



Technical Specification

Technology

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1. DESCRIPTION OF THE *WORKS*

1.1 EXECUTIVE OVERVIEW

Kilbarchan colliery is a defunct coal mine that is situated 10km south of Newcastle in Northern KwaZulu-Natal. The colliery served to supply coal to the nearby Ingagane Power Station from 1981 to 1987 and in 1992 the colliery ceased all mining activities.

The Kilbarchan section of the colliery, is currently decanting mine affected water. Since the closure of the mine the underground workings have filled with water and there is a current decant of this mine affected water into the surrounding water course. Due to the current decant of mine affected water at Kilbarchan, the *Employer* requires the *works* to be an engineering solution to stop and prevent decant of mine affected water. The *works* is required to extract mine affected water from the Kilbarchan colliery, for treatment via a biological/passive mine water treatment plant (WTP) to a quality fit for discharge, as indicated in Appendix A.2, into the surrounding catchment.

The *works* is inclusive of all activities necessary for the provision of a fully functional system that meets the *Employers* requirements. The *Contractor* designs, manufactures, procures, installs and commissions all Mechanical, Civil, Electrical, Control & Instrumentation Plant, Equipment and Material required for the works as defined in this *Works* Information. The *Contractor* shall ensure that the complete design shall be performed by, or under the direction, control and supervision of an Engineering Council of South Africa (ECSA) registered professional engineer/professional technologist as required by the scope of the design. In instances where the design is performed under the direction, control and supervision of a professional engineer/professional technologist, the professional engineer/professional technologist will be responsible for signing off the design.

1.2 EMPLOYER'S OBJECTIVES AND PURPOSE OF THE *WORKS*

1.2.1 Background

At the Kilbarchan section of the colliery both underground and opencast mining was carried out. There is currently ingress of water into the old mine workings as a result of natural ground water movement and surface water runoff. Water resulting from the mine workings is impacted in terms of potential acidity, metals content and salinity. When the Kilbarchan section fills up it decants at two locations into the Ingagane River. The average rainfall is approximately 864mm/annum.

The relation of the Kilbarchan section of the colliery to the Ngagane River is indicated in Figure 1.

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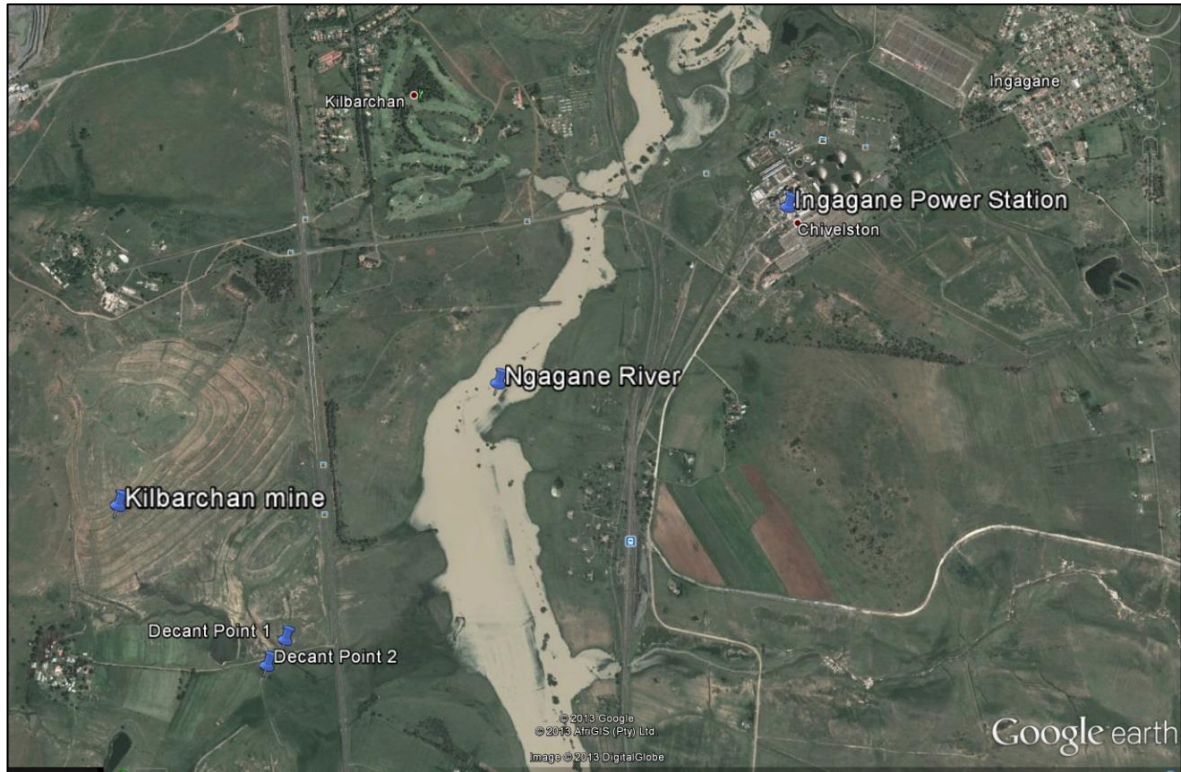


Figure 1: Location of the Kilbarchan section of the colliery with respect to the Ngagane River

1.2.2 Objectives

The objective of this project is to provide a solution that is reliable, maintainable and is safe, for the treatment of the mine affected water from the Kilbarchan section of the colliery to a quality fit for discharge.

1.3 ABBREVIATIONS

The following abbreviations are used in this Technical Specification:

Abbreviation	Description
CAD	Computer-aided design
COD	Chemical Oxygen Demand
CoE	Centre of Excellence
C&I	Control and Instrumentation
ECSA	Engineering Council of South Africa
HAZOP	Hazard and Operability
HMI	Human Machine Interface
HVAC	Heating, Ventilation and Air Conditioning
IP	Ingress Protection
I/O	Input Output
ISO	International Standards Organisation

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ITP	Inspection Test Plan
JB	Junction Box
K ₂₅	Specific Conductivity at a reference temperature of 25°C
kV	Kilo Volts
KVA	Kilo Volts Amperes
LCS	Local Control Station
LPS	Low Pressure Services
LV	Low Voltage
MHSA	Mine Health and Safety Act, Act 29 of 1996
ML/day	Mega Litre per Day
NTU	Nephelometric Turbidity Units
OD	Outer Diameter
OHSA	Occupational Health and Safety Act No. 85 of 1993
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
Pr. Eng.	Professional Engineer
Pr. Tech	Professional Engineering Technologist
QCP	Quality Control Plan
RAM	Reliability, Availability and Maintainability
SANS	South African National Standard
SAQCC	South African Qualification and Certification Committee
SHE	Safety, Health and Environment
SHEQ	Safety, Health, Environmental and Quality
SOC	State Owned Company
SS	Stainless Steel
TOC	Total Organic Carbon
VDSS	Vendor Document Submittal Schedule
WTP	Water Treatment Plant

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1.4 DEFINITIONS

Definitions	Description
Maintainability	Relates to the ability of the intended system to be easily serviced or repaired, including the ability for it to be easily diagnosed. In this context, maintainability is synonymous with 'Repairability' or 'Serviceability'.
Plant	The Plant is any hardware or software, whether fixed or mobile, that forms a part of the system.
Reliability	Relates to the ability of the intended system to perform within the specified limits with correct and consistent results over time. This includes the numerical reliability characteristics (with confidence levels, if appropriate).
System	An integrated set of constituent pieces that are combined in an operational or support environment to accomplish a defined objective. These pieces include people, hardware, software, firmware, information, procedures, facilities, services and other support facets.

2. ENGINEERING AND THE *CONTRACTOR'S* DESIGN

The *Contractor* designs, procures, manufactures, supplies, delivers to site, installs, tests and commissions the entire *works* to ensure a fully functional system. The *works* is to be located at the Kilbarchan Colliery, located in Newcastle in the KwaZulu-Natal Province. The *Contractor* is to design the *works* to operate effectively for a period of 15 years and shall allow for continuous operation.

The *Contractor* is to comply with the *Employer's* Design Review Procedure (240-53113685) and Project Engineering Change Management Procedure (240-53114026) in addition to the *Contractor's* own engineering governance processes. The *Contractor* completes the required design studies and documentation per phase as is covered in the Design Review Procedure (240-53113685) as a minimum. The *Employer* may facilitate a workshop with the *Contractor* to answer questions on these procedures.

2.1 *EMPLOYER'S* DESIGN

2.1.1 Description of the *works*

The *works* for the treatment of the mine affected water is to consist of the following:

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- The mine water abstraction system, that extracts mine affected water from the underground section of the Kilbarchan section of the colliery and conveys this water to the treatment plant. The abstraction system shall consist of the boreholes, borehole pumps, piping, fittings and instrumentation and any other equipment that is required to convey the mine affected water to the treatment plant.
- The mine water treatment plant, that serves to treat the mine affected water, and
- The waste management solution that serves to produce a waste that can be disposed offsite.

A schematic of the components that make up the Kilbarchan Mine Water Treatment *works* is indicated in Figure 2.

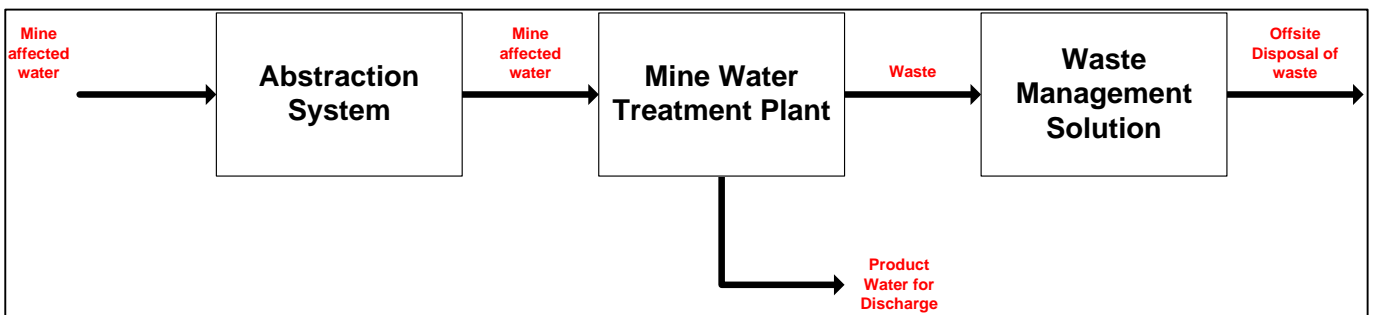


Figure 2: Schematic illustrating the components of the proposed Kilbarchan Mine Water Treatment *works*

2.1.2 *Works* Operating and Control Philosophy

The operation of the *works* is performed from the local control room (containerised room). The modes of operation for the *works* that are to be made available are: automatic, local manual and local maintenance.

The *works* is to be designed and installed with a wireless communication link for monitoring. The wireless communication link will ensure that the *works* can be monitored from anywhere. The monitoring will be for the entire *works*.

The operators are able to view the entire *works* at any given point in time; the indications relayed to the local control room for the operator's information are as follows:

- All motors status
- All alarms from the plant equipment and switchgear
- Individual analogue values (level, flow, pressure etc.)

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2.1.3 Works Function and Requirements

The *Employer* requires that the *works* be designed to function as follows:

- (1) Abstraction system is designed to deliver a minimum throughput of 0,5ML/day of mine affected water.
- (2) The biological/passive mine WTP shall be able to treat a minimum of 0,5ML/day of mine affected water.
- (3) Product water quality from the mine WTP to comply with the water quality parameters specified in Appendix A.2.
- (4) Overall *works* recovery shall be optimised and product water recovery maximised.
- (5) The *works* shall have an availability of at least 95%.

Requirements for the *works* will be as follows:

- (1) Abstraction pipeline delivery capabilities will be assessed by means of flow measurement devices with totalizer capability on the feed pipeline.
- (2) A design and operational water and salt balance for the *works* which will be used to measure the plant efficiency and performance against the design base. Online measurements are to be available to ensure that data is available for the completion of a detailed water and salt balance.
- (3) Online instrumentation shall be provided as part of the design to measure the feed and product water qualities, flows, pressures and other chemical parameters from the system to enable daily confirmation of plant performance. The *Contractor* is to ensure that following minimum online instrumentation is to be installed on the inlet and outlet streams:
 - pH
 - Conductivity (to be temperature compensated)
 - TDS (to be temperature compensated and should be correct to the algorithm applicable to the water)
 - Temperature
 - Dissolved Oxygen
 - ORP (to be temperature compensated)

It is important to note that the *Employer* requires these minimum online instrumentation and subsequent measurements for its own monitoring purposes. The *Contractor* shall propose further online instrumentation it deems necessary for the operation and control of the *works*. The *Contractor's* design is consider the data management, power requirements and capital costs associated with undertaking the data collection.

