure compliance with the OHS Act regulations, and approved design standards.

5. GENERAL REQUIREMENTS

The Contractor is responsible for the design, procurement, construction, and construction monitoring of all Process/Mechanical, C&I, Electrical Civil and Structural Works. All designs will be submitted to the Employer for review and acceptance, as per the design review procedure (240-53113685). The Contractor's Process/Mechanical, Electrical, C&I, Electrical and Structural/Civil designer shall ensure that the design intent is achieved during construction. Once the construction work is completed, the Contractor's designer will issue the necessary certificates (inclusive PE certificates) and as-built documentation (drawings, native files as well as structural and foundation design reports that includes all calculations).

5.1 INSPECTION

It is required that the Contractor verifies and inspects all existing works to confirm quality and/or any possible required modifications to the existing infrastructure. The contractor shall be responsible for any required testing that the contractor's designer might require for designs.

5.2 CIVIL AND STRUCTURAL GENERAL REQUIREMENTS

5.2.1 Concrete Works

The Contractor shall submit to the Employer concrete mix designs, concrete-mix trial test cube results and all other required test results as indicated in the Medupi Power Station Specification for Structural Concrete (84CIVL053) prior to the placement of any concrete. Concrete mix designs with the required acceptance tests as indicated in the specification (84CIVL053) shall be submitted once reviewed and accepted by the Contractor's structural designer. Where tests results are not within specified limits the Contractor's structural designer shall submit a report with recommendations to the Employer for acceptance. Where the requirements of the specification (84CIVL053) appear to be unclear or ambiguous the Contractor and its designer shall discuss these with the Engineer and make the necessary recommendations in accordance with their specific project conditions.

The Contractor shall also submit to the Engineer for review detailed construction method statements and a quality and test plan prior to the casting of concrete. The Contractor shall submit to the Engineer its inspection and test plans (ITP's) for acceptance. The Engineer will indicate his/her hold and witness points on the ITP. All specified tests and required interventions to be itemized on the ITPs and should be easily linked/referenced to all other technical documents.

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Due to the aggressive environment that the reinforced concrete works are exposed to, the exposure condition of all the reinforced concrete is classified as severe in accordance with SANS 10100-2, hence the quality of concrete works is of paramount importance. To ensure durability of the reinforced concrete works the design and construction of reinforced concrete shall be done in such a way to limit the total concrete crack widths as specified by relevant specifications.

In addition to the tests specified in the specification (84CIVL053), durability index tests shall be performed, if required by the Engineer or the Contractor, to confirm the durability of concrete placed. The durability index tests are developed to assess the transport properties of the concrete cover zone. There are three durability tests, namely Oxygen Permeability Index, Chloride Conductivity test and the Water Sorptivity test.

5.2.2 Structural Steel

The Contractor shall ensure that all conceptual, detailed and final construction drawings are approved as per Eskom's review processes prior to beginning construction and that compliance is maintained to all specifications for material grades that are fabricated and erected. This includes fabrication and erection tolerances, testing parameters and corrosion protection required for steel structures and their supporting elements. The Contractor is also required to submit to the Engineer, steel grade certificates, fabrication drawings, welder's certificates and quality and test plans for review prior to fabrication (refer to Section 3.5 for details).

All structural steel work must be designed, manufactured, and erected in accordance with relevant national specifications and relevant Eskom specifications.

Structural steel used shall be manufactured/fabricated to SABS 1431 or EN 10025.

5.2.3 Integration of Civil Design and Construction

The Contractor is responsible for the integration of the design, procurement, construction, commissioning and certification of all systems, including any modified/altered existing infrastructure. During the concept design phase for the various disciplines and their respective designs, the Contractor shall discuss, agree and integrate with the Employer's Engineers as per the change management processes on Medupi Site.

5.2.4 Design and Construction criteria:

- a) The Contractor shall design and construct the Works in accordance with this Technical specification/SOW, all final reviewed and approved construction drawings, Construction Regulations, Medupi Quality control specifications and the SANS 2001 specifications, as well as all other relevant design and construction SANS and Eskom specifications.
- b) The Contractor shall ensure alignment with respect to degree of accuracy for every interface and where the Employer standards are limited on information shall make use of the relevant SANS and design standards.

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- c) The Works to be provided by the Contractor shall include, but is not limited to all scaffolding, site cranes, lifting equipment and construction vehicles. All excavations, earthworks and terracing as required; all signage required; any modifications required for the use of existing infrastructure (including analysis and certification); and all materials, facilities and samples required to perform inspections, tests and commissioning as per the relevant statutory and regulatory standards and as per this Technical Specification.

Construction Monitoring by Contractor's designer and Professional Engineering Certification by Contractor's designer

5.2.5 Construction monitoring includes but limited to:

- a) Review a sample of each important work procedure and construction material and other technical submissions such as construction method statements, inspection and test plans and quality control and quality assurance plans.
- b) Attending site meetings and maintain adequate presence on the construction site to review samples of works and important completed work prior to enclosure or on completion as appropriate.
- c) Provide the construction team and the Engineer with technical interpretation of the plans and specification when required and checks the construction team's civil works and structures for conformity with design requirements and ensures that design intent is achieved during construction.
- d) General inspection of materials and equipment for compliance with the design documentation for adherence to National and International standards.
- e) Provides the construction team with updated design documentation (drawings and specifications) where changes are required to ensure integration with existing works and where design changes are required due to unforeseen site conditions.
- f) Prepares and, on completion of the works, provides the Employer with As-Built drawings and a final (updated) design report signed by the Contractor's ECSA registered professional person.
- g) Certifies the works as complete and that design intent is achieved during construction by issuing a completion certificate (Professional Engineering Certificate (PEC)), signed by an ECSA registered professional, in terms of the Construction Regulations, 2014, Occupational Health and Safety Act, 1993 when the works is deemed safe for commissioning.
- h) The Contractor's Designer shall provide services in accordance with ECSA's Guideline Scope of Services and Tariff of Fees for Persons Registered in terms of the Engineering Profession Act, 2000, (Act No. 46 of 2000) and the Construction Regulations, 2014, Occupational Health and Safety Act, 1993.

CONTROLLED DISCLOSURE

6. PLANT LIFE-CYCLE

- a) The plant is to be designed, manufactured, built and installed to last for the remaining line of the station; 50years is the design life. Remaining life is calculated between Commercial operation and now and 50years.
- b) As part of the detailed design report the *Contractor* provides life-cycle information for all plant and equipment provided to fulfil the *works*. As a minimum the information must include current life-cycle of the product (where in its life-cycle it is), a plan for future obsolescence and upgrade/migration path if a product is nearing the end of itslife-cycle.
- c) The *Contractor* informs the *Project Manager* of any plant which cannot meet any life-cycle requirement captured in the works information.
- d) The *Contractor* makes provision for an independent competent person to perform the Hazardous Location of the laboratories to maintain the current classification of a free-zone. The Employer's zone classification was last conducted in 2011 prior tothe modifications planned in this scope of work. The *Employer's* WTP HAZLOC report (200-52757) is available to the *Contractor* to work from.

7. OPERATING AND MAINTENANCE

The *Contractor* provides operating and maintenance procedures/manuals for all the systems mentioned on this scope.

The *Contractor* shall ensure that the installation of instruments, valves and pumps:

- Allow for safe and easy access for maintenance and calibration.
- Allow for the environmental conditions.
- Allow for the removal of equipment for maintenance in the vicinity of the transducer.

Emergency plans shall be provided for system failures and faults such that appropriate measures can be taken immediately without having to first analyse the cause of the failure.

8. PLANT AVAILABILITY AND RELIABILITY

The availability of the chlorine dioxide system over its life in percentage of time shall be99.99% measured annually.

CONTROLLED DISCLOSURE

9. AUTHORIZATION

This document has been seen and accepted by:

Name & Surname	Designation
Koketjo Seshoka	Lead discipline Engineer (Chemical)
Justin Varden	Chief Chemical Engineer
Banele Mbendane	Electrical Project Engineer
Mdu Shoji	C&I Engineer
Bheki Nene	LPS System Engineer
Kudzai Pakachena	LPS System Engineer
Bruce Tyson	LPS Chief Engineer
Refiloe Lapshe	Civil & Structural Engineer
Mandla Patrick Nkosi	Configuration Management

10. REVISIONS

Date	Rev.	Compiler	Remarks
November 2023	1	P Nkomo	ENS and Clarifier additional scope added to original combined scope
December 2023	2	P Nkomo	Revision after scope challenge with projects

11. DEVELOPMENT TEAM

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

- Justin Williams
- Bathandwa Cobo
- Nontokozo Maseko
- Koketjo Seshoka
- Phumlile Nkomo
- Reliance Mhlanga

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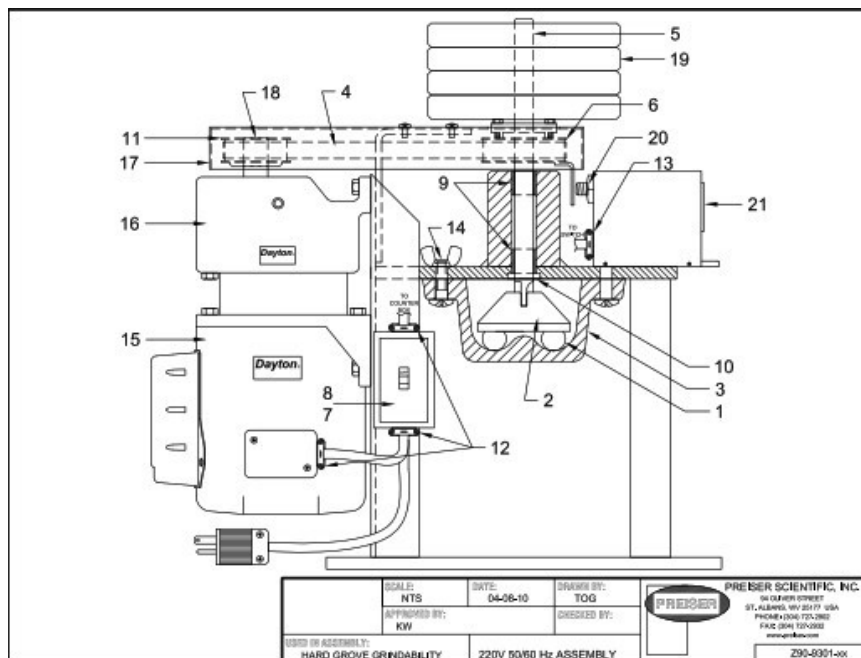
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12. ACKNOWLEDGEMENTS

- Justin Williams
- Sabelo Khanyile
- Khomotso Mohale
- Mpho Mosotho
- Thapelo Nyalunga
- Donald Tshisudzungwane
- Waleed Moses

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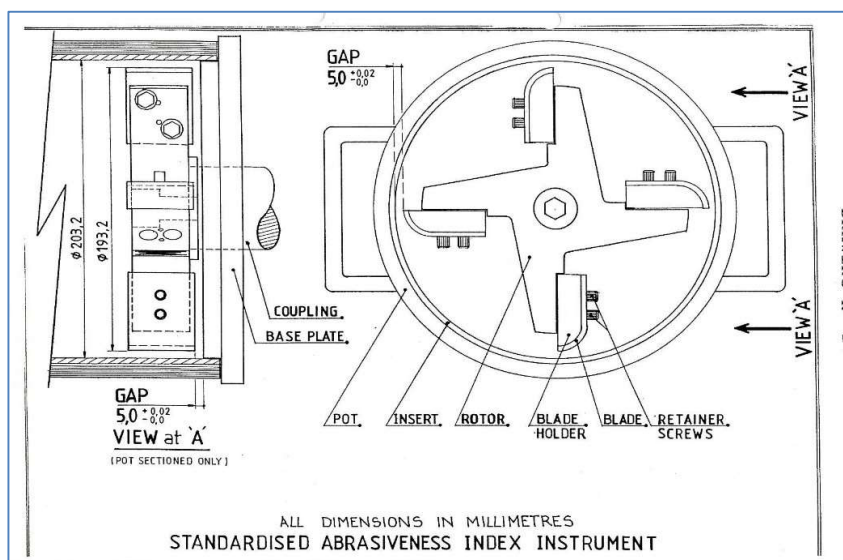
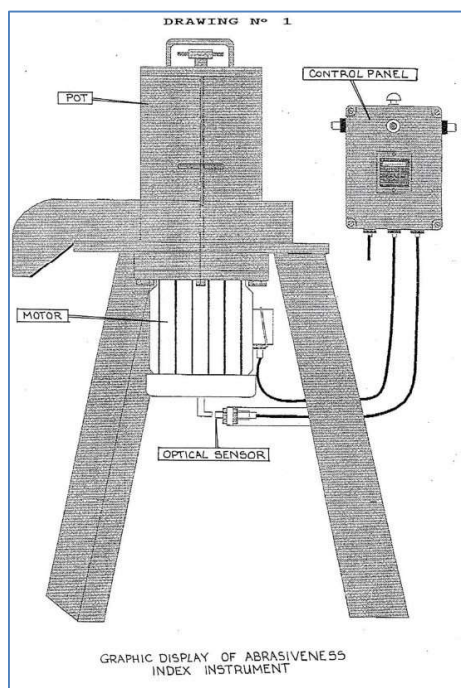
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APPENDIX A: COAL HARDGROVE INDEX EQUIPMENT**Figure 10****Table 9**

Part No:	Description	Diagram Number
Z90-9300-03	Grindability Ball Set, 1" (8)	1
90-9300-04	Upper Grinding Element	2
Z90-9300-05	Lower Grinding Element	3
Z90-9300-07	Timing Belt 230V	4
Z90-9300-12	Shaft	5
Z90-9300-14	Driven Pulley with Trip Arm	6
Z90-9300-16	On/Off Switch	7
Z90-9300-17	Thermal Overload 6.2 230V	8
Z90-9300-18	Brass Bushing (2)	9
Z90-9300-19	Grease Seal	10
Z90-9300-13	Drive Pulley for 230V/115V 60Hz	11
Z90-9300-23	Drive Pulley for 230V 50Hz	11
Z90-9300-20	1/2" Straight Connector	12
Z90-9300-27	90° 1/2" Connector	13
Z90-9300-28	Bolt and Wing Nut (2)	14
Z90-9300-36	Motor 230V 50Hz	15
Z90-9300-30	Motor 230V 50Hz	15
Z90-9300-31	Gear Reducer 230V	16
Z90-9300-32	Belt Guard 230V	17
Z90-9300-34	Bushing, Tapered 1" 230V	18
Z90-9300-37	Weight (4)	19
Z90-9300-38	Proximity Sensor	20
Z90-9300-39	Counter	21
Z90-9300-09	Timing Belt 115V	22
Z90-9300-15	Bushing, Tapered 3/4" 115V	24
Z90-9300-25	Thermal Overload 11.0	25
Z90-9300-29	115V Motor w/ Speed Reducer	26
Z90-9300-35	Belt Guard 115V	27

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APPENDIX B: COAL ABRASSIVENESS INDEX EQUIPMENT**CONTROLLED DISCLOSURE**

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APPENDIX C: WTP LABORATORY DRAWINGS LIST

Note: these drawing and documentation are only available under Non-Disclosure Agreement

Drawing Number	Title
0.84/922 sheet 7	Laboratory Door Schedule Master 1
0.84/926	Laboratory Fire Protection Layout
0.84/38826	Laboratory Ground Floor CCTV System Layout
0.84/38824	Laboratory Ground Floor Access Control System Layout
0.84/35177	Laboratory Fire Detection Layout
0.84/32848	Clean lab layout drawing
0.84/32845	Oil lab layout drawing
0.84/32846	Coal lab layout drawing

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APPENDIX D: STANDARDS AND GUIDELINES

Note: these drawing and documentation are only available under Non-Disclosure Agreement

Type	Number	Name
Eskom	240-86973501	Engineering Drawing Standard – Common Requirements
Eskom	240-93576498	KKS Coding Standard
Eskom	240-71432150	Plant Labelling Standard
Eskom	240-109607332	Eskom Plant Labelling Abbreviation Standard
Eskom	240-49230111	Hazard and Operability (HAZOP) Studies
Eskom	240-49230046	Failure Mode Effects and Criticality Analysis (FMECA)
Eskom	240-52844017	System Reliability, Availability and Maintainability Analysis Guideline
Eskom	240-72249423	Instrument Schedule
Eskom	240-61379755	Drive and Actuator Schedule
Eskom	240-72344339	Virtual signal list
Eskom	240-72346360	Load Schedules for UPS Supply
Eskom	240-56227443	Requirements for control and power cables for power stations
Eskom	240-56355466	Alarm Management System Standard
Eskom	240-56355729	Plant Control Modes Guideline
Eskom	240-52844017	System Reliability, Availability and Maintainability Analysis Guideline
Eskom	240-56355754	Field Instrument Installation Standard
Eskom	240-56355815	Junction Boxes and Cable Termination Standard
Eskom	240-56355843	Pressure Measurement Systems Installation Standard
Eskom	240-56355888	Temperature Measurement Systems Installation Standard
Eskom	240-56364545	Structural Design And Engineering Standard
Eskom	240-107981296	Constructability Assessment Guideline
Eskom	240-57127953	Execution of Site Preparations and Earthworks Standard
Eskom	240-57127951	Standard for the Execution of Site Investigations
Eskom	84CIVL053	Medupi Power Station Specification for Structural Concrete
Eskom	SSZ_45-17	Medupi Power Station Corrosion Protection Specification
Eskom	240-56355815	Field Instrument Installation Standard for Junction Boxes and Cable Termination

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Type	Number	Name
Eskom	240-56355754	Field Equipment Installation Standard
Eskom	240-56355843	Pressure Measurement Systems Installation Standard
Eskom	240-89147446	Instrument Piping for Coal Fired Power Stations Standard
Eskom	240-56355535	Process Calibration Equipment Standard
Eskom	240-55714363	Coal Fired Power Stations Lighting and Small Power Installation Standard
Eskom	240-56356396	Earthing and Lightning standard
Eskom	240-72346591	C&I Defects Check sheet
Eskom	240-72350241	Panel Interface List
Eskom	240-56227443	Requirements for control and power cables for power stations
Eskom	240-56355466	Alarm Management System Standard
Eskom	240-56355729	Plant Control Modes Guideline
Eskom	240-56355815	Junction Boxes and Cable Termination Standard
Eskom	240-56355888	Temperature Measurement Systems Installation
Eskom	240-55410927	Cyber Security Standard for Operational Technology
Eskom	240-49230046	Failure Mode and Effects Analysis Guideline
Eskom	240-56355728	Human Machine Interface Design Requirements Standard
Eskom	240-58552870	Smart Plant for Owner Operators (SPO) Documentation Metadata Standard
Eskom	240-71432150	Plant Labelling Standard
Eskom	240-93576498	KKS Coding Standard
Eskom	240-53114186	Project/Plant Specific Technical Document and Records Management Procedure
Eskom	240-109607332	Eskom Plant Labelling Abbreviation Standard
Eskom	240-56227443	Requirements for control and power cables for power stations
Eskom	240-56357424	MV and LV Switchgear Protection Standard
Eskom	240-56227426	Generation MV and LV protection philosophy for Eskom Power Stations
Eskom	0.84/3482	Medupi Power Station Earthing Standards

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Type	Number	Name
Eskom	240-57617975	Procurement of Power Station Low Voltage Electric Motors Specification Standard
Eskom	240-64685228	Generic Specification for Protective Intelligent Electronic Devices
Eskom	240-56227589	List of Approved Electronic Devices to be Used on Eskom Power Stations Standard

International and National Guidelines and Standards

Code	Description
SANS241:2015	Drinking water standard
SANS 52671:2021	Chemicals used for treatment of water intended for human consumption – Chlorine dioxide generated in situ
IEC 62381	Automation systems in the process industry - Factory acceptance test(FAT), site acceptance test (SAT), and site integration test (SIT)
SANS 10142 – Part 1	The Wiring of Premises Part 1: Low-voltage installations.