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2.1.4 General Design and Manufacturing Process Constraints

In providing the system, the *Contractor* is fully responsible for the delivery to, offloading and storage of all plant, equipment and materials required for the works on site. The *Project Manager* reserves the right to carry out any checks of his/her own on any plant, equipment and materials that have been delivered to site for the *works*.

The *Contractor* is fully responsible for the installation of all mechanical, civil, electrical, process control and instrumentation components, equipment and material as well as the interfacing and tie-ins with existing plant and equipment as required for the *works*.

The *Contractor* is responsible for the complete optimisation of the *works* in order to meet or exceed the guaranteed performance levels.

The *Contractor* is required to indicate the full extent of the guarantees they are prepared to offer with respect to water quality, volumetric flow, efficiency and availability of the *works*.

The *works* will require expansion in the future, so construction shall allow for space (for up to 1ML/day) and be designed in a modular approach. The allowance for future expansion shall be indicated in the *Contractors* basic and detailed design drawings.

On completion of the basic design phase, the *Contractor* provides all the design information required to the *Employer* to obtain all necessary approvals, permits, licenses for the *works*. The applications will be the responsibility of the *Employer*; however technical support will be required from the *Contractor* through the authorising phase.

2.1.5 Works Life-expectancy

The design life of the *works* shall be for a full 15 year life from commissioning of the Kilbarchan Water Treatment System.

2.1.6 External environmental requirements

The proposed site location is to be at the defunct Kilbarchan Colliery. The following site characteristics will have an influence on the plant design or operating of the plant:

Table 1: Site characteristics at Kilbarchan Colliery

Site	Kilbarchan Colliery
Regional Authority	Newcastle Municipality, KwaZulu-Natal Province
Nearest Towns	10 km south of Newcastle

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Latitude & longitude	27°50'38.88"S 29°59'7.00"E
Landowner	Eskom
River catchment	Lower Ingagane river sub-catchment
Wind direction	Winds in the region are mainly southerly and northerly to north-westerly, but are affected locally by the topography.
Rainfall & Evaporation	Rainfall occurs mainly during the summer from November to March with an average of 12 to 13 rain days per month as against 2 to 3 in the mid-winter months. The annual rainfall for the area is approximately 878mm per annum with a maximum recorded annual precipitation of 1322 mm (1943) and a minimum of 464 mm (1982). Rainfall is largely of the thunderstorm type, sometimes with great intensity, however mist and drizzle are also experienced due to the site's close proximity to the mountains. Hail storms occur on average 5 times per year. The evaporation rate for the area is approximately 620 mm/year.

2.2 PARTS OF THE *WORKS* WHICH THE *CONTRACTOR* IS TO DESIGN

The *Contractor* designs, procures, supplies, manufactures, delivers to site, installs, and commissions and tests the entire system to ensure a fully functional system. The system is to be located at the Kilbarchan Colliery. The *Contractor* is to design the system to operate effectively and shall allow for continuous operation.

2.2.1 Scope of Work

The scope of work describes the major activities, plant and material that falls within the scope of the *Contractor*. It is the responsibility of the *Contractor* to ensure that all the activities are carried out and all equipment, plant and material is supplied to complete the *works* in every respect. The *Contractor* is responsible for but not limited to:

- a) Basic Design of the *works*
- b) Detailed Design of the *works*
- c) Manufacture and procurement of plant, material and equipment necessary to complete the *works*
- d) Delivery to and offloading at site
- e) Installation
- f) Commissioning, testing and optimisation
- g) Documentation as specified
- h) Quality management for all activities

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- i) Safety and plant signage
- j) HAZOP study
- k) Compliance to Eskom environmental requirements
- l) Fire protection for the *works*

The *Contractor* supplies the following information to the *Employer* prior to installation:

- Basic design for the *works*
- Detailed design for the *works*
- A general arrangement drawing indicating the relevant components included in the design of the *works*
- Equipment list
- Design calculations of the different components and process parameters where applicable
- QCP for the design, installation, testing and commissioning of the *works*
- Process flow diagrams and P&ID's of the total *works* to be installed by the *Contractor*
- Site route drawing / general arrangement for the wiring from instrumentation to junction box
- Description, technical schedules and specifications of all piping and system components that form part of the *works*
- Operating and Control Manuals and Philosophies for the *works*
- HAZOP studies
- Project schedule for the installation of the *works*
- Utility requirements for the *works*
- Loading requirements for the *works*
- Logic and electric single line diagrams for the *works*
- Engineering Plan and Approach

2.2.2 Engineering Disciplinary Requirements

The scope of *work* for the project, includes the basic design, detailed design, procurement, manufacture, supply, installation and commissioning of a biological/passive mine WTP at Kilbarchan Colliery.

2.2.2.1 Chemical and Process Engineering Requirements

2.2.2.1.1 Design Philosophy

The *works* shall be designed to treat a minimum of 0,5ML/day of mine affected water.

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2.2.2.1.2 Process Description

Mine affected water shall be pumped from the underground section of the Kilbarchan colliery to the above ground section for treatment, via borehole pumps. The mine affected water will then be fed to the mine WTP. The mine WTP will serve to treat the mine affected water to produce product water that will be compliant to the Treated Water Quality as indicated in Appendix A.2.

Any waste that is produced shall be disposed offsite. This waste is shall be disposed of in a general waste disposal facility.

2.2.2.1.3 Basis of Design

Feed water quality

An example of the feed water quality is shown in Appendix A.1. Historic chemical analysis of the feed water will be provided by the *Employer*. The *Contractor* is to conduct any specialised analysis on the feed water deemed necessary to ensure the integrity of the design basis, for example organic matter analysis and/or profiling. Manual sample points shall be provided on the feed water to measure water qualities.

Mine WTP and Waste Management Solution Requirements

- The mine WTP and waste management solution must be designed to be able to treat a minimum of 0,5ML/day of mine affected water. A design that favours a modular approach is required.
- The treatment of the mine affected water is to take place via a biological/passive treatment process. In this process the minimum steps that are to be undertaken:
 - Iron oxidation step
 - Metal precipitation step
 - Sulphate precipitation or conversion step (to sulphides)
 - Supported by biological process
- The *Contractor* makes provision for online measurements that shall be incorporated into the design to ensure continuous automatic operation.
- The *Contractor* ensures any and all chemicals required for the plant operation shall be contained in bunded areas and meets the requirements of SANS 310.
- The *Contractor* designs such that possible reuse and recycling is to be incorporated to reduce the amount of waste to be handled and processed.
- The waste management solution shall only produce a waste to be disposed of at a licenced general waste disposal facility off-site.
- Chemicals utilised on the *works* should be such that the product water could be used for dilution etc. Where this is not possible then the chemicals should be delivered in a pre-made solution or form.

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- The *Contractor* is to ensure this treatment facility requires the smallest footprint possible, is modular in nature and is containerised.
- The *Contractor* is to ensure that the proposed *works* can operate on energy generated via solar power. The *Contractor's* design is to cover the solar power and battery storage requirements.

Product Water Quality

The *Contractor* shall design the *works* such that:

- The mine WTP shall ensure that the final product water produced complies with the Treated Water Quality indicated in Appendix A2 or better
- All plant, equipment and material supplied shall be designed with due regard for the need for effective operation under variances in water qualities. The materials of construction of all components of the *works* are to be suitable for use under the varied process conditions as well as in the different atmospheric conditions of the Newcastle area.
- Manual sample points shall be provided on the feed water and discharge side of the mine WTP to measure the input and outlet water qualities, respectively.
- The following minimum online instrumentation shall be provided on the feed and product water qualities:
 - pH
 - Conductivity (to be temperature compensated)
 - TDS (to be temperature compensated and should be correct to the algorithm applicable to the water)
 - Temperature
 - Dissolved Oxygen
 - ORP (to be temperature compensated)

Probes are to be robust to function under the conditions of use for the *works*.

2.2.2.1.4 General Requirements

- The process/chemical design shall be signed off by an ECSA registered Professional Engineer/Technologist.
- The *Contractor* is to take cognisance of environmental, safety and housekeeping constraints. The *Contractor* is to be responsible to overcome any issues that may arise due to space constraints with prior consent from the *Project Manager*.

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- The *Contractor* is to keep the *works* design, operation and maintenance as simple as possible. Factors such as quick and easy maintenance, inspection doors, readily removable parts, lifting lugs as well as standardised, locally manufactured components, are to be at the fore front of all design considerations. The *Contractor* shall bring to *Employer's* attention all special maintenance features, for acceptance.

2.2.2.2 Mechanical and Materials Requirements

2.2.2.2.1 General

Each component or unit of the *works* must be installed in such a manner as to allow isolation of any component or unit, without taking the rest of the plant offline.

In the event that the solution proposed by the *Contractor* is that of a complete packaged solution (predesigned units and/or pre-fabricated) normally used by the *Contractor* for rapid deployment, the *Contractor* is to provide the offer stating such. The *Contractor* is to state any deviation to the *Project Manager* for acceptance.

The *Contractor* shall provide to the *Project Manager* with 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 calculations for the selection and sizing of all mechanical equipment such that 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 to verify the design and provide these calculations to the *Employer*.

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.

All the pipework supplied in this works and complying with this specification shall be 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 of codes from different countries of origin is not acceptable.

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2.2.2.2.2 Design Codes

The *works* conform to the following design codes:

- EN 13445 (All parts): Unfired Pressure Vessels
- EN 13480 (All parts): Piping

2.2.2.2.3 Minimum design requirements for valves

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

The following minimum requirements apply:

- a) 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.
- b) 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* specification.
- c) The face of each hand wheel is clearly marked with the words "OPEN" and "SHUT" with relevant direction arrows adjacent to it.
- d) All valves for the *works* are numbered for identification purposes.

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 fail-safe valve mechanism in positions the *Employer* deems it critical.

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 *Project Manager* for acceptance.

The *Contractor* ensures that local support for the valves; spares availability and short lead times in cases of emergency are available.

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2.2.2.2.4 Minimum design requirements for pumps

The *Contractor* submits the pump data sheets and design documentation to the *Project Manager* for acceptance on completion of the *works* design. The following minimum requirements apply:

- Pumps are made of materials suitable to handle corrosive materials, or lined with a suitable liner in accordance with the *Employers'* specification.
- All centrifugal pumps are fitted with mechanical seals (unless submerged).
- 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 are to be provided at pump discharges after pressure sustaining valves.
- Preference must be given to locally manufactured pumps, so as 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 *Project Manager* for acceptance prior to the procurement and installation and are provided for use after commissioning of the works.
- The materials of construction for the pumps must be suitable for the water and environment it is in contact with.
- All pumps and motors for the works are numbered for identification purposes.
- The pumping system shall have pressure indication to measure the inlet and outlet pressures on the pumps.
- Pumping systems shall be designed to be energy efficient.
- A full set of pump characteristics is to be provided for acceptance by the *Project Manager*. Pumps shall be selected such that they run within 5% forward and 10% backwards 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* prior to the supply and installation:
 - recommended spares list
 - part list of the pump and part number
 - pump curves and system curves clearly indicating the pump duty point
 - pump assembly and disassembly procedure
 - maintenance procedure (including the routine maintenance of the pump)

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- delivery rate total minimum 0,5ML/day
- 100% redundancy of feed pipelines and its pumps

2.2.2.2.5 Minimum design requirements for system pipe work

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

General

The materials of construction for the pipework must be suitable for the water and environment it is in contact with.

The *Contractor* ensures positive sloping as far as possible to avoid stagnant areas when the system is drained. Pipes are equipped with vent valves for purging of air during start-up.

The *Contractor* marks all pipe work associated with the *works* with the description of the medium and direction of flow is clearly displayed and visible from a normal operating perspective.

Pipe Supports

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.