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APPENDIX E: EXISTING PLANT CIVIL DRAWINGS FOR THE CHLORINATION ROOM

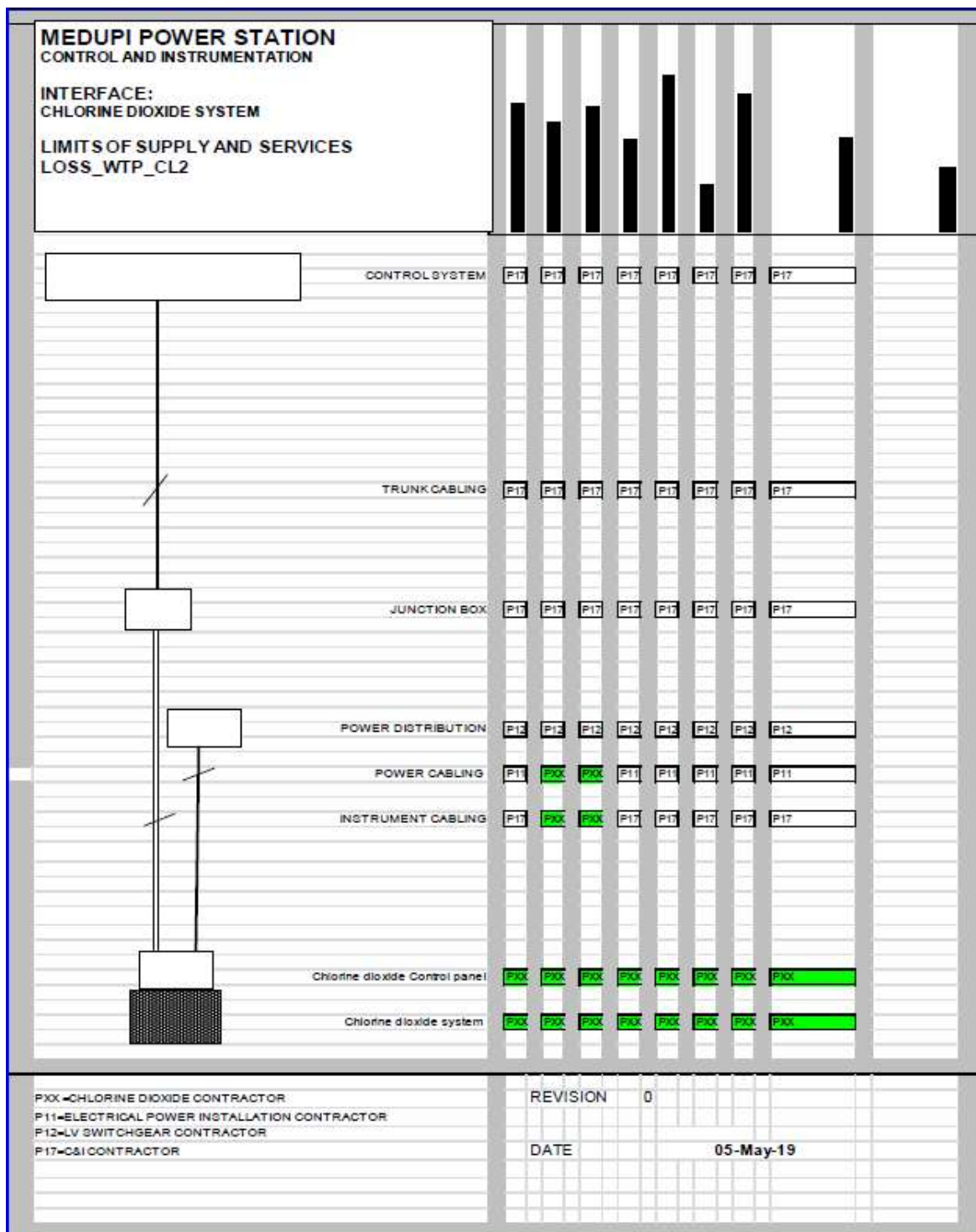
Chlorination room civil drawings

Eskom drawing number	Type	Revision	Title
0.84/915-SHEET 21	Reinforcement	7	WTP CHLORINATION BUILDING DOOR, WINDOW AND FINISHES SCHEDULES
0.84/915-SHEET 18	Section	7	WTP CHLORINATION BUILDING GROUND FLOOR PLAN SECTIONS & ELEVATIONS
0.84/915-SHEET 20	Section	5	WTP CHLORINATION BUILDING CONSTRUCTION DETAILS
0.84/13027-SHEET 1	Layout	5	CHLORINATION BUILDING LAYOUT PLAN
0.84/13027-SHEET 2	Layout	4	CHLORINATION BUILDING TYPICAL DETAILS
0.84/13027-SHEET 4	Reinforcement	3	CHLORINATION BUILDING REINFORCEMENT
0.84/13027-SHEET 3	Layout	3	CHLORINATION BUILDING TYPICAL DETAILS
0.84/3327-SHEET 12	Layout	2	MEDUPI POWER STATION CHLORINATION BUILDING HVAC LAYOUT
0.84/3327-SHEET 15	Layout	1	MEDUPI POWER STATION CHLORINATION BUILDING BUILDERS WORK
0.84/3327-SHEET 16	Layout	1	MEDUPI POWER STATION CHLORINATION BUILDING BUILDERS WORK LAYOUT
200-54694	Layout	0	MEDUPI POWER STATION WATER TREATMENT PLANT CHLORINATION BUILDING HVAC LAYOUT
200-54694	Layout	1	CHLORINATION BUILDING HVAC LAYOUT - MPSJV- ENV-0107 SHEET 00 REV 02 CONST DWG-ENV-ME- CHL-001
0.84/3368 Sheet 02			Ground floor layout
0.84/3368-Sheet 0			Water treatment plant ground floor detail layout 3 and sections K, I, M and P
0.84/3368-Sheet 12			Water treatment plant suspended floor slab, section 23 and HD bolt details

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APPENDIX F: APPLICABLE LOSS FOR CHLORINE DIOXIDE



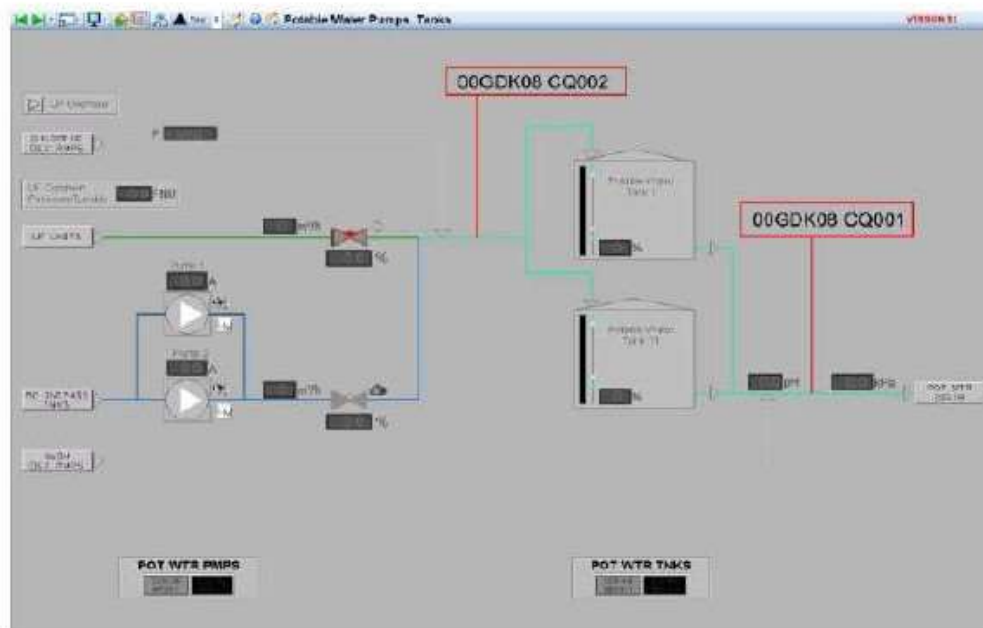
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APPENDIX G: THE WTP POTABLE WATER SYSTEM



19.3 00GDK3M: Potable Water Pumps & Tanks



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ALSPA CONTROPLANT DCS
BOP HMI Mimic Displays

MED/90/D/-----DC/ER/002
DCC EFG

Rev. 5
195/440

APPENDIX H: AUXILIARY POWER SCHEDULE TEMPLATE (EXAMPLE)

[illegible]

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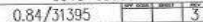
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**APPENDIX I: CORRODED COMPONENTS ISOMETRIC DRAWINGS
SEMI-BULK AREA**

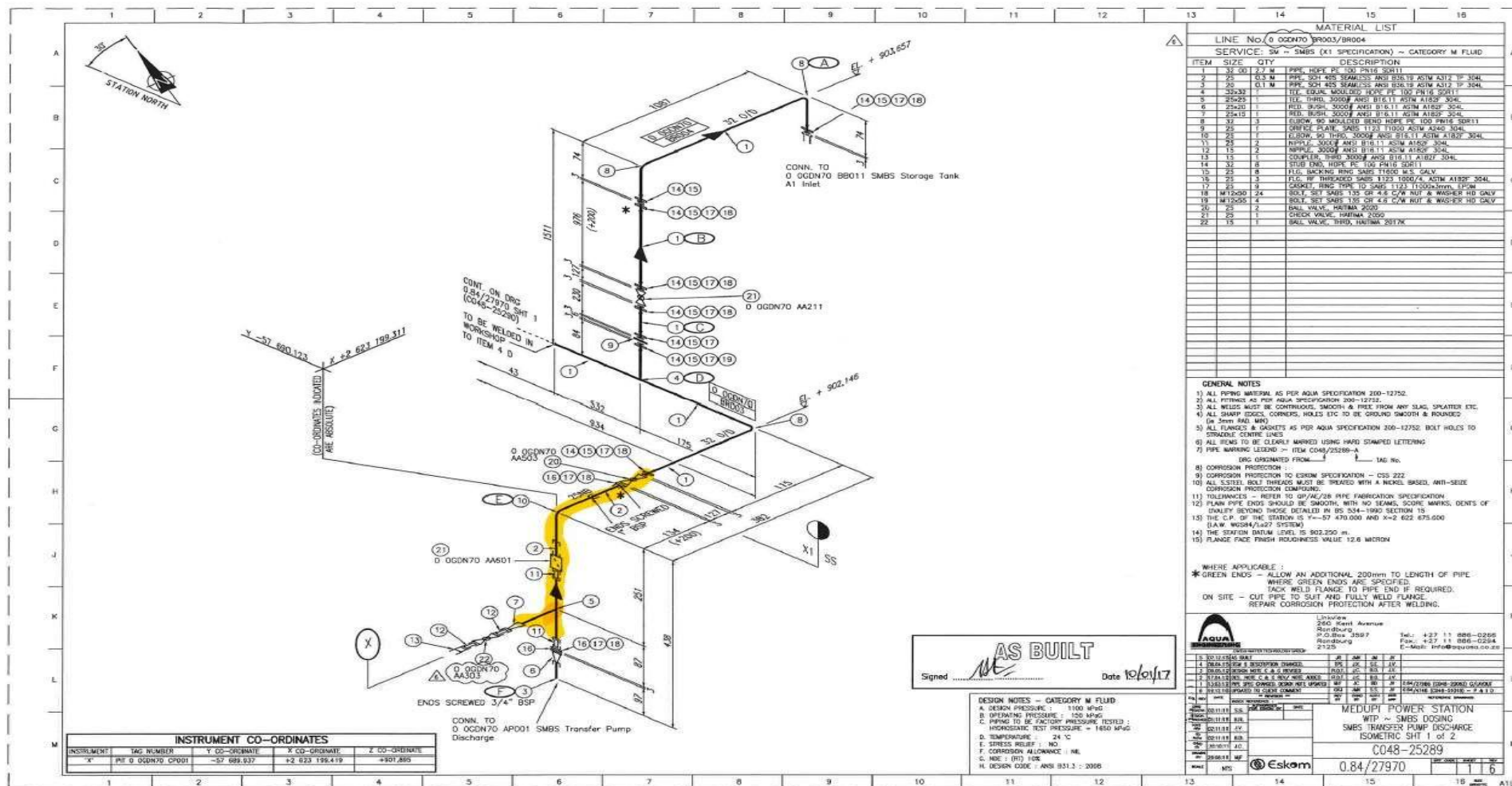
Drawing number	Description
0.84/43808	Potable water supply to safety shower 11 & 12
0.84/27970	SMBS transfer pump discharge isometric sheet 1 &2
0.84/27974	Demin water to SMBS dosing tank
0.84/28288	Demin water supply to sodium chloride tank
0/84/28221	Demin water to hypochlorite mixing tank
0.84/28101	Demin service pumps to tri-sodium phosphate tank
0.84/28106	Demin service pumps to tolytriozole tank
0.84/28090	Demin service pumps to UF coagulant tank
0.84/28634	Demin water to antiscalant

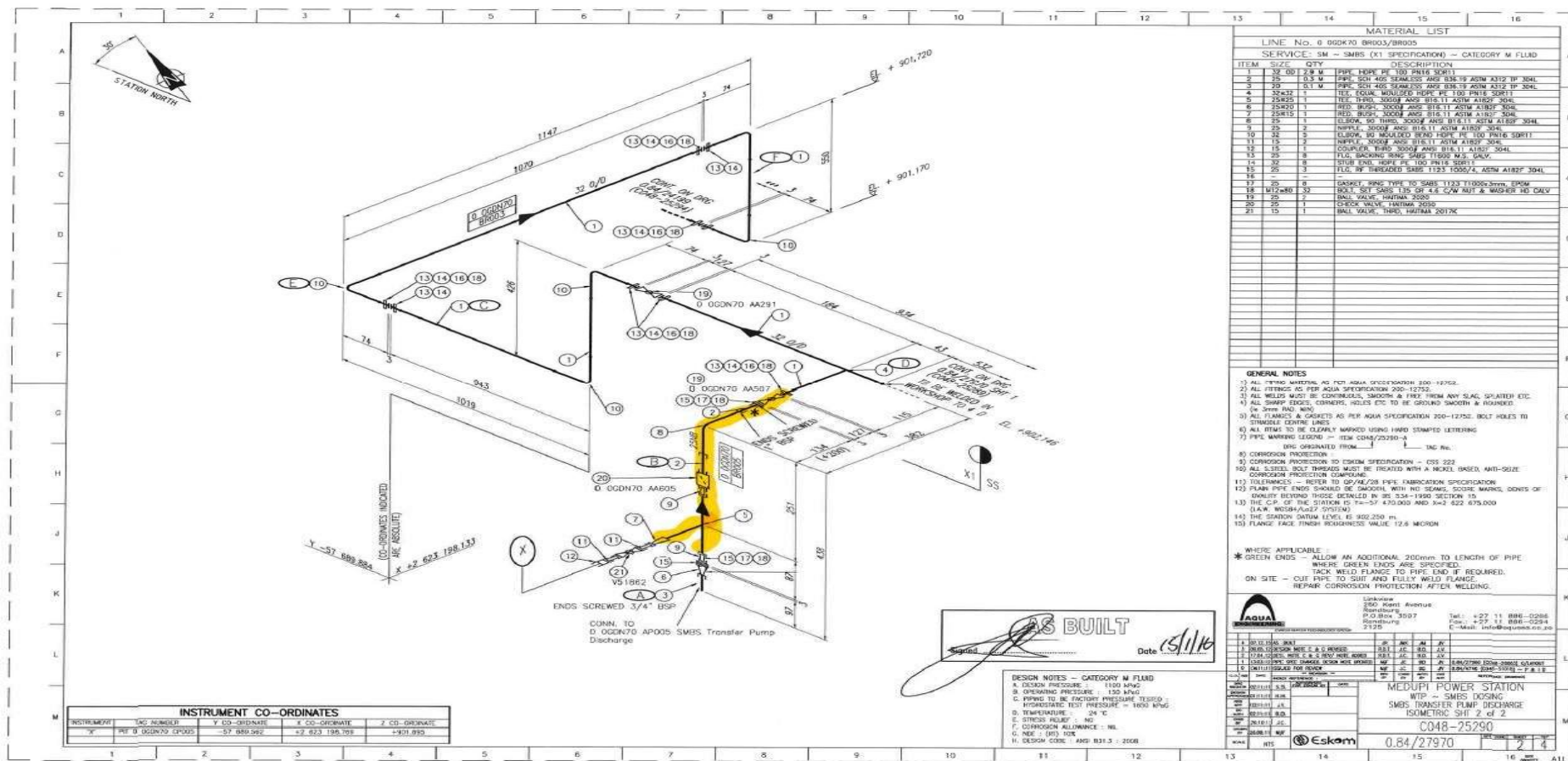
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APPENDIX J: VALVES DATASHEET

KKS number	Description
00GDN70AA291	SMBS TO RO FLUSHING IV 1 UNIT
00GDN70AA211	SMBS STORAGE TANK INLET IV UNIT
00GDN70AA201	SMBS DISSOLVING TANK OUTLET IV UNIT
00GDN70AA211	SMBS STORAGE TANK INLET IV UNIT
00GDK45AA281	SMBS DISSOLVING TANK DISWTR INLET IV UNIT
00GDK45AA278	SODIUM CHLORIDE MIX TANK DISWTR INLET IV
00GDN50AA261	TRI-SODIUM PHOSPHATE DSG COOLING UNIT 6 IV 2 UNIT
00GDN50AA265	TRI-SODIUM PHOSPHATE DSG COOLING UNIT 5 IV 2 UNIT
00GDN50AA271	TRI-SODIUM PHOSPHATE DSG COOLING UNIT 4 IV 2 UNIT
00GDN50AA275	TRI-SODIUM PHOSPHATE DSG COOLING UNIT 3 IV 2 UNIT
00GDN50AA281	TRI-SODIUM PHOSPHATE DSG COOLING UNIT 2 IV 2 UNIT
00GDN50AA285	TRI-SODIUM PHOSPHATE DSG COOLING UNIT 1 IV 1 UNIT
00GDN51AA261	TOLYLTRIAZOLE DSG COOLING UNIT 6 IV 2 UNIT
00GDN51AA265	TOLYLTRIAZOLE DSG COOLING UNIT 5 IV 2 UNIT
00GDN51AA271	TOLYLTRIAZOLE DSG COOLING UNIT 4 IV 2 UNIT
00GDN51AA275	TOLYLTRIAZOLE DSG COOLING UNIT 3 IV 2 UNIT
00GDN51AA281	TOLYLTRIAZOLE DSG COOLING UNIT 2 IV 2 UNIT
00GDN51AA285	TOLYLTRIAZOLE DSG COOLING UNIT 1 IV 2 UNIT

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B02007-1-E SP doc pag 1 of 2

“SP” series limit switch box

The **SOLDO** SP series limit switch box provides a compact design and the most economical solution for both visual and remote electrical indication of rotary valve/actuator position. Integral NAMUR mounting legs provide additional cost saving by eliminating the need for a separate mounting bracket. The switch options available make the SP series suitable for use in IP65 weather proof applications and also intrinsically safe applications.

- **Weather proof**
IP65 and Nema4 and 4X weather proof enclosure.
- **Compact design**
SP switchboxes have been engineered in order to reduce overall dimensions. Total height from actuator pinion is 76 mm. It is ideal for use on all size actuators including very small units.
- **Integral mounting bracket**
SP housing incorporates integral mounting legs and drive shaft that conform to NAMUR VDI/VDE3845 international dimension standards. Using a single adjustable sliding bracket it is possible to fit SP switchboxes onto any VDI/VDE3845 actuator. Both 30x80 and 30x130 top pattern and 20mm, 30mm, 40mm and 50 mm pinion height can be matched with a single bracket. This maximizes interchangeability plus reduces cost by eliminating need for bracket and coupler.
- **Corrosion resistant**
SP switchboxes are made of high tech reinforced polymers. UV resistant and V0 polycarbonate cover and V0 reinforced PPE body provide a very high mechanical resistance. The resin construction makes this unit ideal for use in hostile environments. The housing also incorporates captive cover screws.



Materials

body: V0 reinforced Polyphenyl Ether
cover: UV resistant and V0 polycarbonate
shaft: reinforced techno polymer
fasteners: stainless steel

For detailed part list and materials
consult specific model data sheet

- **High thickness cable entry**
SP switch box is provided with a PG13.5 (1/2" npt/f or M20x1.5 as option) cable entry. SP cable entry has a 15 mm (1/2") thickness thread. This feature prevent housing damage due to very heavy cables or cable glands. No back nut are required to fit cable glands.
- **High resolution splined cams**
easy-set cams are splined and independently adjustable. This design offers tool free calibration and positive vibration resistant engagement.
- **Switch options**
Mechanical switches are available for general purpose applications. Gold plated mechanical switches or proximity PNP are available for low current applications. Inductive proximity NAMUR switch option provides an effective choice for intrinsically safe applications.

temperatures

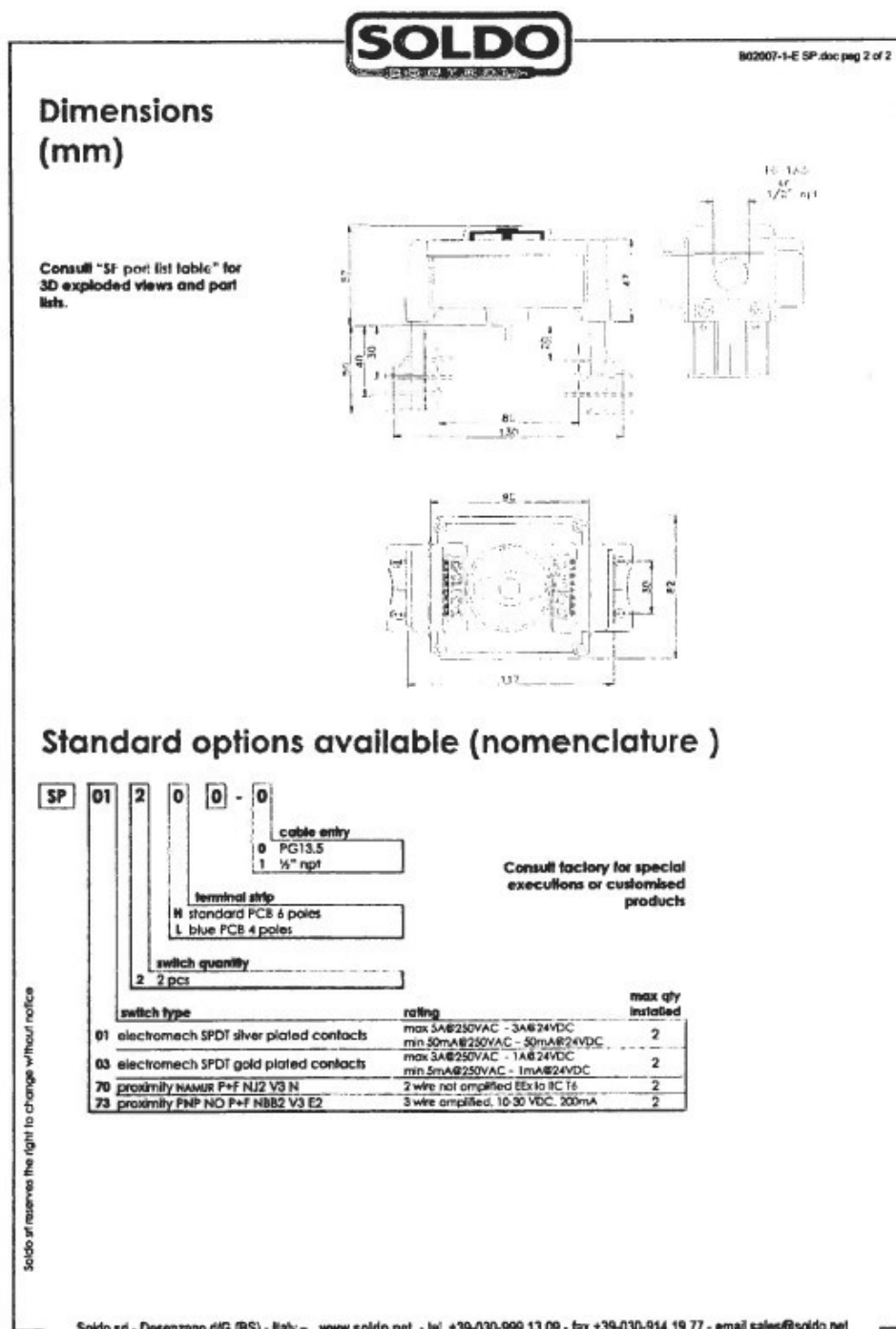
temperature range : standard -15°C +60°C

Electrical : according to switch option

Soldo srl - Desenzano d/G (BS) - Italy - www.soldo.net - tel. +39-030-899.13.09 - fax +39-030-814.19.77 - email sales@soldo.net

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The Solido Group, BE
12016 Smeetsdijk 4/5 (Brussels) Italy
Tel: +31 830 197 1237 - Fax: +31 830 197 1237
http://www.solido.net
e-mail: info@solido.net

Installation & Operating Manual
ICM-SP-0040-02

**SP
SM**

READ THIS INSTRUCTION FIRST
To avoid serious or fatal personal injury or major property damage, read and follow all safety instructions in this manual.
If you require additional assistance, please contact SOLDO.

SAVE THIS INSTRUCTION

A WARNING!
Work of repair that MAY cause serious personal injury, death or major property damage.

HAZARDOUS VOLTAGE. Disconnect all power before servicing equipment.

DO NOT REMOVE COVER WHEN ENERGISED.