Pressure and Flow Measurement

Pressure and flow measurement connections to transmitters are to have 12mm OD tubing. The chemical nature of the application is taken into account when selecting the tubing material. Drainage connections are provided.

Vent/Drain lines

Drip trays are provided for the protection of electrical installations. The trays are drained to an approved position external to cubicles or panels. Alternatively, vent/drain tubes are run directly to drainage systems. The outflow is visible from the instrument.

The *Contractor* provides routing drawings of pipes and tubes to be installed under this contract before work commences for the acceptance of the *Project Manager*.

2.2.2.2.6 Tests and Inspections before delivery

- Vibration tests according to ISO 10816
- Pump hydraulic performance acceptance tests according to ISO 9906

2.2.2.2.7 Tests and Inspections

The *Contractor* performs the following site acceptance tests:

- Vibration tests according to ISO 10816

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- Confirm pump duty point
- System performance at minimum and maximum system flow rate
- Confirm that all control valves are operated within the valve's control range

The *Contractor*, as a minimum, includes the following on his QCP:

- Acceptance of all relevant documents, drawings and design phases
- All inspections required by the relevant codes and standards
- Confirmation of the Permit to Work
- Inspection of components on delivered to Site
- Anchor bolt position checks
- Position and dimension checks on all items before being grouted
- Alignment check for all piping connected to fixed components (vessels, pumps etc.)
- Inspections during flushing and pressure testing
- Plant inspection before safety clearance
- Plant labelling
- Issuing of all certificates
- All site acceptance tests

2.2.2.2.8 Fire Detection and Protection Requirements

The *Contractor* must provide a fire risk analysis as part of the design approval process to the *Project Manager* for review and acceptance. The *Contractor* shall implement the protection measures required to mitigate the risks identified in the fire risk analysis.

Fire Protection shall be done in accordance with the Eskom standard 240-54937450: Fire Protection & Life Safety Design Standard and is to be completed by an ECSA registered person (Pr. Tech/Pr. Eng.) who will sign off the designs and fulfil SAQCC requirements.

2.2.2.2.9 Heating, Ventilation and Cooling Requirements

The *works* shall be designed to cater for adequate illumination, ventilation, cooling and heating where applicable. The HVAC Design shall be done in accordance with the Eskom standard 240-70164623 Design Guideline for HVAC in the Eskom Coal Fired Power Stations, 240-102547991: General Technical Specification for HVAC Systems Standard, 240-56355731: Environmental Conditions for Process Control Equipment Used at Power Stations Standard and 240-56177186: Battery Room Standard.

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2.2.2.3 Civil and Structural Engineering Requirements

2.2.2.3.1 General Requirements

The *Contractor* takes full professional accountability and liability for the *works*.

1. The *Contractor* initially undertakes a geotechnical study/investigation that informs the construction of the *works*. The geotechnical investigation and report is undertaken and signed by a professionally registered Geotechnical Engineer/Technologist/Geologist (5 similar project experience). The report is adequate to inform/s all further construction works on site.
2. The Geotechnical report must include amongst other criteria include:
 - Intrusive geotechnical investigation works by means of trial pits (2 off 2,5 m deep) and dynamic probe super heavy/dynamic cone penetrometer tests to determine geotechnical input parameters required for design.
 - Identify soluble and collapsible soils condition
 - Soil laboratory testing to determine soil parameters required for civil engineering design of structures and layer-works. Special attention must be paid to the quality of the materials for usability on site in construction works.
 - The *Contractor* must make use of SANAS accredited laboratories. All geotechnical investigations and geotechnical reporting must be conducted by a professionally registered engineering geologist or geotechnical engineer.
3. The Geotechnical report must make recommendations that inform the design and construction of the *works*, and specification on the need of a structural engineer or other specialist engineering services
4. Should such a report initiate the services of a structural engineer , the *Contractor*, informs that PM of such and provides the PM with all the necessary professional Esca certificates, CV's and experience of the intended person for acceptance

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- All reports are provided to the to the *Project Manager* for review and acceptance and Any Survey drawings, design criteria/parameters, specifications and standards that were used, loadings, assumptions, calculations and results including detailed design calculations, design models, sources of information and any record of other information associated with the completed works. All calculation files and analysis/design models are also submitted in native electronic format together with the design report.

All engineering reports include any

5. Detailed drawings for construction. Drawings are also submitted in CAD formats (.DGN).
6. All submitted drawings to be signed by a Professional Civil Engineer or Technologist with ECSA registration number stated on drawing.
7. Construction Specifications for the *works*.
8. Any discrepancy or ambiguity between the *Employer's* Specifications or requirements is immediately brought to the attention of the *Project Manager* for clarification.
9. The *Contractor* is mandated in terms of Construction Regulations 2014: Duties of Designer, 6(1) a - j and 6(2) a – d, to fulfil the duties described therein for the detailed and temporary works designs done by the *Contractor*. Any risk associated with the *Contractor's* design is highlighted to the *Employer* together with mitigation measures. The *Contractor* is responsible for construction monitoring at the level required to certify that the *works* have been constructed in accordance with the *Contractor's* design.

2.2.2.3.2 Surveying

1. Should the works require any survey, The *Contractor* is responsible for the same(survey) for the detailed design of the works. The level of detail of the survey conducted is as required for the detailed design.
2. All surveys are done using the WGS84 coordinate system and are in accordance with TMH 11.
3. The *Contractor* is responsible for the complete surveying and setting out of the works including establishment and protection of any benchmarks required to complete the works.
4. The *Contractor* is required to consult the Surveyor-General's office to obtain information on available registered beacons in the vicinity to use for the establishment of any required benchmarks close to the works.
5. It is the *Contractor's* responsibility for the detection and protection of underground and above ground services prior to any excavations.

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6. Geophysical scanning is done by the *Contractor* to locate sub-surface utilities both metallic and non-metallic prior to any excavations. Hand excavations may also be done to verify the presence of underground services where required excavations for the works will not be deeper than the hand excavations.
7. Where Geophysical scanning is conducted, the type of scanning employed is at the discretion of the Contractor, taking note of the required output. The *Contractor* therefore considers the working environment prior to selection of test methodology and equipment.
8. The *Contractor* considers possible signal interferences which may be experienced by the geophysical scanning equipment caused by equipment, and services stray current in and around the areas.
9. The *Contractor* submits the results of the underground services detection activities to the *Project Manager* and indicates and possible services which may interfere with the *works*.

2.2.2.3.3 Structural

1. The *Contractor* is responsible for the design and construction of all associated Structural infrastructure required for the works including but not limited to foundations, supports, floor slabs, buildings etc. as required for the functioning of the *works*.
2. The *works* is enclosed with a 2.4m high security fence in accordance with 240-76368574: High Security Mesh Fencing Standard. A lockable pedestrian gate is provided as well as a lockable double swing gate.
3. The *Contractor* is responsible for the analysis and verification of any existing infrastructure impacted by or required to form part the *works*, including the implementation of any modifications required, taking full accountability for any changes made to existing infrastructure.

2.2.2.3.4 Stormwater and Drainage

1. The *Contractor* is responsible for the design and construction of all associated stormwater and drainage infrastructure required for the *works*.
2. The *Contractor* complies with all relevant legislation including Government Notice 704 of the National Water Act ensuring that all contaminated water or spillages are contained without discharge into the environment unless treated to discharge standards.
3. The *Contractor* ensures that all clean stormwater is returned into the natural surroundings without any adverse impact to the receiving environment.

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4. The *Contractor* is responsible for the design of the infrastructure required for the discharge of the treated effluent into the receiving environment such as channels, taking into account existing stormwater drainage and erosion control. The *Contractor* ensures that the discharge of the effluent will not adversely impact the receiving environment or result in the formation of wetland areas.

2.2.2.4 Electrical Requirements

The electrical *works* to be conducted by the *Contractor* includes basic and detail designs, manufacture and/or procure, the factory acceptance tests, supply and delivery to site, quality assurance, installation, site acceptance tests, commission and handover of power supply at the Kilbarchan Colliery for the mine water treatment system. The *Contractor* shall comply with the requirements detailed herein.

2.2.2.4.1 Available Power Supply at the Site

The current power supply onsite is a 11/0.415kV 315kVA pole mount transformer. This will be made available to provide power to the *works*.

2.2.2.4.2 Construction Power

The *Contractor* shall make use of the available power on site during construction phase, however, in the event that construction phase overlaps with commissioning phase, commissioning phase will have preference with the power requirements available on site and the surplus can be used with the remaining construction activities with the excess power requirement being provided by the *Contractor*. The *Contractor* shall also provide own distribution board for the supply of all construction activities on both sites.

2.2.2.4.3 Electrical Battery Limit

The electrical scope boundary is from the feeder cables on the distribution board on the LV side of the 11/0.415kV 315kVA pole mount.

2.2.2.4.4 Scope of Work

- During the submission of the *Contractor's* basic and detail design for acceptance by the *Employer*, the *Contractor* shall indicate the total power requirement for the *works*.
- The *Contractor* shall supply and install the correct feeder breaker to supply the *works*.
- The *Contractor* shall include in his detail design, small power and lighting design for the plant area.
- The *Contractor* shall ensure that the *works* is properly earthed to an earth mat and shall demonstrate that the plant is well protected against lightning strikes.
- LV Switchgear, Earthing and Lightning Protection, DC Power and UPS, Motors and Drives shall comply with Eskom's Standards as specified in section 5.4.

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2.2.2.4.5 Cabling and Racking

- The *Contractor* is responsible for the design, supply, delivery, quality assurance, install, test, commission and handover of power cabling and associated accessories for termination.
- Low voltage 600/1000 V cables shall be manufactured to latest SANS 1507 and SANS 1411 parts 1 and 2.
- PVC SWA cables shall be round steel wire armoured for burial in ground and for installations where mechanical stresses are expected.
- The *Contractor* shall use cables with connectors which are contact-proof and designed to avoid corrosion.
- All necessary cable racks shall be provided by the *Contractor* and these shall be provided such that every cable is adequately supported throughout its run.
- Where cables are laid in ground, such runs shall be shown in detail on appropriate drawings for reference purposes and protected by concrete slabs or yellow plastic cover plates and marker tapes. Every effort shall be made to run cables either in tunnels, trenches or sleeve pipes, should they have to be laid below ground level.
- The *Contractor* shall provide durable cable numbers on all installed cables and these shall be included in the cable schedules. All cables shall be labelled with standard UV resistant EP Type flexible cable markers on nine digit carrier strips and attached on both ends with suitable cable ties.
- The insulation resistance of each core to sheath or conduit and between cores of all cables shall be measured and recorded after the cable has been installed and made off.
- Cables having 110 V grade insulation or higher shall be tested by applying a voltage of 500Vdc for 1 min, as set out in SANS 5526. When performing insulation resistance testing, cable length and temperature (inclusive of temperature correction factor from OEM) shall be taken into consideration. Insulation resistance values shall be in line with Table 9 of SANS 1507-3 (2020).

2.2.2.4.6 Distribution Panels

The *Contractor* provides distribution panels for lighting and small power application, process plant loads and control & instrumentation loads in accordance to SANS 10142-1: The wiring of premises Part 1: Low-voltage installations. The distribution panels shall also satisfy the following requirements:

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- The distribution panel shall be constructed in such a way that it will be capable of withstanding all the mechanical, electrical and thermal stresses as well as the effects of dust ingress and humidity which will be encountered during normal operation.
- Cubicle doors shall be designed such that they close onto seals by means of pad lockable lever operated catches. Finishing colour shall be light grey G29 to SANS 1091. Cable entry shall be from the bottom or the top.
- The distribution panel shall be provided with an internal equipment cover plate in accordance with SANS 10142-1. The cover plates shall not be used to keep components in position. The cover plates shall be provided with hinges for opening/closing and shall be provided with a square key lock.
- The minimum thickness for the plate steel shall be 1.6mm.
- All incomer breakers on three phase distribution panels shall be rated a minimum of 32A with a minimum fault current level of 10kA.
- All bus-bars, wiring, terminals, etc., are to be adequately insulated and supported for fault current forces. The circuit breakers shall be mounted within the distribution panels to give a flush front panel.
- The distribution panels shall be equipped with correctly sized MCBs complying with SANS 556-1 and cascaded correctly for adequate protection of supplied loads.
- The distribution panel circuit design shall be such that the load distribution between the phases is even (within 10%).
- An energy meter shall be installed for monitoring of usage and system availability unless this can be derived from Inverters.
- Clearly engraved labels for the supplied loads shall be mounted on or below every switch. The wording of the labels shall be in English. Furthermore, a legend for the loads connected shall be provided within the distribution panels.
- The distribution panels may be flush mounted, surface mounted or floor standing. The *Contractor* shall assess and advise on the most feasible positioning of the distribution panel.
- The distribution panel shall have a dedicated MCB for the supply to control panel/ motor control centre for the process plant loads such as pumps.
- The *Contractor* shall obtain approval of the *Employer* before manufacturing the distribution panels.