CAUTION!
Do not remove the main switch potentiometer indicator. Exceeding the rotation may cause damage to the indicator, actuator and valve.
The switch plug supplied with the switch boxes are for general purpose only. (P6) protection circuitry on cable gland and wiring must be used.
(Line switches for submersible valve control (SP) rotation). Maximum rated angular velocity 230 rpm.
For valve adjustment & indicator setting before servicing the SP switch box.

Conformity
This product accords to the following norms:
1. Directive 2004/108-EC Electromagnetic compatibility.
EN 61326-1:2009
2. Directive 2006/95/CE Low voltage
EN 60529:1991
EN 60730-1:2003

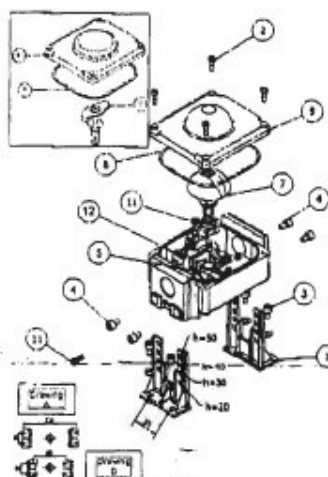
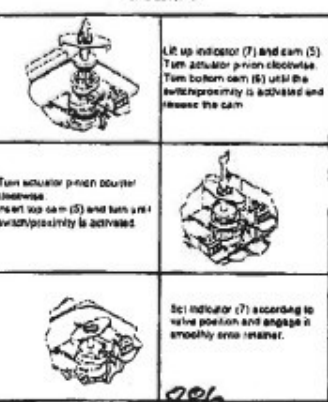
1. INSTALLATION
1.1. SP and SM boxes supplied with kit for installation in accordance to VDI 3622 (30x30x30 mm). Actuator (1) fits actuators with shaft 30, 32, 40 and 50 mm high.
1.2. Remove the two lugs (2) from the body of the box. Fit lugs (2) on actuator according to drawing A or B, using screws provided (4). Place the bracket inside the side of the body of the box.
1.3. Align shaft (1) to actuator shaft and engage it.
1.4. Fit bracket to the box with the 4 screws provided (4).

2. SWITCH ADJUSTMENT & INDICATOR SETTING
2.1. See the cam setting drawing.
2.2. Loosen 4 screws (2) and remove cover (5). **Warning: do not touch potentiometer (7) when loosening and mounting.**
2.3. Lift up indicator (7) and cam (5).
2.4. Turn actuator pinion clockwise.
2.5. Turn bottom cam (5) until the switch/proximity is activated and disengages.
2.6. Turn actuator pinion counter clockwise.
2.7. Insert top cam (11) and turn until switch/proximity is activated.
2.8. Set indicator (7) according to valve position and engage it smoothly into indicator.
2.9. Reassemble cover (5). Warning: check that (5) is properly fixed in slot. Tighten the 4 screws (2) in the cover.

3. ELECTRICAL WIRING
3.1. Remove cover (5) according to point 2.5.
3.2. Remove protection plug from cable entry and sealhouse them with a cable gland suitable for type of protection required.
3.3. Connect terminal wire (16) using a screwdriver max 3.5 mm according to the wiring diagram.
3.4. Reassemble cover (5) according to point 2.8.
3.5. Grounding connection available only for SP 3 series limit switch boxes - Extra price for alternative wire and optional.

NOMENCLATURE

SP	SM	CS	2	8	1	11	16
							Extra wire
							To define special option
							Cable entry
							Terminal wire
							Switch receptacle
							Switch type

886

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APPENDIX K: MIXER MOTOR DATASHEET

ELECTRICAL TECHNICAL SCHEDULES

1

1. ELECTRIC MOTORS

Description	AG-51801
a. Item application description	SMBS Mixer
b. Driven Machine Requirements	
(i) Description of Driven Machine	Mixer 1000 / 1027
(ii) Maximum power required (ref to motor shaft) (kW)	0.18
(iii) Power at duty point (ref to motor shaft) (kW)	0.18
(iv) Number installed	1
(v) Speed at Duty Point (ref to motor shaft) (rpm)	1390
(vi) Inertia (Mr^2 ref to motor shaft) (kgm^2)	
(vii) Maximum permissible torque (Nm)	2.54
(viii) Maximum permissible start up time (s)	DEPENDENT ON MOTOR
(ix) Maximum permissible thrust toward motor (N) and away from motor (N)	NONE
(x) Rotation (viewed on motor drive shaft)	CLOCKWISE
(xi) Torque/speed curve(s) of driven machine (Y/N)	YES
(xii) Speed range (rpm)	149
(xiii) Number of starts per hour	DEPENDENT ON MOTOR
(xiv) Utilisation factor (Uf)	
c. Motor manufacturer	CMG
d. Motor guarantees	
(i) Rated power	0.37 kw SGA
(ii) Breakaway torque (at 100 % V)	330%
(iii) Pull-up torque (at 100 % V)	TBA
(iv) Pull-out torque (at 100 % V)	270%
(v) Duty point efficiency	71.9%
(vi) Duty point power factor	0.66
(vii) Starting current	450%
(viii) Maximum permissible stall time (s) hot cold	TBA TBA
(ix) Run-up time at minimum (%) voltage(s)	TBA
(xii) Maximum expected design temperature Stator Rotor	120 TBA
e. Motor Ratings and Design Details	
(i) Voltage (V)	400
(ii) Speed or speed range (rpm)	1378
(iii) Number of starts per hour	Dependant on mixer
(iv) Full load current (A)	1.1
(v) Full load efficiency	72.2%
(vi) Phases (1 or 3)	3
(vii) Motor mounting: horizontal or vertical fast coupling or flange	V1 - Vertical

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ELECTRICAL TECHNICAL SCHEDULES

2

ELECTRIC MOTORS (Cont.)

Description	Schedule B
(viii) Cable Details -Maximum size that terminal box can accept (mm ²) -Number of cores -Outside diameter	M20 x 1.5 2
(ix) Duty Class (S1, S2, S3)	S1
(x) Rating class (P or Q)	
(xi) Enclosure: to IEC 60034	IP 55
(xii) Stator core dimensions Inside diameter Outside diameter	TBA TBA
(xiii) Air gap	TBA
(xiv) Insulation Class Stator Rotor	F Die Cast Aluminium
(xv) Motor Cooling Method	TEFC
(xvi) Frame Size	71
(xvii) Mass	17
(xviii) Bearings: Type Lubrication method Lubrication type Lubrication interval	FAG Re Grease able Lithium based 9100

ELECTRICAL TECHNICAL SCHEDULES

3

2. SPEED CONTROL EQUIPMENT

Description	SCHEDULE A
(a) Manufacturer	
(b) Type and designation	
(c) Protection on thyristors -Maximum Voltage RMS. -Maximum Current RMS.(Repetitive peak)	2.8 x Normal 1.8 x I _N
(d) Type of protection for system transient voltages (voltage spikes)	
(e) Protection for thyristors: -Against over voltage -Against over current	
(f) RF interference's guaranteed (Hand held radios)	400 MHz - 5 W
(g) Thyristor details -Water cooling -Manufacturer -Number of thyristors in parallel -Maximum continuous current -Maximum short time temp -Heatsink °C -Thyristor °C -Maximum continuous operating temperature at full load with ambient 40°C Heatsink °C Thyristor °C -Maximum junction temperature -Lifetime at maximum full load temp	no
(h) Alarms High Temp Trip Temp Fan Failure	Yes Yes
(i) Expected component lifetime	10 Years
(j) Air flow required at full load	
(k) Maximum continuous input current at 400 V	
(l) Maximum continuous input current at -10% volt +10% volt	
(m) Other alarms available	

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ELECTRICAL TECHNICAL SCHEDULES

1

1. ELECTRIC MOTORS

Description	AG-51702
a. Item application description	Sodium Chloride Mixer
b. Driven Machine Requirements	
(i) Description of Driven Machine	Mixer 1000 / 1027
(ii) Maximum power required (ref to motor shaft) (kW)	0.18
(iii) Power at duty point (ref to motor shaft) (kW)	0.18
(iv) Number installed	1
(v) Speed at Duty Point (ref to motor shaft) (rpm)	1390
(vi) Inertia (Mr ² ref to motor shaft) (kgm ²)	
(vii) Maximum permissible torque (Nm)	2.54
(viii) Maximum permissible start up time (s)	DEPENDENT ON MOTOR
(ix) Maximum permissible thrust toward motor (N) and away from motor (N)	NONE
(x) Rotation (viewed on motor drive shaft)	CLOCKWISE
(xi) Torque/speed curve(s) of driven machine (Y/N)	YES
(xii) Speed range (rpm)	212
(xiii) Number of starts per hour	DEPENDENT ON MOTOR
(xiv) Utilisation factor (Uf)	
c. Motor manufacturer	CMG
d. Motor guarantees	
(i) Rated power	0.37 kw SGA
(ii) Breakaway torque (at 100 % V)	330%
(iii) Pull-up torque (at 100 % V)	TBA
(iv) Pull-out torque (at 100 % V)	270%
(v) Duty point efficiency	71.9%
(vi) Duty point power factor	0.66
(vii) Starting current	450%
(viii) Maximum permissible stall time (s) hot cold	TBA TBA
(ix) Run-up time at minimum (%) voltage(s)	TBA
(xii) Maximum expected design temperature Stator Rotor	120 TBA
e. Motor Ratings and Design Details	
(i) Voltage (V)	400
(ii) Speed or speed range (rpm)	1378
(iii) Number of starts per hour	Dependant on mixer
(iv) Full load current (A)	1.1
(v) Full load efficiency	72.2%
(vi) Phases (1 or 3)	3
(vii) Motor mounting: horizontal or vertical fast coupling or flange	V1 - Vertical

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ELECTRICAL TECHNICAL SCHEDULES

2

ELECTRIC MOTORS (Cont.)

Description	Schedule B
(viii) Cable Details -Maximum size that terminal box can accept (mm ²) -Number of cores -Outside diameter	M20 x 1.5 2
(ix) Duty Class (S1, S2, S3)	S1
(x) Rating class (P or Q)	
(xi) Enclosure: to IEC 60034	IP 55
(xii) Stator core dimensions Inside diameter Outside diameter	TBA TBA
(xiii) Air gap	TBA
(xiv) Insulation Class Stator Rotor	F Die Cast Aluminium
(xv) Motor Cooling Method	TEFC
(xvi) Frame Size	71
(xvii) Mass	17
(xviii) Bearings: Type Lubrication method Lubrication type Lubrication interval	FAG Re Grease able Lithium based 9100

ELECTRICAL TECHNICAL SCHEDULES

3

2. SPEED CONTROL EQUIPMENT

Description	SCHEDULE A
(a) Manufacturer	
(b) Type and designation	
(c) Protection on thyristors -Maximum Voltage RMS. -Maximum Current RMS.(Repetitive peak)	2.8 x Normal 1.8 x I _N
(d) Type of protection for system transient voltages (voltage spikes)	
(e) Protection for thyristors: -Against over voltage -Against over current	
(f) RF interference's guaranteed (Hand held radios)	400 MHz - 5 W
(g) Thyristor details -Water cooling -Manufacturer -Number of thyristors in parallel -Maximum continuous current -Maximum short time temp -Heatsink °C -Thyristor °C -Maximum continuous operating temperature at full load with ambient 40°C Heatsink °C Thyristor °C -Maximum junction temperature -Lifetime at maximum full load temp	no
(h) Alarms High Temp Trip Temp Fan Failure	Yes Yes
(i) Expected component lifetime	10 Years
(j) Air flow required at full load	
(k) Maximum continuous input current at 400 V	
(l) Maximum continuous input current at -10% volt +10% volt	
(m) Other alarms available	