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- All lighting and small power within the container shall be in accordance with the specified wiring code and SANS 10114-1.
- Area lighting shall be provided around the plant and shall satisfy the requirements of all applicable SANS 10389. The lighting shall have day/night switches.
- All lighting used shall be energy efficient.

2.2.2.4.7 Earthing and Lightning Protection

- The *Contractor* shall design the earthing and lightning protection system in accordance to SANS 62305: Protection against lightning and SANS 1063: Earth rods, couplers and connections. The earthing and lightning protection system shall be such that it eliminates the risk to personnel or animals of electric shock under normal operating conditions as well as fault conditions and for equipment protection during electrical faults and lightning strikes.
- The *Contractor* shall provide earthing drawings, reflective of As Built status of all electrically bonded equipment and container(s). Drawings shall indicate, as a minimum, the *Contractor's* designed earthing system itself, the connection points on the equipment etc.

2.2.2.4.8 General Requirements

- All transportation, storage, handling and installation of equipment are to be in accordance with the specifications from the manufacturers, as to not impact on the equipment manufacturer's warranties.
- All equipment shall be designed for the environmental conditions where they are to be located.

2.2.2.4.9 Documentation

All documentation shall be submitted as per the Vendor Document Submittal Schedule (VDSS) in Appendix A.4, at different project stages.

2.2.2.4.10 List of documents to be provided by the *Employer*

- The *Employer* provides the following documentation to the *Contractor*:
 - 240-56176097: Electrical Cable Schedule Template
 - 240-77300784: Electrical Termination Schedule
 - 240-56227927: Electrical Load List Template
 - 240-56356396: Earthing and Lightning Protection Standard

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2.2.2.5 Control and Instrumentation Requirements

2.2.2.5.1 General Requirements

The *Contractor* shall provide a PLC based control systems with an HMI SCADA for the control and monitoring of the Kilbarchan Mine Water Treatment Plant, meeting the functional requirements as contained within this section. The specification gives requirements for the system architecture, communication methods, and reliability and performance requirements for the control system. Included as well are interfacing requirements of all control components, such as instrumentation and actuation for control and monitoring.

Technology preference is given to PLC based SCADA systems for the automation system for industrial control applications, and the need for accomplishing networked communication with for remote control.

This specification covers the design, engineering, manufacture, inspection and testing at the manufacturer's works, supply, packing and delivery to site, unloading, storage and in plant transportation at site, erection, supervision, pre-commissioning and testing, commissioning and performance testing of the C&I system, along with associated control system components and devices specified herein.

It is not the intent of this specification to completely specify all details of the design and construction, but to give broad sizing and quality criteria for the major components, equipment and systems necessary to meet the functional requirements of the works.

The *Contractor* is to supply the following scope of works for C&I:

- The *Contractor* shall design, supply, manufacture, install, commission and document a PLC Control System. The proposal shall cover the following activities and services in respect to all equipment and works specified in various sections of this specification:
 - The workmanship shall be of the highest quality and shall conform to all applicable quality standards of the Original Equipment Manufacturer (OEM) and the *Contractor*.
 - All hardware components shall conform to the latest products based on industry standards.
 - Basic engineering design of all equipment and equipment systems shall be performed by the *Contractor*.
 - Detailed design of all the equipment and equipment system(s) shall be performed by the *Contractor*, and submitted to the *Project Manager* for design review and approval.
 - Providing engineering drawings, data, instruction manuals, as built drawings and other information for the review, approval and for records.

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- All items and equipment though not specifically mentioned in this specification, but is needed to complete the system to the intent of the specification shall be deemed to be included in the scope of the *Contractor*.
- The *Contractor* shall provide hardware configuration equal or above to meet the technical, functional and performance requirements, and shall provide a complete solution.
- All hardware / software required to meet the functional, performance and availability requirements shall be provided by the *Contractor*.
- The design and manufacturing of the PLC shall be in accordance with the applicable codes, standards and requirements mentioned in this specification.
- The PLC shall have the following features:
 - The PLC shall be of proven design and suited for plant operation and control.
 - The PLC shall have capabilities to execute control and closed loop control applications for all control functions forming part of the operating and control philosophy, perform interlocking functions and interfaces to electrical switchgear.
 - The *Contractor* is responsible for the compilation of a detailed operating and control philosophy document according to plant functions, which will form the basis of control programming within the PLC.
 - The PLC shall be of modular design and scalable. This would allow for the expandability and addition for new control modules, for increased control capacity. For example, power supply modules, CPU modules, communication modules, communication interface modules and modules for Input / Output purposes shall be expandable.
 - The PLC rack shall be of IP66 rating or higher.
 - The PLC shall allow for multiple signal types.
 - The PLC modules shall be hot swappable.
 - The PLC shall be designed around microprocessor based technology.
 - For ease of maintenance, the control architecture shall support pluggable modules on the backplane.
 - The field wiring shall be terminated such that they are easily detachable from the IO modules.
- The *Contractor* design for the integrated plant historian is to be able to be integrated to the Employer's Wonderware eDNA enterprise historian.

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- The *Contractor's* design regarding the remote monitoring of the works is to be sent to the *Project Manager* for review and acceptance prior to any procurement and installation. The *Contractor* is to ensure compliance to the *Employer's* information security requirements as indicated in section 5.6 for the remote monitoring of the works.

2.2.2.5.2 Basic PLC Functions

The PLC control system shall perform all the control functions necessary for the operation and control as per the operating and control. In addition, all functional capability described herein shall be provided by the *Contractor*, and designed to form a holistic control solution.

The basic functions of the PLC shall consist of the follow points as a minimum:

- The CPU of the PLC shall be configured as a single PLC (simplex).
- The power supply of the PLC shall be redundantly configured.
 - Redundant 24V DC Power Supply Modules.
 - Redundant 220V AC Power Supply Modules (where applicable).
- The PLC shall perform all analogue and binary data acquisition, control processing and commands for actuation.
- The PLC shall be capable of data acquisition through various instruments and transmitters, having signal ranges of 4 – 20mA, 0 ± 10mA, 0 ± 10V etc., configurable using the analogue modules. Binary signals shall be 0 – 24V DC, configurable from the binary modules.
 - 24V DC Digital Input Modules.
 - 24V DC Digital Output Modules.
 - 4 – 20mA Analogue Input Modules.
 - 4 – 20mA Analogue Output Modules.
- Receiving and processing of digital commands and communication from the HMI SCADA system, for operator control and monitoring.
- The PLC shall have the capability of time synchronisation with a GPS receiver system. The GPS system shall use NTP.
- In addition, the PLC system shall have integrated real time clock modules.

2.2.2.5.3 Availability, Maintainability and Equipment Life Cycle

a. Availability

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The PLC control system shall be designed to provide a high degree of safety as well as availability. This would reduce the risk of control system failures and loss of production. The PLC shall be having an availability of greater than 99.9%.

Therefore, to ensure this degree of availability, the PLC shall be fabricated, assembled and finished with the highest production quality and shall conform to all applicable quality control standards. Nonetheless, the manufacturer's standard designs shall be used to the fullest extent possible.

Software updates and upgrades for planned and unplanned maintenance shall be included as part of the availability calculations. Hardware upgrades shall require an emphasis on online maintenance of control system components.

b. Maintainability

Documentation necessary for the support and maintenance of the PLC control system shall be provided. This is to facilitate the operation and repair of the PLC. Although periodic preventative maintenance activities may be required for the upkeep of the PLC, any such work shall be performed without the need to de-energise networks of the associated control circuit. Therefore, to facilitate maintenance activities, a modular design shall be used.

c. Equipment Life Cycle

The PLC control system shall have a design life of at least 15 years from the date of final acceptance. The *Contractor* shall make available, at no cost to Eskom, the manufacturing designs, technical drawings and the rights to manufacture any sub-assemblies that the manufacturer (*Contractor* / OEM) will not support or discontinues to support during the life span of the equipment.

2.2.2.5.4 C&I Specification of the works

Given below is an overview of the required control system architecture (conceptually). The *Contractor* to meet functional and operational requirements as described below. Figure gives an overview of the desired control system architecture and its functional interface to the PLC solution.

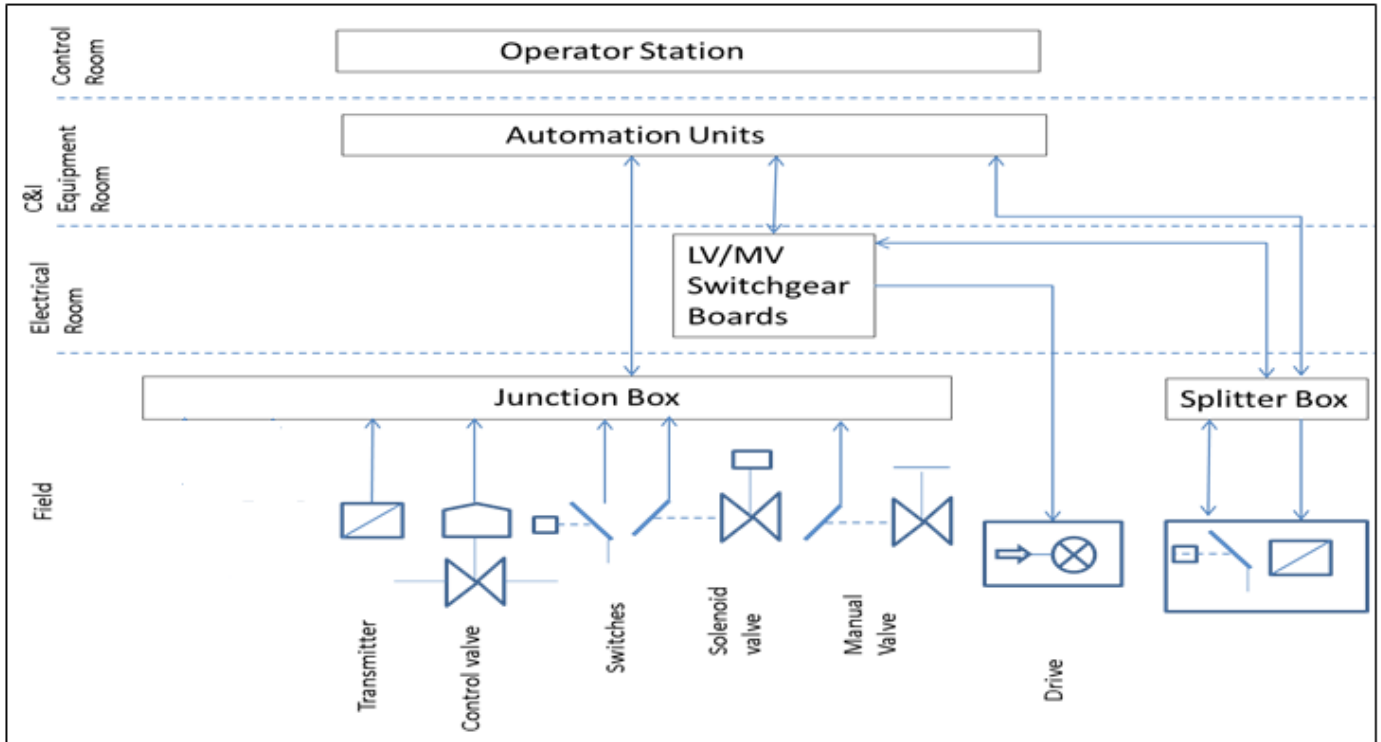


Figure 3: A typical C&I design architecture for WTP

The works can be broadly divided into the following parts:

- Supply, design, of a PLC based system, with relating HMI SCADA.
- All instrumentation and actuators for the plant is provided and installed by the *Contractor*. All interfaces are verified, commissioned by the *Contractor* for functional performance and integration to the control system.
- Installation of all Plant field instrumentation.
- Installation valve actuators with integrated local control.
- Installation of all field cabling, truck cabling for Control Systems and Power Supply.
- Installation of new flow, pressure measurement, which includes all installation requirements of primary devices as requirement measurement principle.
- Installation of new online analyzers to monitor the feed water quality, which includes all installation requirements of primary devices as requirement measurement principle.
- Perform all engineering for interfaces to the PLC installation, HMI configuration, and system archiving functions to meet the operational and functional requirements of the scope.

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- The *Contractor* also provides for an integrated plant Historian. The integrated plant historian is to be able to be integrate to the Employer's Wonderware eDNA enterprise historian.
- All functional components and interfaces are monitored and archived.
- The *Contractor* shall integrate the technical schedules, wiring diagrams and other applicable engineering documents and shall document a complete document package according to the VDSS.

2.2.2.5.5 Design of Control System Equipment

The *Contractor* shall be responsible for the Design, Engineering of Hardware and Software Engineering, its Configuration, Commissioning and Testing of all C&I related equipment and interfaces to existing control system.

- The *Contractor* shall provide all equipment, services and executes all work in accordance with the requirements specified in this Specification.
- The *Contractor* is responsible for all system interfaces, and modifications required to interfacing.
- The *Contractor* shall engineer the PLC control solution as a fully operational system, and implemented in a consistent and integrated manner.
- The control system solution shall use standard function blocks with all software and hardware implemented in a standard manner, configuration and design.
- The PLC solution shall perform the following functions, for control system operations and control. All control functions as listed below shall be provided as a complete functioning system.
 - Analogue and Binary Control.
 - Process Interlocking, Safety and Protection Functions.
 - Data Acquisition, Signal Conditioning and Signal Validation.
 - Networked Data Communications.
 - Engineering Functions and Configuration Processing.
 - Alarm Management.
 - Operating and Supervisory Functions.
- The *Contractor* shall supply the following schedules and engineering documents in accordance with the VDSS as contained within the Appendix A.4
- The scope shall include the following as well, and list here for reference.

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- Drive and Actuator Schedule – The *Contractor* is responsible for the engineering of the Drive and Actuator Schedules, in compliance the Design Requirements.
- Instrument Schedule – The *Contractor* is responsible for the engineering of the Instrument Schedule, in accordance with the Design Requirements.
- Electrical Load Lists – The *Contractor* is responsible for the engineering of the Electrical Schedules in compliance to the Design Requirements.
- Switchgear Schedules – The *Contractor* is responsible for the engineering of the Switchgear Schedules in accordance with the Design Requirements (Basic & Detailed Design).
- The Design Requirements refers to the Basic and Detailed Design elements forming part of the scope of work relating to Control and Instrumentation. The *Contractor* is responsible for this design and the delivery of the related Engineering Documentation and Design.
- The design applies to both Hardware and Software Engineering Functions and the Functional requirements for meeting the requirements of the PLC, SCADA and HMI.

2.2.2.5.6 C&I Design

a. Field Design

The *Contractor* must ensure that field installation inclusive of instrumentation, junction boxes, cabling and racking shall be properly labelled with permanent labels that will not be effortlessly removed. All labelling shall be consistent throughout the plant. Field device labels must be made of stainless steel, text on labelling be engraved as per the 240-563554: Field Installation Standard.

- Field equipment shall be designed according to 240-56355815: Field Instrument Installation Standard - Junction Boxes and Cable Termination and 240-56355754: Field Instrument Installation Standard whilst also adhering to SANS 10108 Hazardous area classifications.
- All equipment shall be installed in accordance with the manufacturer's instructions, listed standards and industry best practices. Additional protection hoods and enclosures must protect those transmitters situated outdoors or in adverse environments.
- Flow Transmitters
Flow transmitter will provide flow at the control room with a totalizer to account for water used on monthly basis. The *Contractor* to follow the 240-563554: Field installation standard when installing flow transmitters.
- Signal and trunk Cabling
UGV cable and Field/Trunk Cable installations will be used to transfer instrumentation from field to control room according to 240-56355815: Cabling standards.

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- Junction Box

New junction box to be provided to terminate all new instrumentation and valves. All field equipment shall be selected according to the environment in which they will operate in. Junction boxes shall be properly labelled with permanent labels that will not be effortlessly removed. The *Contractor* must follow this standard for 240-563555: Junction box and cable termination.

b. Control System Design

The *Contractor* to provide full Control System Design that will monitor and control the plant; it must come with I/O, design of Control Logics, HMI design and selected Field Design. The *Contractor* needs to follow the 240-723447: Control system installation guideline.

- I/O Modules

I/O modules will be used on all Process Measurements, control system Outputs for binary and control. As a minimum, the following I/O signals are catered for;

- Analogue Inputs (4 – 20mA) for measurement of all process monitoring parameters.
- Analogue Outputs (4 – 20mA) (in case of Modulating Control for I to P).
- Binary Inputs (24V DC) for feedback monitoring (for Limits).
- Binary Output (24V DC (in case of Solenoids and S/G Interface).

- Control System Requirements

The *Contractor* shall provide a control system which will control all equipment, perform logic functions and processes for the system. All control functions are engineered within the control system and interface with the I/O modules for the execution of control commands. Engineering includes all Hardware Engineering, Software Engineering, and Configuration of the Control System.

As part of the hardware design, the control system will be used for the control and monitoring of the plant. The hardware design consists of the following components which form part of the C&I interface for control and monitoring.

The *Contractor* must follow the 240-723447: Control System Installation Guideline.

c. HMI Design

The *Contractor* shall provide HMI design that shall be engineered to match the Process Diagram and Control Functions abiding by 240-563558: HMI standard document number, HMI mimics for control and monitoring interfaces and configuration. The *Contractor* shall provide historian and trending design as part of the HMI design for investigation purposes. The Operator interface (HMI) must be connected

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via the control network to the process control system. Alarming to the operator will be accomplished through the process control system HMI abiding to the 240-563556: Alarm standards.

Plant Information System The PIS (Plant Information System) is the central database repository for the long term storage of all plant information produced at the WTP. This includes plant information generated by the C&I system.

The *Contractor* provides an integrated PIS with the following functionality:

- The PIS stores all plant information and tags from the Plant.
- The PIS is able to store each analogue tag according to the amount of change in the tag value, where the amount of change is specified by the user.
- Data Quality and Validation
 - The control and validation procedures are set up to ensure that all data transferred to the PIS is correct and relevant before being stored in the PIS database(s)
 - The PIS indicates and stores data which has been identified as “bad or corrupt” by the C&I system in a clearly defined way.
- PIS Database(s)
 - The PIS database(s) stores online all plant information produced at Plant.

d. C&I Power Distribution

The *Contractor* is responsible for the Power Distribution System C&I System. The *Contractor* is responsible for the power distribution design of the 220V C&I DB’s to all the 220V C&I Loads. The *Contractor* shall provide for a standby time of 4 hours for both AC and DC systems.

e. Testing and Commissioning

Testing shall adhere to at least the minimum requirements set by IEC 62381 (Automation systems in the process industry - Factory Acceptance Test (FAT), Site Acceptance Test (SAT), and Site Integration Test (SIT)).

Provision within the scope also makes rooms for Testing and Commissioning of each control loop for each Plant Area and shall be tested in accordance with the design objectives

As a minimum, the following functions shall be tested.

- Instrument Calibration, settings and configurations for Pressure and Flow Transmitters.
- Actuator Settings (Testing and Commissioning of Actuators – such as I to P’s, Solenoids, and Positioners).

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- Commissioning and Testing of Control Logics, its functions and controllability.
- Manual and Automatic Functions.
- Control from the HMI, and Operator actions.
- Alarms and Control Response.

Each of the aforementioned shall have dedicated test procedures and documents necessary for testing.

f. Spare Capacity in Enclosures, Trunking, Conduits, and Racking

The *Contractor* to provide trunking, junction boxes, enclosures and racking has 20% spare capacity, rounded up. All conduits have 50% spare space capacity, rounded up.

g. Earthing and Lighting Protection

The *Contractor* shall implement the correct earthing concept for reliable operation. All earthing concepts will follow as a minimum the OEM best practices and 240-56356396: Earthing and Lightning Protection Standard to ensure safe and reliable operation. The integrity of the earthing system will be tested upon completion of the C&I installation to ensure compliance.

h. Power Supplies

The Control System shall accept, a normally 24V DC direct current power source, redundantly configured. All equipment, Control Modules, IO Modules and other, shall be supplied with supplies with fault tolerance and fault monitoring capabilities. The power supplies shall be monitored for failures, and alarmed on the Plant Operator HMI.

i. Computer Hardware and Software

The *Contractor* shall comply with Eskom standard for the 240-75651280: Functional Measurement Requirements for Network Management. The System Hardware shall be suitable for installation in a building meeting the stated Environmental Conditions of the Control System and its Components. Hardware and Software design shall be performed to meet the functional specifications of the Control System Equipment and of the Functional and Operational Specifications of the Controlled Plant.

2.2.2.5.7 C&I Documentation

The *Contractor* is required to provide the following engineering documents as part of his design for C&I according to the 240-85521112: C&I Documentation Requirements from Vendors Template:

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- Drive and Actuator Schedule – The *Contractor* of the Drive and Actuator Schedules, in compliance the Design Requirements.
- Instrument Schedule – The *Contractor* is responsible for the engineering of the Instrument Schedule, in accordance with the Design Requirements.
- Limit Off Supply and Services – The *Contractor* is responsible for the engineering of the Limit Off Supply and Services, in accordance with the Design Requirements.
- C&I Design – The *Contractor* is responsible for the engineering of the C&I Design, in accordance with the Design Requirements.
- Preliminary cable rack design and routes – The *Contractor* is responsible for the engineering of the preliminary cable rack design and routes, in accordance with the Design Requirements.
- Preliminary cable schedules – The *Contractor* is responsible for the engineering of the preliminary cable rack design and routes, in accordance with the Design Requirements.
- Preliminary I/O count – The *Contractor* is responsible for the engineering of the preliminary I/O count, in accordance with the Design Requirements.
- FAT Procedure (preliminary) - The *Contractor* is responsible for the engineering of the FAT Procedure (preliminary), in accordance with the Design Requirements.
- Operational Acceptance Test Procedure (preliminary) - The *Contractor* is responsible for the engineering of the Operational Acceptance Test Procedure, in accordance with the Design Requirements.
- Project Drawings – The *Contractor* is responsible for the engineering of the C&I Drawings (P&ID), in accordance with the Design Requirements.
- Function I/O Block Diagram – The *Contractor* is responsible for the engineering of the C&I Function I/O Block Diagram, in accordance with the Design Requirements.

2.2.3 Design Review

- The design reviews will occur on the *Contractor's* respective engineering discipline design packages and is to occur in the following order:
 - Chemical/Process Design Package
 - Mechanical Design Package
 - Control and Instrumentation Design Package
 - Electrical Design Package
 - Civil and Structural Design Package

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These design packages will be submitted to the *Project Manager* and will be reviewed for acceptance by the *Employers* representatives. The *Contractor* is not required to wait for feedback from the *Project Manager* with respect to the outcome of the review process in order for them to start with the development of another design package.

- The design documentation shall be submitted to the *Project Manager* as stipulated in the *Works Information*. The *Project Manager* accepts or rejects as stipulated in the *Works Information* after the design is submitted.
- All design work is signed and approved by the Professional Engineer/Technologist (mechanical, electronic, electrical, chemical, civil etc.) responsible for their preparation before being submitted to the *Project Manager*.

2.2.4 HAZOP Study

The *Contractor* shall conduct a HAZOP study with the participation of the *Employer* prior to the detailed design freeze. Upon completion of the study, the HAZOP report shall be issued to the *Project Manager* for acceptance.

2.2.5 Tender Returnables

The *Contractor* is to submit the required documentation as indicated in Appendix A.3 as part of their tender returnable.

2.3 PROCEDURE FOR SUBMISSION AND ACCEPTANCE OF *CONTRACTOR'S* DESIGN

The *Contractor* establishes a document tracking system to record the dates for the supply and receipt of all design drawings, calculations, requests for information and design documentation.