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APPENDIX L: WATER QUALITY FOR POTABLE WATER DISINFECTION SYSTEM

Comparison of crocodile-west water quality with SANS 241 (Drinking water standard)

Parameter	Actual Minimum	Actual Maximum	SANS 241 limit	Comment
Colour			15	
pH	7.360	10.180	5-9.7	Not within range
EC mS/m	47.800	98.500	170	Good
Na mg/l	43.000	87.000	200	Good
Cl mg/l	0.005	130.000	300	Good
SO ₄ mg/l	50.810	99.770	250	Good
NO ₃ N mg/l	0.020	2.660	11	Good
F mg/l	0.070	0.390	1.5	Good
Fe(total) mg/l	0.030	2.100	0.3	Bad
Mn mg/l	0.010	0.560	0.1	Bad
Cr mg/l	0.010	0.010	0.05	Good
Al mg/l	0.010	2.800	0.3	Bad
Zn mg/l	0.010	0.100	5	Good
NO ₂ (N) mg/l	0.060	0.660	0.9	Good
Ba	0.010	0.290	0.7	Good
B mg/l	0.030	0.440	2	Good
Turbidity	0.619	127.000	1	Bad
Nickel as Ni	0.005	0.010	0.07	Good
Cu	0.005	0.060	2	Good
TOC	4.290	17.800	10	Bad
TDS	101.700	700.500	1 200	Good

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Crocodile west river downstream locally 2021 yearly water quality

		Crocodile River													Domestic
Locality		CR DS													
Variable	Unit	22-Feb-21	15-Mar-21	21-Apr-21	05-May-21	01-Jun-21	19-Jul-21	17-Aug-21	14-Sep-21	18-Oct-21	09-Nov-21	08-Dec-21	18-Jan-22	Median	
pH		9,08	7,89	7,80	8,05	7,91	8,58	8,10	7,64	8,25	7,91	7,90	7,77	7,91	
Electrical Conductivity (EC) at 25°C	mS/m	56,00	81,20	87,20	74,20	76,40	91,30	99,9	97,0	75,5	90,4	67,2	48,5	78,80	
Total Dissolved Solids (TDS)	mg/l	301,53	428,00	485,00	402,00	418,00	489,40	594	550	426	506	393	256	426,91	
Total Suspended Solids (TSS)	mg/l	83,20	3,60	34,80	36,00	26,40	16,80	45,6	24,0	44,8	1,60	91,6	119	35,40	
Dissolved Oxygen (DO)	mg/l	6,83	6,78	6,54	6,58	6,37	7,59	6,68	6,29	6,42	6,62	6,32	6,56	6,57	
Chemical Oxygen Demand (COD)	mg/l	40,00	30,00	39,00	30,00	32,00	44,00	49,0	26,0	30,0	22,0	32,0	26,0	31,00	
Turbidity	NTU	61,40	14,30	23,40	24,40	23,10	28,70	32,8	15,6	43,1	4,07	53,1	122	26,55	
Ammonia as N	mg/l	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	0,00	
Nitrate & Nitrite as N	mg/l	<0,35	1,65	2,32	2,08	2,91	2,50	2,29	1,80	2,73	1,30	1,77	1,28	2,08	
Calcium as Ca	mg/l	31,50	47,80	52,20	42,90	44,00	51,60	59,1	57,8	43,0	49,6	37,7	30,4	45,90	
Chloride as Cl	mg/l	58,10	91,10	98,40	78,60	87,60	94,36	134	123	75,8	120	72,0	51,8	89,35	
Sodium as Na	mg/l	47,30	62,50	74,30	60,30	56,00	69,60	84,5	81,9	64,7	78,5	62,5	32,3	63,60	
Fluoride as F	mg/l	0,22	0,30	0,18	0,16	0,38	0,43	0,42	0,37	0,24	0,21	0,20	0,21	0,23	
Orthophosphate as P	mg/l	0,06	0,21	0,16	0,26	0,25	0,18	0,12	0,21	0,27	0,23	0,63	0,35	0,22	
Aluminium as Al	mg/l	0,44	0,03	0,19	0,05	<0,01	<0,01	<0,01	0,04	<0,01	<0,01	0,07	1,73	0,07	
Cadmium as Cd	mg/l	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	0,00	
Chromium as Cr	mg/l	0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,01	
Copper as Cu	mg/l	<0,01	<0,01	<0,01	0,02	<0,01	<0,01	<0,01	<0,01	0,01	0,01	0,01	0,01	0,01	
Cyanide as CN	mg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	
Iron as Fe	mg/l	0,36	0,07	0,03	0,08	<0,01	<0,01	0,03	0,06	0,03	<0,01	0,08	1,17	0,07	
Lead as Pb	mg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	
Manganese as Mn	mg/l	0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,01	0,01	
Mercury as Hg	mg/l	<0,003	<0,003	<0,003	0,01	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	0,01	
Zinc as Zn	mg/l	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	
Sodium Absorption Rate (SAR)	mg/l	1,82	1,80	1,99	1,77	1,61	1,86	2,06	2,07	1,95	7,80	62,5	32,3	1,97	
Soap, Oil and Grease	mg/l	0,30	0,80	0,30	0,30	0,40	4,00	0,10	0,70	0,50	0,20	0,50	0,70	0,45	
Escherichia coli (E.coli)	(CFU/100ml)	60	48	70	38	2,00	38	22	238	0	10	0	0	30	
Faecal Coliforms (CFU/100ml)	(CFU/100ml)	104	68	84	48	>300	58	24	254	0	24	0	0	48	

Legend	
Ideal	
Acceptable	
Tolerable	
Unacceptable	
Totally Unfit	

Crocodile river discharge surface 2021 yearly water quality

Water Quality Data: Probe Data		Time / Comment	Temp (C)	Bare (m/s)	pH (Value at 25C)	pH/V	ORP (REDOX)	DO (% Sat)	DO (mg/L)	EC (mS/m @25C)	RES (Osm/cm)	TDS (mg/L)	SAL (PSU)	SSG (t/t)	Turbidity (NTU)
Surface Water															
CR DS	Apr-21		21,18	924,00	8,09	-116,50	-15,50	71,10	5,77	901,00	1199,00	585,00	0,38	0,00	62,60
	May-21		19,53	916,00	7,82	-103,90	6,00	153,90	12,77	725,00	1540,00	471,00	0,30	0,00	60,20
	Jun-21		14,80	916,00	7,33	-76,70	4,50	7,30	0,67	794,00	1562,00	516,00	0,33	0,00	39,20
	Jul-21		12,50	927,00	9,19	-149,30	-75,00	77,70	7,59	882,00	1488,00	573,00	0,37	0,00	50,00
	Aug-21		17,70	920,00	9,18	-142,20	20,80	79,80	6,91	967,00	1200,00	628,00	0,41	0,00	129,00
	Sep-21		19,90	911,00	8,56	-109,30	26,20	55,30	4,54	1028,00	1077,00	668,00	0,49	0,00	94,70
	Oct-21		21,70	924,00	8,00	-79,70	31,60	18,60	1,49	806,00	1322,00	523,00	0,34	0,00	132,00
	Nov-21		23,80	915,00	8,47	-105,50	52,60	32,10	2,45	918,00	1114,00	596,00	0,38	0,00	96,70
	Dec-21		24,60	918,00	7,82	-87,70	52,90	1,80	0,13	873,00	1153,00	567,00	0,37	0,00	108,90
	Jan-22		22,30	868,00	7,98	-97,80	-82,60	39,10	2,91	501,00	2100,00	325,00	0,21	0,00	98,60

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Crocodile west river upstream of balancing reservoir 2021 yearly water quality

Crocodile River														
Locality		CR BR US												
Variable	Unit	22-Feb-21	15-Mar-21	21-Apr-21	04-May-21	01-Jun-21	19-Jul-21	17-Aug-21	14-Sep-21	18-Oct-21	09-Nov-21	08-Dec-21	18-Jan-22	Median
pH		9.37	8.15	8.35	8.06	8.09	8.23	7.89	7.73	7.92	8.11	7.82	7.92	8.08
Electrical Conductivity (EC) at 25°C	mS/m	55.60	82.20	86.50	79.60	76.30	85.10	98.8	93.2	75.6	93.1	67.2	49.9	80.90
Total Dissolved Solids (TDS)	mg/l	292.97	453.00	489.00	416.00	413.00	498.17	581	542	430	530	379	260	441.73
Total Suspended Solids (TSS)	mg/l	93.20	28.40	50.40	39.80	26.00	14.40	5.20	16.8	66.8	0.80	199	57.6	34.10
Dissolved Oxygen (DO)	mg/l	6.23	6.44	6.61	6.48	6.74	7.25	6.44	6.45	6.67	6.43	6.55	6.22	6.47
Chemical Oxygen Demand (COD)	mg/l	52.00	45.00	41.00	30.00	28.00	31.00	41.0	28.0	35.0	16.0	32.0	33.0	32.50
Turbidity	NTU	66.30	22.00	29.30	26.60	18.50	11.60	12.5	9.36	43.8	4.13	98.9	76.3	24.30
Ammonia as N	mg/l	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	0.00
Nitrate & Nitrite as N	mg/l	<0.35	1.98	2.28	1.89	2.82	3.19	2.66	1.78	2.40	1.33	2.99	1.54	2.28
Calcium as Ca	mg/l	31.00	54.00	50.00	44.70	40.10	52.30	58.4	55.0	42.8	56.1	38.7	30.8	47.35
Chloride as Cl	mg/l	59.50	90.30	98.50	83.70	87.00	92.33	129	131	75.7	121	70.3	52.5	88.65
Sodium as Na	mg/l	45.60	66.50	81.30	62.30	57.60	69.00	83.0	81.2	67.0	79.6	55.4	33.0	66.75
Fluoride as F	mg/l	0.24	0.36	0.18	0.16	0.38	0.35	0.37	0.38	0.25	0.23	0.21	0.22	0.25
Orthophosphate as P	mg/l	0.06	0.21	0.18	0.29	0.37	0.23	0.24	0.20	0.27	0.25	0.75	0.35	0.25
Aluminium as Al	mg/l	0.28	0.04	0.19	0.05	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.18	1.24	0.18
Cadmium as Cd	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.00
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00
Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.00
Oxide as OH	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00
Iron as Fe	mg/l	0.27	0.07	0.03	0.07	<0.01	<0.01	0.01	0.04	0.02	<0.01	0.16	0.94	0.07
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.00
Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.00
Mercury as Hg	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.00
Zinc as Zn	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00
Sodium Absorption Rate (SAR)	mg/l	1.59	1.75	2.20	1.78	1.69	1.81	1.98	2.09	2.03	7.49	55.4	33.0	2.00
Soap, Oil and Grease	mg/l	0.40	0.20	0.10	0.40	0.90	1.08	0.30	0.30	0.40	0.30	0.80	0.20	0.35
Escherichia coli (E.coli)	(CFU/100ml)	64	30	300	4	40	14	30	178	0	44	240	40	40
Faecal Coliforma (FCU/100ml)	(CFU/100ml)	84	48	300	36	62	16	34	194	0	>300	70	>300	55

Legend	
Ideal	
Acceptable	
Tolerable	
Unacceptable	
Totally Unfit	

Crocodile river upstream of balancing reservoir 2021 yearly surface water quality