The *Contractor* is to supply the following documentation as the minimum requirements of this specification in the basic and detailed design packages to the *Project Manager* for the *Employers* review and acceptance before any manufacturing, construction or commissioning commences:

- Document submittal schedule indicating when all documents will be submitted
- Drawing Register indicating when drawings will be submitted
- Complete detailed design file
- Functional Specifications
- Mass and Energy Balance

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- Line Sizing Calculations and Material Selection
- Final isometric and general arrangements illustrating pipe dimensions, pipeline layouts and showing pipe supports
- General Arrangement Drawing of System and boundaries (for the plant, control panel for trace heating and electrical panel)
- Piping and Instrument Diagrams
- Component material datasheets
- Constructability Assessment
- Quality Control Procedures
- Quality Control Plan and Inspection and Test Plan
- Method Statements
- Commissioning procedures
- Assembly procedures
- Operating and Control Philosophies
- Maintenance Philosophy
- System curves and pump curves (for applicable motive water pumps)
- Updated P&ID's with coding
- Loop Diagrams
- Field termination drawings
- Pipeline Schedule
- Instrument schedule
- Drive and Actuator Schedules
- Mechanical Hook-up diagrams
- Electrical Hook-up diagrams
- I/O block diagrams
- LOSS diagrams
- Alarm list

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- Cubicle Internal Equipment Schedule
- Functional Distribution (Allocation of field devices to I/O)
- Detailed I/O List and Channel Assignments
- Electrical cable schedules
- C&I cable schedules
- Electrical termination schedules
- C&I termination schedules
- Instrument datasheets
- Instrument calibration certificates
- Valve datasheet
- Schematics for the electrical design
- Critical Spares List
- PLC operating and maintenance manual
- Welding Procedure Specifications
- Welding Procedure Qualification Record
- Operating, Maintenance and Engineering Training Manuals

2.4 OTHER REQUIREMENTS OF THE *CONTRACTOR'S* DESIGN

2.4.1 Human Factors Engineering Requirements

The *Contractor* is to ensure that ergonomics are considered for installation, operation and maintenance of all equipment.

2.4.2 Physical Characteristics Requirements

The *Contractor* is to ensure that the design of the system is consistent throughout; such as valves, pumps and tanks. This is to include the same type and mode of operation for the valves and pumps.

All equipment shall be protected from external ingress, corrosion and be explosion proof where applicable.

The design of the system shall cater for the lifting and removal of all plant equipment.

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The *works* shall fit in the existing areas and no new areas will be identified for large or extra equipment/plant.

The *Contractor* is to ensure that the current ergonomics of the plant are to be improved with the implementation of the *works*.

2.4.3 Corrosion Protection

The system is designed to ensure that equipment is adequately protected from physical damage and corrosion during storage and erection.

2.4.3.1 Internal Corrosion Protection

The required internal corrosion protection required for a system is dependent on the properties of the liquid in contact with it. The *Contractor* is to comply with all sections of the *Employer's* Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings (240-101712128).

2.4.3.2 External Corrosion Protection

External corrosion protection for a system is dependent on its operating environment. The *Contractor* is to comply with all sections as per the *Employer's* Standard for the External Corrosion Protection of Plant, Equipment and Associated Piping with Coatings (240-106365693).

2.4.4 Welding Requirements

The *Contractor* is to provide all the welding and related documentation to *Employer's* Welding Engineering for review and acceptance prior to any welding activity.

All welding conforms to the following:

- 240-106628253, Standard for Welding Requirements on Eskom Plant
- 240-83539994, Eskom NDT Personnel Approval (NPA) for Quality Related Special Processes on Eskom Plant Standard

2.4.5 Plant Life Cycle

The *Contractor* in providing the *works* is to ensure that the life cycle for the *works* is to have a minimum life of 15 years.

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2.4.6 Testing and Commissioning

The price shall include all allowances for testing and commissioning whereby all sections of the system are made ready for full duty operation.

Testing and commissioning shall include as a minimum:

- a) The services of skilled Engineers to supervise the testing and commissioning and making ready for the full duty operation of the complete *works*.
- b) All management, supervision, labour, tools, instruments, chemicals and other consumables, test apparatus, calibration equipment and any other equipment and facilities as may be necessary.

The *Contractor's* preliminary trials and commissioning of the plants shall be carried out by the *Contractor's* representatives, who shall remain in attendance until such time as the plants are working to the *Employer's* satisfaction. A requirement of these trials is a 72 hour performance test to determine that all activities as laid down in the operating manuals are correct and are carried out in the correct sequence and to determine that all the plants have been provided as required in the scope of *work*.

The *Contractor* is required to ensure the following requirements are met as part of the performance test period:

- The throughput through the *works* is a minimum of 0,5ML/day
- The product water quality produced from the *works* complies with the minimum water quality objectives specified in Appendix A.2.
- The *Contractor* takes three manual samples of the treated water quality produced by the *works*. One for their own independent analysis and two which will be provided to the *Employer*

The operating and maintenance manuals shall be submitted at least 3 weeks prior to the start of commissioning for acceptance by the relevant employer's representative. The *Contractor* is to supply all data books with signed ITPs and As build drawings of the works.

Commissioning of the system shall be done by the *Contractor's* staff with the *Employer's* dedicated operations/commissioning staff.

The *Contractor* submits a commissioning schedule and program for acceptance by the *Project Manager* by the contract date.

Before plant and equipment is placed in service the *Contractor* certifies that it is in a suitable and safe condition. In addition, the *Contractor* provides a complete list of numbered schematic, wiring and cable diagrams which are a true record of the plant and equipment as installed and certifies that the system has been wired in accordance with these diagrams.

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Prior to the time when commissioning is to commence, the *Project Manager* will appoint a representative who will co-ordinate the commissioning of all plant and equipment forming an integral part of the system being commissioned. The *Contractor* is responsible for the commissioning of all the plant and equipment he/she is to supply to the requirements of this specification in conjunction with the *Project Manager* and the *Employer*. Where various components are already in place, or are supplied by the *Employer* to form an integrated system, the *Contractor* at the time of commissioning, carries the responsibility for the correct functioning of the whole system.

In the event of incorrect functioning, the *Contractor* determines the cause and he/she corrects the defect if the defect is within plant and equipment of his/her own supply. The *Contractor*, at the time of commissioning, has the agreement, or alternatively, the attendance of the *Project Manager* involved in a particular phase, before proceeding with commissioning. Consequently, the *Contractor* must assure himself/herself as to the safety of his/her own plant and equipment in respect of any particular commissioning test and in the event of damage accept responsibility for such plant and equipment.

The Contractor is to ensure compliance to the requirements as specified in the *Eskom* Standard for On-Site Commissioning for Low Pressure Systems (240-56356376).

2.5 SAFETY AND RISK MANAGEMENT

2.5.1 General

All parties (i.e. the *Contractor* and the *Employer*) involved in this project shall adhere to the General Safety regulations of the Occupational Health and Safety Act (Act 85 of 1993), Mine Health and Safety Act, Act 29 of 1996 (MHSA), Eskom Lifesaving Rules and Occupational Health and Safety Act (Act 85 of 1993): Construction Regulations, 2014.

The *Contractor* ensures safety awareness at all times through continuous training.

Operating and maintenance philosophies development will consider the safety of personnel and equipment.

The control system used to automate the process will have the functionality to prevent/avoid situations where the process state puts the safety of personnel and plant at risk. The control system will automatically perform all interlocking and protection according to the operating philosophy.

The *Contractor* shall at all times be responsible for the supervision of its employees, agents, subcontractors and mandatories and shall take full responsibility and accountability for ensuring they are competent, aware of the SHEQ requirements and that they execute the project in accordance with the SHEQ requirements.

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The *Contractor* ensures that all statutory appointments and appointments required by the employer are made and that all appointees fully understand their responsibilities and are trained and competent to execute their duties. The *Contractor* supervises the execution of their duties by all such appointees.

2.5.2 Meetings

Monthly management safety briefings/meetings to be conducted for the entire team on site shall be mandatory.

2.5.3 Housekeeping

The *Contractor* will ensure that the site is cleaned daily. All electrical cables and hoses are routed so as not to cross over floors and walkways. All equipment is packed neatly without interference to access. All excess scaffolding material is removed from site after the scaffolding is erected. Scrap bins are made available by the *Contractor* and the *Contractor* is responsible for their removal to the designated scrap area on a daily basis.

2.5.4 Barricading

Access to danger zones is restricted using handrail type guards of at least 1.2 meters high and able to block access to the danger zone. Symbolic safety signs depicting 'Danger' and 'No entry' are attached to the guards.

2.5.5 Safety of workers

Risks associated with the system are the responsibility of the appointed *Contractor* and will be managed by the *Project Manager* in conjunction with the *Contractor*.

The *Contractor* ensures the safety of all persons working in the Site. All welding, flame cutting and grinding work is properly screened to protect persons from arc flashes or eye injuries. Fire blankets are fitted over the scaffolding planks and platforms. Precautions are taken to prevent any objects welding or grinding splatter from falling.

The *Contractor* shall comply with the following requirements:

- Baseline SHE risk assessment which will identify the risk that they will be exposed to.
- Risk register (updated annually) to be developed and maintained;
- Job Safety Analysis to be conducted and records kept;
- The minimum required PPE must be kept and maintained.
- Ensure access to medical treatment facilities are provided, arrangements to be made with local municipality for emergency response requiring advanced life support services;
- Ensure records pertaining to fitness for work are kept;

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- Ensure an induction training procedure and consent system is in place for all visitors and employees.
- Ensure evacuation drills are conducted regularly from the main work areas;
- Tool box talk to be discussed at the beginning of each task.
- A copy of the legal appointments and related qualifications where applicable Record of Legal Appointments.

2.5.6 Fire Protection

Precautions are taken to prevent any occurrence of fires or explosions while carrying out any work near the gas and fuel oil systems. Ensure firefighting systems are in place, arrangements with municipality for emergency response.

2.6 USE OF *CONTRACTOR'S* DESIGN

The completed design will become the property of the *Employer*.

2.7 COPYRIGHT ISSUES

The *Employer* requires that the *works* is to be operated by *Others*. The *Contractor* is to make the *Employer* aware of any copyright and or intellectual property issues associated with their design. These issues are to be resolved between the *Employer* and *Contractor* to ensure that the *Employer* is able to operate and maintain the *works*.

2.8 DESIGN OF EQUIPMENT

All plant, equipment and material supplied shall be designed with due regard for the need for effective operation under variances in water qualities. The materials of construction of all components of the works are to be suitable for use under the varied process conditions as well as in the different atmospheric conditions of the Newcastle area.

All plant, including electrical and process control and instrumentation components are designed, selected and located by the *Contractor* taking into account the ambient conditions, including operational conditions, resulting from the existing plant and process such that the works efficiency and reliability is not impaired.

2.8.1 Inspection and Testing of Materials and Equipment at the Manufacturer's Works

All material and equipment is to be comprehensively tested prior to delivery. The *Contractor* supplies a schedule and program of all the tests that are to be carried out. The *Contractor* provides a test certificate for each test performed. The *Project Manager* accepts the format of this certificate. The *Contractor*

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indicates the details of tests he proposes to perform and the manner in which the results of tests will be documented.

Specimen tests used by the *Contractor* are also submitted.

The *Project Manager* reserves the right to appoint a representative or representatives to inspect all parts during manufacture and erection and to be present at any of the tests specified.

The *Contractor* is not relieved of his responsibilities if the *Project Manager* chooses to waive the witnessing of any tests.

Such tests as may be required by the *Project Manager* are carried out by the *Contractor* after erection to prove compliance with the specification independently of any test which may have been carried out at the manufacturer's works.

The *Contractor* must provide current calibration certificates for all test equipment used when required to do so by the *Project Manager*.

2.8.2 Packaging, Handling and Transporting Requirements

The *Contractor* is to provide a plan for the transportation, handling and storage of all plant equipment during the execution phase. The plan will specify requirements for logistical support during delivery, transportation and storage of components, e.g. requirements for the labelling, packaging, handling, transportation and storage of the system/components for the *works*.

2.9 EQUIPMENT REQUIRED TO BE INCLUDED IN THE *WORKS*

The *Contractor* shall prepare and submit a project Inspection and Test Plan (ITP) for all equipment included in the scope. The project ITP shall detail all elements of the plant and shall itemize the required quality levels for each of these components.

The *Contractor* shall indicate in the project ITP which items are of a proprietary nature where the level of certification is limited to standard documentation and certificates of conformity. The *Contractor* shall use only ISO 9001 accredited suppliers for these products. Evidence of ISO 9001 certification shall be supplied with the delivery documentation. Failure to include this certification at the time of delivery shall result in rejection of the equipment by the *Employer*.

All equipment not shown as proprietary equipment in the project ITP shall be designed / manufactured / constructed by an ISO 9001 certified organization. The relevant portions of the project ITP shall be issued to the supplier to ensure that all of the quality requirements are complied with. The supplier shall develop and apply approved quality plans for the design / manufacture / construction / testing / commissioning of

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the equipment. Each of these quality plans shall be submitted to the *Employer* for review and inclusion of intervention points.

2.10 DOCUMENTATION REQUIREMENTS

The *Contractor* establishes a document tracking system to record the dates for the supply and receipt of all design drawings, calculations, requests for information and design documentation.

2.10.1 Document Management

The *Contractor* shall include the *Employer's* drawing number in the drawing title block. This requirement only applies to design drawings developed by the *Contractor* and his *Subcontractors*. Drawing numbers will be assigned by the *Employer* as drawings are developed.

2.10.1.1 Document Submission

The *Contractor* is to supply the following documentation as the minimum requirements of this specification in the design package to the *Employer* for acceptance before any manufacturing, construction or commissioning commences:

- Document submittal schedule indicating when all documents will be submitted
- Drawing Register indicating when drawings will be submitted
- Complete detailed design file
- Functional Specifications
- Mass and Energy Balance
- Line Sizing Calculations and Material Selection
- Final isometric and general arrangements illustrating pipe dimensions, pipeline layouts and showing pipe supports
- General Arrangement Drawing of System and boundaries (for the plant, control panel for trace heating and electrical panel)
- Piping and Instrument Diagrams
- Component material datasheets
- Constructability Assessment
- Quality Control Procedures
- Quality Control Plan and Inspection and Test Plan
- Method Statements
- Commissioning procedures
- Assembly procedures

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- Technical, Operation and Maintenance Manuals of all plant equipment
- Operating and Control Philosophies
- Maintenance Philosophy
- System curves and pump curves (for applicable motive water pumps)
- Updated P&ID's with coding
- Loop Diagrams
- Field termination drawings
- Pipeline Schedule
- Instrument schedule
- Drive and Actuator Schedules
- Mechanical Hook-up diagrams
- Electrical Hook-up diagrams
- I/O block diagrams
- LOSS diagrams
- Alarm list
- Cubicle Internal Equipment Schedule
- Functional Distribution (Allocation of field devices to I/O)
- Detailed I/O List and Channel Assignments
- Electrical cable schedules
- C&I cable schedules
- Electrical termination schedules
- C&I termination schedules
- Instrument datasheets
- Instrument calibration certificates
- Valve datasheet
- Schematics for the electrical design
- Critical Spares List
- PLC operating and maintenance manual
- Welding Procedure Specifications
- Welding Procedure Qualification Record
- Operating, Maintenance and Engineering Training Manuals

All project documents must be submitted to the *Project Manager* with transmittal note according to Project / Plant Specific Technical Documents and Records Management Work Instruction (240-76992014). In

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order to portray a consistent image it is important that all documents used within the project follow the same standards of layout, style and formatting.

The *Contractor* adheres to the following standards:

- Documentation Management Review and Handover Procedure for Gx Coal Projects (240-66920003).
- Project Documentation Deliverable Requirement Specification (240-65459834).
- Technical Documentation Classification and Designation Standard (240-54179170).

2.10.1.2 Engineering Change Management

All Design change management shall be performed in accordance to the latest revision of the *Employer's* Project Engineering Change Management Procedure (240-53114026). All design reviews will be conducted according to the Design Review Procedure (240-53113685).

2.10.1.3 DRAWINGS FORMAT AND LAYOUT

The creation, issuing and control of all Engineering Drawings will be in accordance to the latest revision of 240-86973501: Engineering Drawing Standard. Drawings issued to *Employer* will be a minimum of one hardcopy and an electronic copy. The *Contractor* submits electronic drawings in Micro Station (DGN) format, and scanned drawings in pdf format. No drawings in TIFF, AUTOCAD or any other electronic format will be accepted. Drawings shall not be "Right Protected" or encrypted.

2.10.2 As-built drawings, operating manuals and maintenance schedules

All as-built drawings, operating manuals and maintenance schedules to be available to the *Employer* as soon as the plant is ready for commissioning. All drawings and reports compiled for the works are to become the property of the *Employer* on completion of the *works*.

The *Contractor* ensures the following:

- Submit four prints of all "as built" drawings with approval signatures at Completion by the ECSA registered professional engineer as required by the design, backed up on the electronic medium.

2.10.3 Technical, Operating and Maintenance Manuals

The *Contractor* provides operating and maintenance manuals prepared by experienced personnel. The maintenance manuals must state explicitly the maintenance requirements for each piece of equipment. Copies of the first draft manuals as well as all "as built" drawings are submitted to the *Project Manager* for acceptance. Manuals are in English and each manual is complete with the Project's name, contract number and index. The *Contractor* must also provide an electronic copy of these documents.

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The manuals should indicate the level of responsibility of the operating personnel for each action in the procedures. Included in these manuals are the following:

- Design data including descriptions of control philosophy with alarms, set-points, interlocks and logics clearly explained.
- Process and instrumentation diagrams.
- Range, calibration factors, calibrations certificates, data sheets, etc., for all control and instrumentation equipment.
- Electrical diagrams.
- General arrangement and installation drawings and instructions.
- Operating procedures and instructions for normal and emergency conditions, including flow diagrams.
- Maintenance procedures and instructions for specific plant and equipment.
- All drawings required for component location, dismantling and re-assembly for maintenance.
- Equipment details such as make, model, type, specifications, etc.
- Detailed parts lists and ordering instructions pertaining to storage of spare parts or to their shelf life.
- Exploded view type drawings clearly detailing the part and uniquely identifying it, technical descriptions of the equipment and component parts.
- Catalogues, schedules and other product support documents.
- Troubleshooting and fault finding guide.
- Safety procedures and instructions.
- All special tools and equipment required for maintaining and operating the works.

The maintenance manuals shall be separated into mechanical, electrical and C&I volumes.

The technical manuals shall include fully detailed descriptions, as-built drawings, diagrams, illustrations, schedules and data for use by *Employer's* technical staff to evaluate performance, trace faults, adjust, maintain and fully understand the plant and plant equipment and to allow satisfactory training of junior staff in conjunction with the operating manuals.

The operating manuals shall be set out in simple terms in ordinal, tabular or pictorial form to provide factual and concise descriptions of:

- How to carry out start-up, shut-down, and service operation of the plants by automatic, semi-automatic and by manual control.

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- What happens when the plants are operated, e.g. where does the water, chemical, air, etc. flow when a sequence is initiated or a valve is operated.
- What an alarm condition implies and how it is corrected.
- What problems can occur and how they are overcome.
- A routine visual plants inspection procedure.

The operating manuals are intended for daily use and therefore shall be separated from the technical and maintenance manuals. Bold print, diagrams, illustrations, etc. shall be used.

The maintenance instruction manuals shall include schedules to cover plant inspection procedures, fully detailed maintenance programmes for plant and plant equipment services at daily, monthly, three monthly, six monthly, yearly and any other necessary intervals, and contain manufacturer's and supplier's detailed maintenance and lubrication instructions, diagrams, sectional drawings giving part numbers, descriptions, etc. Where spare parts have been provided these should be coloured in, scheduled, and their filling procedure described. The manual shall also include minimum surveillance requirements for the plant.

Detailed maintenance procedures, covering removal, dismantling, replacement of parts, re-erection, checking, and reassembly and re-commissioning shall be included for all equipment. The re-commissioning shall be included for all equipment. The maintenance manual shall be fully comprehensive and cover all plant and equipment installed. As the manuals will be frequently used for training and maintenance, they shall be prepared similarly to those described for the operating instruction manuals for use by operating personnel.

2.11 PLANT CODING AND LABELLING

2.11.1.1.1 Plant Coding

The *Contractor* shall allocate codes to plants or systems included in the *works*. The *Contractor* is to provide the proposed coding system to be used to the *Project Manager* for review and acceptance. Plant Coding shall be undertaken by the *Contractor* and will be required to include allocated codes to all other designs and related documentation. It is also the responsibility of the *Contractor* to consistently apply the codes throughout the rest of the technical documentation which shall include, but not limited to:

- load schedules
- cable schedules
- cable schedules
- board parts lists
- cable block diagram

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- termination diagram
- drive & actuator schedules
- instrument schedules
- alarm lists, loop diagrams
- signal lists
- schematic diagrams
- termination diagrams
- logic diagrams, etc.

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

2.11.1.1.2 Plant Labelling

It is the responsibility of *Contractor* to manufacture and install coded equipment's labels. The *Contractor* will label all coded equipment. The *Employer* shall facilitate base-lining of all equipment lists, and only baseline equipment lists shall be used as a basis for the production of labels.

Coding and labelling of components inside electrical and C&I panels shall be done by the *Contractor*.

All equipment shall be labelled according to the requirements as follows:

- List of labels to be finalised in the detail design.
- All labels shall be manufactured by *Contractor*.
- All labels shall be installed by the *Contractor*.
- Label fixing devices shall not penetrate the equipment housing or constitute a potential source of corrosion.
- All labels shall be securely mounted by the *Contractor*.
- Labels shall not be mounted in such a way as to cover equipment specification plates.
- Labels or back plates/brackets installed by the *Contractor* will not have sharp edges or protrude in such a way as to pose a safety risk.
- Labels will not cover equipment specification plates.
- The following three labelling types will be used:

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Description	Dimensions	Font Type	Information	Installation
Large	95mm x 70mm	SL 513 INT	AKZ code and description	Cable ties
Small	80mm x 20mm	SL 513 INT	AKZ code only	Cable ties
Panel label	160mm x 33mm	SL 513 INT	AKZ code and description	Slide in

3. QUALITY MANAGEMENT

- The *Contractor* shall ensure that quality management is done in accordance with the *Employer's* 240-105658000: Supplier Quality Management: Specification.

4. HANDOVER

The *Contractor* compiles data packs progressively for all manufacturing and construction/erection inspection, operating manuals and test records and documents for every piece of plant worked on. The *Contractor* submits data packs to the supervisor and *Project Manager* for their review for all equipment and works undertaken with the applicable requirements and specifications.