Water Quality Data: Probe Data		Time / Comment	Temp (C)	Baro (mb)	pH (Value at 25C)	pHmV	ORP (REDOX)	DO (% Sat)	DO (mg/L)	EC (mS/m @25C)	RES (O ₂ mg/L)	TDS (mg/L)	SAL (pSU)	SSG (µt)	Turbidity (NTU)
Surface Water															
CR BR US	Apr-21		19.40	925.00	8.10	-116.50	-13.00	69.60	5.86	961.00	1164.00	624.00	0.40	0.00	51.30
	May-21		19.53	923.00	7.32	-76.60	-10.80	62.50	5.22	734.00	1522.00	477.00	0.31	0.00	10.40
	Jun-21		15.13	916.00	7.16	-66.80	-1.40	4.50	0.41	807.00	1526.00	524.00	0.34	0.00	41.00
	Jul-21		11.10	928.00	9.05	-141.80	-6.10	104.90	10.58	854.00	1592.00	555.00	0.36	0.00	26.00
	Aug-21		16.40	923.00	8.91	-127.30	17.70	85.20	7.61	953.00	1254.00	619.00	0.40	0.00	20.30
	Sep-21		18.00	916.00	8.61	-111.30	23.70	49.80	4.26	1000.00	1153.00	650.00	0.47	0.00	81.30
	Oct-21		21.80	925.00	7.72	-64.50	34.40	17.00	1.37	809.00	1315.00	525.00	0.34	0.00	116.00
	Nov-21		24.50	914.00	8.51	-108.00	83.20	39.60	2.98	954.00	1058.00	620.00	0.40	0.00	73.80
	Dec-21		24.98	918.00	7.80	-86.50	42.90	0.90	0.07	944.00	1060.00	613.00	0.40	0.00	90.00
	Jan-22		22.00	868.00	13.80	-387.80	-22.50	38.80	2.91	516.00	2053.00	335.00	0.22	0.00	105.6

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Crocodile West River Downstream of Balancing Reservoir 2021 yearly water quality

Locality		Crocodile River													Domestic
		CR BR DS													
Variable	Unit	22-Feb-21	15-Mar-21	21-Apr-21	04-May-21	01-Jun-21	19-Jul-21	17-Aug-21	14-Sep-21	18-Oct-21	09-Nov-21	08-Dec-21	18-Jan-22	Median	
pH		9.33	8.02	8.28	8.07	8.10	8.39	7.91	7.74	7.91	7.99	7.84	7.86	8.01	
Electrical Conductivity (EC) at 25°C	mS/m	55.40	81.30	86.80	77.50	76.60	90.70	99.1	93.4	75.7	94.0	66.6	49.3	79.40	
Total Dissolved Solids (TDS)	mg/l	300.63	436.00	503.00	420.00	413.00	449.68	575	550	426	534	378	262	431.02	
Total Suspended Solids (TSS)	mg/l	95.20	22.00	40.80	39.20	23.60	24.40	16.8	16.0	49.6	9.60	150	132	31.80	
Dissolved Oxygen (DO)	mg/l	6.66	6.71	6.77	6.37	6.67	7.43	6.31	6.48	6.29	6.62	6.48	6.41	6.55	
Chemical Oxygen Demand (COD)	mg/l	52.00	35.00	42.00	23.00	32.00	55.00	37.0	21.0	41.0	18.0	33.0	36.0	35.50	
Turbidity	NTU	59.80	17.30	30.90	24.40	17.70	58.90	10.3	9.06	41.7	6.25	65.9	103	27.65	
Ammonia as N	mg/l	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	<0.45	0.00	
Nitrate & Nitrite as N	mg/l	<0.35	1.97	2.25	2.12	2.82	2.50	2.66	1.75	2.40	1.33	2.99	1.58	2.25	
Calcium as Ca	mg/l	31.20	48.80	48.90	44.50	42.40	47.30	58.7	55.8	42.6	59.5	38.8	31.2	45.90	
Chloride as Cl	mg/l	60.10	91.10	97.80	83.40	86.30	84.56	128	130	75.4	121	70.2	52.6	85.43	
Sodium as Na	mg/l	47.30	63.20	89.90	62.50	54.80	61.70	83.8	81.2	66.9	79.4	55.7	33.0	62.85	
Fluoride as F	mg/l	0.22	0.29	0.18	0.15	0.40	0.38	0.37	0.38	0.24	0.23	0.22	0.20	0.24	
Orthophosphate as P	mg/l	0.11	0.20	0.18	0.29	0.25	0.19	0.23	0.20	0.27	0.25	0.63	0.35	0.24	
Aluminium as Al	mg/l	0.26	0.04	0.18	0.07	<0.01	0.14	<0.01	0.02	<0.01	<0.01	0.15	1.48	0.15	
Cadmium as Cd	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.00	
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Cyanide as CN	mg/l	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	
Iron as Fe	mg/l	0.25	0.08	0.03	0.09	<0.01	0.14	0.01	0.04	0.02	0.01	0.14	1.01	0.08	
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	
Mercury as Hg	mg/l	<0.003	<0.003	<0.003	0.01	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.01	
Zinc as Zn	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Sodium Absorption Ratio (SAR)	mg/l	1.63	1.78	2.44	1.79	1.59	1.70	2.05	2.07	2.03	7.47	55.7	33.0	2.04	
Soap, Oil and Grease	mg/l	0.50	0.70	0.30	0.80	0.90	0.77	0.20	0.50	0.80	0.30	0.50	0.30	0.50	
Escherichia coli (E.coli)	(CFU/100ml)	20	36	300	30	10	22	16	>300	0	34	0	0	20	
Faecal Coliforms (CFU100ml)	(CFU/100ml)	26	44	300	34	62	46	16	>300	0	>300	0	0	30	

Legend	
Ideal	
Acceptable	
Tolerable	
Unacceptable	
Totally Unfit	

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Crocodile west river upstream locality 2021 yearly water quality

Locality		Crocodile River													Domestic
Variable	Unit	CR US													
Variable	Unit	22-Feb-21	15-Mar-21	21-Apr-21	04-May-21	01-Jun-21	19-Jul-21	17-Aug-21	14-Sep-21	18-Oct-21	09-Nov-21	08-Dec-21	18-Jan-22	Median	
pH				8,24	8,20	7,07	8,18	8,15	7,70	8,08	7,96	7,89	7,79	8,02	
Electrical Conductivity (EC) at 25°C	mS/m			89,50	77,80	75,50	90,70	91,7	88,1	75,0	92,4	65,0	49,7	82,95	
Total Dissolved Solids (TDS)	mg/l			498,00	413,00	423,00	499,58	517	494	421	527	375	263	458,69	
Total Suspended Solids (TSS)	mg/l			42,00	29,20	40,40	26,00	6,40	13,2	96,0	4,40	106	64,0	34,80	
Dissolved Oxygen (DO)	mg/l			6,69	6,66	6,81	7,28	6,75	6,59	6,35	6,73	6,29	6,32	6,68	
Chemical Oxygen Demand (COD)	mg/l			37,00	28,00	39,00	48,00	41,0	23,0	28,0	33,0	35,0	26,0	34,00	
Turbidity	NTU			25,20	23,00	28,30	23,20	9,71	9,22	30,8	6,98	47,6	102	24,20	
Ammonia as N	mg/l			<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	<0,45	0,00	
Nitrate & Nitrite as N	mg/l			2,43	2,01	2,74	3,20	2,38	1,99	2,33	1,15	3,24	1,52	2,36	
Calcium as Ca	mg/l			51,40	44,10	44,90	52,68	54,0	53,5	42,6	55,5	38,0	31,4	48,15	
Chloride as Cl	mg/l			97,50	81,50	85,80	95,01	110	112	73,9	123	66,5	53,2	90,41	
Sodium as Na	mg/l			84,60	61,20	59,10	72,81	76,2	75,6	66,1	80,2	55,4	33,4	69,45	
Fluoride as F	mg/l			0,18	0,17	0,44	0,40	0,35	0,35	0,24	0,23	0,21	0,22	0,24	
Orthophosphate as P	mg/l			0,17	0,28	0,37	0,25	0,46	0,23	0,27	0,26	0,69	0,37	0,28	
Aluminium as Al	mg/l			0,19	0,04	0,04	<0,01	<0,01	<0,01	<0,01	<0,01	0,15	1,30	0,15	
Cadmium as Cd	mg/l			<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	0,00	
Chromium as Cr	mg/l			<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	
Copper as Cu	mg/l			<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,01	0,01	0,00	
Cyanide as CN	mg/l			<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	
Iron as Fe	mg/l			0,03	0,06	0,09	0,01	0,03	0,01	<0,01	0,01	0,13	0,94	0,03	
Lead as Pb	mg/l			<0,01	<0,01	0,03	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	
Manganese as Mn	mg/l			<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,01	0,00	
Mercury as Hg	mg/l			<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	<0,003	0,00	
Zinc as Zn	mg/l			<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01	0,00	
Sodium Absorption Rate (SAR)	mg/l			2,28	1,76	1,69	1,96	2,01	2,03	2,01	7,54	55,4	33,4	2,02	
Soap, Oil and Grease	mg/l			0,20	0,80	0,30	0,31	0,40	0,30	0,40	0,20	0,70	0,10	0,31	
Escherichia coli (E.coli)	(CFU/100ml)			68	32	14	34	10	148	0	64	0	>300	32	
Faecal Coliforms (CFU/100ml)	(CFU/100ml)			94	36	24	60	16	158	0	>300	0	>300	30	

Legend

Ideal

Acceptable

Tolerable

Unacceptable

Totally Unfit

Legend	
Ideal	
Acceptable	
Tolerable	
Unacceptable	
Totally Unfit	

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Crocodile west river downstream of LLPS tower locality surface 2021 yearly water quality