Apart from any statutory data packages required, the *Contractor* also compiles and signs off a data package of the relevant drawings, test certificates etc. to the *Project Manager* for acceptance. These include, but are not limited to:

- Geotechnical Investigations;
- Surveys;
- Approved ITP's, QCP's;
- Method statements and specifications adhered to;
- Risk assessments;
- Approved Drawings;
- Design Calculation Reports
- Fabrication Drawings;
- Material Certificates;
- Weld Map;
- Weld Matrix Sheet;
- Weld Sequence;
- Welding Consumables Certificates;
- Welding Procedure Specifications;
- Welders' Qualifications;

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- ESKOM approved NDT Contractor;
- Approved NDT procedure;
- NDT Technician Qualifications;
- NDT Reports/ Results;
- Weld test certificates
- Certificate of Manufacture;
- Inspection Reports;
- Corrosion Protection Consumables Certificates;
- Calibration Certificates;
- Notifications;
- Modifications;
- Concessions;
- Technical Queries, Engineering Responses and communications with *Project Manager/ Employer*
- Non-conformance reports;
- Internal Release Notes;
- Transport notifications;
- Calculations for any temporary works that may be required for the safe execution of the works;
- Concrete 7 day and 28 day cube test results;
- Slump test results;
- Concrete mix designs including all required test results e.g. aggregate test results;
- Pre-concrete and post concrete surveys;
- Batch Plant certificates;
- Slump tests certificates;
- Compaction tests;
- Material certificates;
- As-built data and drawings of the completed *works* signed by a Professional Engineer/Technologist. As-built drawings are submitted in PDF and native CAD formats (.DGN / .DWG).
- Completion Certificates signed by Professional Engineer/Technologist confirming that *works* have been constructed in accordance with the design as stipulated in the National Building Regulations

5. STANDARDS AND SPECIFICATIONS FOR THE *WORKS*

The *Contractor* is to comply with the following standards and guidelines in providing the *works*:

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5.1 CHEMICAL AND PROCESS STANDARDS

- 240-101712128: 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
- 240-96302601: Water Treatment Plant Personal Protective Equipment Guideline
- SANS 310:2011: Storage tank facilities for hazardous chemicals — Above-ground storage tank facilities for flammable, combustible and non-flammable chemicals
- ANSI/ISEA Z358.1-2014 – American National Standard for emergency Eyewash and Shower Equipment
- BS EN 15154-5:2006 – Emergency Safety Showers
- BS EN 15154-2:2006 – Emergency Eye Wash

5.2 MECHANICAL STANDARDS

- ISO 10816: Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts
- ISO 9906: Rotodynamic pumps. Hydraulic performance acceptance tests. Grades 1 and 2.
- EN 13445 - All parts: Unfired pressure vessels
- EN 13480 - All parts: Piping
- ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
- ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- 240-106628253: Standard for Welding Requirements on Eskom Plant
- 240-83539994, Eskom NDT Personnel Approval (NPA) for Quality Related Special Processes on Eskom Plant Standard
- 240-105020315: Standard for Low Pressure Valves
- 240-56030557: Specification for Centrifugal Pumps

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- 240-54937450: Fire Protection & Life Safety Design Standard
- 240-105929225: Compressed Air System Standard
- 240-123801640: Standard for Low Pressure Pipelines
- 240-56356376: On-Site Commissioning for Low Pressure Systems Standard
- 240-70164623: Design Guideline for HVAC in the Eskom Coal Fired Power Stations
- 240-102547991: General Technical Specification for HVAC Systems Standard
- 240-56355731: Environmental Conditions for Process Control Equipment Used at Power Stations Standard
- 240-56177186: Battery Room Standard

5.3 CIVIL AND STRUCTURAL

The *Contractor* is required to adhere to the latest editions of, and the normative references within, the following SANS standards, codes of practice, regulations & standards:

- 240-56364545: Structural Design and Engineering Standard
- 240-56364535: Architectural Design and Green Building Compliance Manual
- 240-107981296: Constructability Assessment Guideline
- 240-85549846: Standard for Design of Drainage and Sewerage Infrastructure
- 240-57127953: Execution of Site Preparation and earthworks
- 240-91244751: Specification for Geotechnical Investigations Standard
- SANS 1083: Aggregates from natural sources - Aggregates for concrete
- SANS 2001: All Parts Construction works
- SANS 10400: The Application of the National Building Regulations
- AWS D1.1: American Welding Society - Structural Welding Code – Steel
- SANS 10044-1: Welding Part 1: Glossary of terms
- SANS 2553: Welded, brazed and soldered joints - Symbolic representation on drawings
- SANS 9606-1: Approval testing of welders - Fusion welding Part 1: Steels
- SANS 10064: The preparation of steel surfaces for coating

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

- SANS 50025: series Hot rolled products of structural steels Parts 1-6
- SANS 121: Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods

5.3.1 Additional Requirements and Specifications

5.3.1.1 General

- The *Contractor* is required to confirm all site dimensions, levels and cast-in items positions on site prior to any fabrication of steel or casting of concrete.
- The *Contractor* is required to submit a comprehensive method statement of the *works* to the *Project Manager* for acceptance prior to the start of the *works*.
- The *Contractor* is responsible for the design, erection, maintenance and removal of all temporary bracing or propping required for the execution of the *works*.
- The *Contractor* takes full professional accountability and liability for all temporary items required for the execution of the *works*.

5.3.1.2 Concrete

- All concrete work is required to be in accordance with SANS 2001-CC1 and SANS 10100-2 unless otherwise stated.
- All concrete surfaces and cast-in items is required to be inspected and accepted by the *Project Manager* in writing before casting of concrete may commence.
- The *Contractor* is required to obtain written acceptance from the *Project Manager* for the use of any add-mixture or the use off ready mixed concrete, to pump concrete, or to use cement or cement blends other than ordinary Portland cement (OPC).
- Compaction of concrete is required to be done by means of mechanical vibrators only.
- The *Contractor* is required to submit the concrete mix design to the *Project Manager* for acceptance.
- The *Contractor* is required to demonstrate, by means of a report from an approved laboratory, that the aggregates do not exhibit excessive shrinking properties in accordance with SANS 1083 and is also required to demonstrate that the aggregates do not have a potential alkali silica reaction.
- The *Contractor* is required to perform a slump test on the same batch of concrete every time a sample is taken and the result recorded.

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The table below indicates particular specifications pertaining to SANS 2001-CC1 and must be read in conjunction with the code.

Clause	Particular Specification
3.5	Concrete – Strength characteristics
3.4.3	Minimum concrete Grade is required to be: <ul style="list-style-type: none"> • Class 15 MPa/ 19 mm for Blinding Concrete (28 days), • Class 35 MPa/ 19 mm for Structural Concrete (28 days).
4.2	Materials
4.2.7	In general, one of the following types of non-shrink grout are required to be used: <ul style="list-style-type: none"> • Cement-based non-shrink grout, not less than 50 MPa; • Special proprietary non-shrink or expansive grout, not less than 50 MPa.
4.2.3.5	The following tests are required: <ul style="list-style-type: none"> • drying shrinkage on fine and course aggregates; • drying shrinkage of concrete; • flakiness index of the stone; • alkali-silica reaction.
4.4	Reinforcement
4.4	Add the following: All reinforcement is stamped with a SANS quality assurance mark
4.4.3.1	Cast in-situ concrete cover is required to be a minimum of: <ul style="list-style-type: none"> • 50 mm for exposed to earth or water; • 40 mm for above ground or not in contact with soil.
4.7	Quality of Concrete
4.7.1.1	<ul style="list-style-type: none"> • <i>Contractor</i> submits to the <i>Supervisor</i> full details and samples of all materials which he proposes to use for making concrete at least 28 days before the concreting of the works is due to commence.
4.7.10	Add the following: <ul style="list-style-type: none"> • A layer of blinding concrete of 50 mm minimum thickness is required to be placed under foundations. • A polyethylene sheet with a minimum thickness of 250 microns is required under ground slabs
4.7.12.2.3	<ul style="list-style-type: none"> • All angled corners are chamfered 20 mm x 20 mm, unless such other larger size is detailed on the Drawings.
4.7.19.3	<ul style="list-style-type: none"> • <i>Contractor</i> submits a detailed procedure for acceptance by the <i>Supervisor</i> on how he intends to carry out the repairs of structural concrete defects

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Clause	Particular Specification
4.7.22	<ul style="list-style-type: none"> For concrete pour records, the <i>Contractor</i> submits a detailed Quality Control Plan to the <i>Supervisor</i> for acceptance. In addition the <i>Contractor</i> supplies the <i>Supervisor</i> with two copies of these records each day covering works carried out the preceding day.
5.1	Testing
5.1.1.4	<ul style="list-style-type: none"> Six 150 mm cube samples taken from each batch or place of concrete deposition, three cubes are tested at 7 days and three at 28 days. Strength at 7 days is required to be at least two thirds of 28 day strength.
5.1.2.1	<ul style="list-style-type: none"> Any of the cube samples tested indicating a result more than 3 MPa below the specified strength is disregarded.
5.1.3.3	Add the following: <ul style="list-style-type: none"> ..., unless no more than three batches of concrete is being mixed.
5.2	Tolerances
5.2.1	<ul style="list-style-type: none"> Tolerances on all concrete work is required to be a level II degree of accuracy as specified in SANS 2001-CC1 with and is to be carefully maintained throughout the construction.
5.2.2.1 Table 11	Add the following under "Location of holding-down bolts": <ul style="list-style-type: none"> 3) The permissible deviation between any two bolts that share the same base-plate is limited to 2mm for bolt sizes up to and including M24, and 3mm for bolts larger than M24.

5.3.1.3 Steelwork

- All work is required to be in accordance with the latest edition of SANS 2001-CS1.
- The *Contractor* is responsible for the stability of the entire structure and all structural elements during all the erection stages.
- All dimensions are required to be verified on site by the *Contractor* before any fabrication of steelwork commences.
- All welding is required to be conducted by coded welders. Supporting documentation is also required to be submitted to the *Project Manager* for acceptance. All welding is required to comply with AWS D1.1.
- All welds are required to be inspected using visual aids.

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- The *Contractor* is required to supply all bolts, washers, nuts etc. for the structural steelwork.
- All structural steel used is required to be grade S355JR in accordance with SANS 50025.
- Welded connections are required to be welded all around with a minimum of 6 mm fillet welds or the appropriately designed fillet weld size. Butt welds are required to be full penetration welds.
- Grade 8.8 bolts are to be used throughout.
- Minimum thickness of gusset plates is to be 10 mm.

The table below indicates particular specifications pertaining to SANS 2001-CS1 and must be read in conjunction with the code.

Clause	Particular Specification
4.1	Materials
4.1.1	Add the following: <ul style="list-style-type: none"> • All structural steelwork is required to be grade S355JR
4.1.4.1	<ul style="list-style-type: none"> • Electrodes for electric welding are required to be E7018.
4.1.5.1	<ul style="list-style-type: none"> • Ordinary bolts to be grade 8.8 with class 8 nuts, as a minimum
4.6	Workmanship - Erection
4.6.5	<ul style="list-style-type: none"> • On site welding is not permitted
5.3	Non-destructive testing of welds
5.3.3	<ul style="list-style-type: none"> • Fillet welds are required to undergo magnetic particle inspection (20 % of welds)
5.3.4	<ul style="list-style-type: none"> • All butt welds and full penetration welds are required to undergo Ultrasonic or X-ray non-destructive testing (100 % of welds)

5.4 ELECTRICAL STANDARDS

- SANS 10142-1: The wiring of premises part 1: Low-voltage installations
- SANS1507: Electric cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3 300 V). all applicable parts.
- SANS 1091: National colour standard
- 240-56356396: Earthing and Lightning protection
- 240-56355466: Procurement of Power Station Low Voltage Motors Specification
- 240-53114248: Thyristor and Switch Mode Chargers, AC/DC To DC/AC Converters
- 240-56227516: LV Switchgear and Control Gear Assemblies and Associated Equipment for Voltage up to and Including 1000V AC and 1500V Standard

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5.5 CONTROL AND INSTRUMENTATION STANDARDS

- 240-56355754 - Field Instrument Installation (FIIS 1)
- 240-56355815 Rev 1 - Junction Boxes and Cable Termination (FIIG 2)
- 240-56355843 Rev 1 - Pressure Measurement Systems Installation (FIIS 6)
- 240-64430501 Rev 1 - Low Voltage Variable Speed Drive Control Equipment
- 240-54937439: Fire protection/Detection Assessment Standard
- 240-56355888: Temperature Measurement Systems Installation Standard
- 240-56355754: Field instrument Installation Standard
- 240-56355815: Field Instrument Installation Standard for Junction Boxes and Cable Termination
- 240-56355815: Pressure Measurement Systems Installation Standard
- 240-56227443: Requirements for Control and Power Cables for Power Stations Standard
- 240-89147446: Instrument Piping for Fossil and Hydro Power Plant Standard

5.6 INFORMATION SECURITY STANDARDS

- 32-85: Information Security Policy

5.7 GENERAL STANDARDS

- 240-53113685: Design Review Procedure
- 240-53114026: Project Engineering Change Management Procedure
- Occupational, Health and Safety, Act Number 85 of 1993
- 240-49230111: Hazard and Operability Analysis (HAZOP) Guideline
- 240-30008949: Safety, Health and Environmental Specifications for Contractors
- 240-28463367: SHE Organization
- 240-62196227: Life Saving Rules
- 240-86973501: Engineering Drawing Standard
- 240-66920003: Documentation Management Review and Handover Procedure for Gx Coal Projects
- 240-76992014: Project / Plant Specific Technical Documents and Records Management Work Instruction
- 240-105658000: Supplier Quality Management: Specification
- 240-65666252: Waste Management Work Instruction
- Construction Regulations 2014
- National Water Act: Government Notice 704
- 240-145581571: Standard for the Identification of the Contents of Pipelines and Vessels

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