Locality		Crocodile River													Domestic
Variable	Unit	22-Feb-21	15-Mar-21	21-Apr-21	04-May-21	01-Jun-21	19-Jul-21	17-Aug-21	14-Sep-21	18-Oct-21	09-Nov-21	08-Dec-21	18-Jan-22	Median	
pH		9.43	8.15	8.35	8.05		8.40		7.64	7.95	7.78	7.90	7.84	8.00	
Electrical Conductivity (EC) at 25°C	mS/m	54.70	81.00	86.20	77.60		91.90		89.2	75.1	91.5	64.0	48.9	79.30	
Total Dissolved Solids (TDS)	mg/l	296.49	434.00	477.00	417.00		486.99		509	426	526	376	299	430.24	
Total Suspended Solids (TSS)	mg/l	71.20	6.40	34.40	30.00		10.40		3.60	35.6	16.4	120	104	32.20	
Dissolved Oxygen (DO)	mg/l	6.35	6.38	6.35	6.75		7.43		6.63	6.73	6.58	6.72	6.48	6.61	
Chemical Oxygen Demand (COD)	mg/l	56.00	34.00	40.00	26.00		83.00		21.0	30.0	22.0	20.0	25.0	28.00	
Turbidity	NTU	70.10	15.40	25.30	20.60		10.20		4.64	46.1	13.4	74.0	107	22.95	
Ammonia as N	mg/l	<0.45	<0.45	<0.45	<0.45		<0.45		<0.45	<0.45	<0.45	<0.45	<0.45	0.00	
Nitrate & Nitrite as N	mg/l	<0.35	2.00	2.24	1.88		2.85		1.77	2.35	1.36	3.09	1.55	2.00	
Calcium as Ca	mg/l	30.80	48.60	47.20	44.60		52.70		53.2	42.5	55.6	38.9	30.6	45.90	
Chloride as Cl	mg/l	59.00	90.70	97.40	83.40		94.71		115	76.1	121	66.4	52.9	87.05	
Sodium as Na	mg/l	46.40	63.60	74.40	61.60		71.36		77.0	66.6	79.6	55.2	32.6	65.10	
Fluoride as F	mg/l	0.27	0.35	0.18	0.15		0.51		0.36	0.25	0.23	0.20	0.21	0.24	
Orthophosphate as P	mg/l	0.08	0.21	0.18	0.30	No Access	0.26	No Access	0.22	0.28	0.35	0.63	0.38	0.27	
Aluminium as Al	mg/l	0.27	0.05	0.18	0.05		<0.01		<0.01	<0.01	<0.01	0.28	1.37	0.23	
Gadolinium as Gd	mg/l	<0.002	<0.002	<0.002	<0.002		<0.002		<0.002	<0.002	<0.002	<0.002	<0.002	0.00	
Chromium as Cr	mg/l	<0.01	<0.01	<0.01	<0.01		<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Copper as Cu	mg/l	<0.01	<0.01	<0.01	<0.01		<0.01		<0.01	<0.01	<0.01	<0.01	0.01	0.00	
Cyanide as CN	mg/l	<0.01	<0.01	<0.01	<0.01		<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Iron as Fe	mg/l	0.26	0.09	0.02	0.07		0.01		<0.01	0.03	<0.01	0.23	0.90	0.08	
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01		<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Manganese as Mn	mg/l	<0.01	<0.01	<0.01	<0.01		<0.01		<0.01	<0.01	<0.01	<0.01	0.01	0.00	
Mercury as Hg	mg/l	<0.003	<0.003	<0.003	0.00		<0.003		<0.003	<0.003	<0.003	<0.003	<0.003	0.00	
Zinc as Zn	mg/l	<0.01	<0.01	<0.01	<0.01		<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	0.00	
Sodium Absorption Rate (SAR)	mg/l	1.62	1.81	2.01	1.76		1.92		2.05	2.03	7.51	55.2	32.6	2.02	
Soap, Oil and Grease	mg/l	0.60	0.70	0.10	0.50		0.62		0.20	0.80	0.20	0.70	0.20	0.55	
Escherichia coli (E.coli)	(CFU/100ml)	42	40	300	20		8		14	0	58	0	0	17	
Faecal Coliforms (CFU/100ml)	(CFU/100ml)	74	56	300	20		12		24	0	>300	0	0	20	

Legend	
Ideal	
Acceptable	
Tolerable	
Unacceptable	
Totally Unfit	

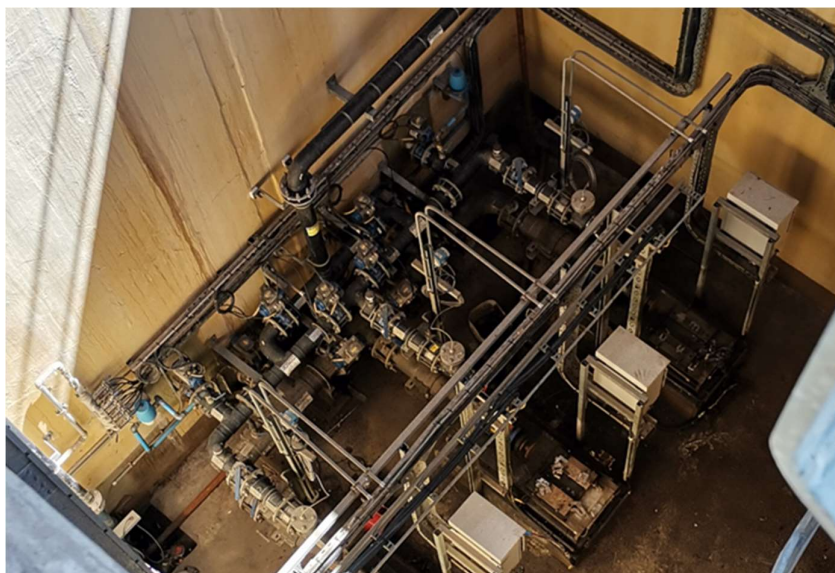
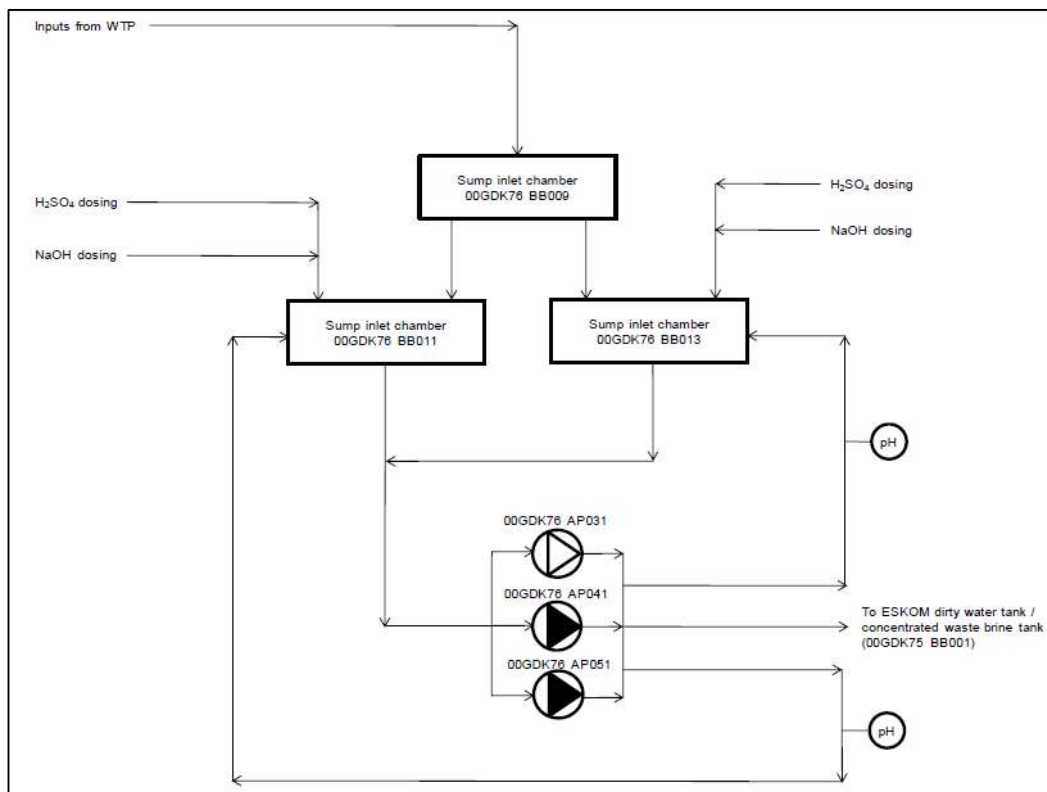
Crocodile West river downstream of LLPS tower locality 2021 yearly water quality

Water Quality Data: Probe Data		Time / Comment	Temp (C)	Baro (mb)	pH (Value at 25C)	pHmV	ORP (REDOX)	DO (% Sat)	DO (mg/L)	EC (µm/cm @25C)	RES (Ohm.cm)	TDS (mg/L)	SAL (pSU)	SSG (g)	Turbidity (NTU)
Surface Water															
CR LLPS DS	Apr-21		19,20	925,00	7,92	-106,80	-20,40	71,50	6,04	967,00	1162,00	626,00	0,41	0,00	52,30
	May-21		18,10	923,00	8,12	-119,90	4,20	52,40	4,52	738,00	1560,00	479,00	0,31	0,00	0,00
	Jun-21	No Access	-	-	-	-	-	-	-	-	-	-	-	-	-
	Jul-21		14,05	925,00	8,92	-135,70	-7,20	197,20	18,56	858,00	1474,00	557,00	0,36	0,00	0,00
	Aug-21	No Access	-	-	-	-	-	-	-	-	-	-	-	-	-
	Sep-21		16,70	917,00	8,52	-106,10	7,30	53,10	4,69	941,00	1262,00	611,00	0,39	0,00	79,90
	Oct-21		20,85	925,00	7,50	-52,30	-9,50	17,80	1,46	816,00	1331,00	530,00	0,34	0,00	107,00
	Nov-21		22,60	915,00	8,20	-90,30	48,00	18,40	1,44	919,00	1140,00	597,00	0,39	0,00	95,60
	Dec-21		25,30	917,00	7,67	-79,40	38,40	2,90	0,22	900,00	1103,00	585,00	0,38	0,00	102,00
	Jan-22		21,40	868,00	8,30	-87,60	-167,90	35,70	2,71	513,00	2092,00	333,00	0,22	0,00	118,00

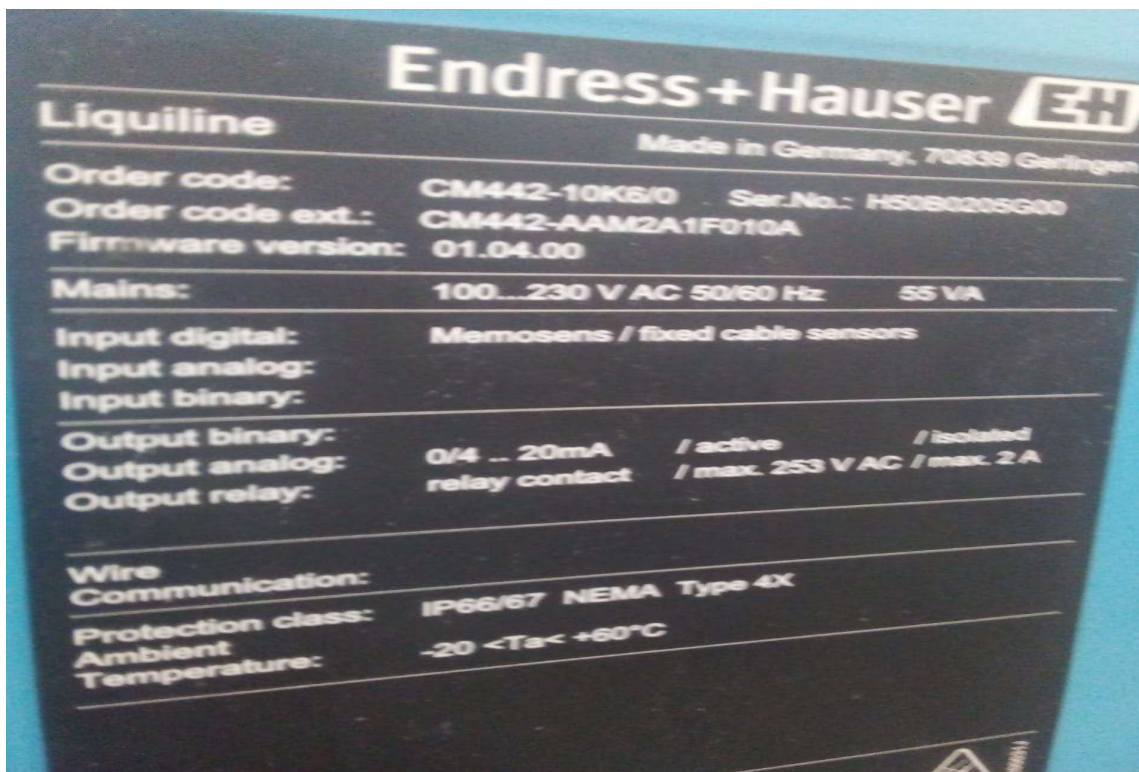
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APPENDIX M: END DRAWINGS

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APPENDIX N: FLOW SPECIFICATION**CONTROLLED DISCLOSURE**

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