TENDER NO. RIM05-IFM-2025/26

SPECIFICATION DOCUMENT

FOR THE

DESIGN BUILD AND COMMISSION OF A REVERSE OSMOSIS DESALINATION PLANT, ROBBEN ISLAND

VOLUME 2

(EMPLOYER'S REQUIREMENTS)
June 2025

Client: **The Robben Island Museum** Nelson Mandela Gateway (NMG) V&A Waterfront Cape Town 8001 Tel: +27 21 413 4200 Email : scm@robben-island.org.za	**Consultant:** **Greenfield Resources (Pty) Ltd** 142 South Street Centurion 0157 Tel: +27 12 643 0357 Email: admin@gfrsa.co.za

Part C3: Scope of Work

Status

Should any requirement or provision in the parts of the Scope of Work conflict with any requirement of any Standardised Specification, particular specification or any drawings, the order of precedence, unless otherwise specified, is:

Drawings
Scope of Work (Parts C3.1, C3.4 C3.5 and C3.6)
Standardised Specifications

This Scope of Works is set out as follows:

C 3.1: **DESCRIPTION OF THE WORKS** covers a general description of the works or project and the facilities available.

C 3.2: **ENGINEERING** covers a list of drawings and standard drawings supplied separately and/or bound with the tender document

C 3.3: **PROCUREMENT** covers the requirements; resource standard pertaining to targeted procurement, scope of mandatory subcontract works; preferred subcontractors / suppliers; subcontracting procedures; attendance on subcontractors, etc.

C 3.4: **CONSTRUCTION** covers variations and additions to the standard specifications that are applicable to the contract, as well as Particular Specifications that is applicable.

All clauses in the Specification Data are preceded with "SD" followed by the relevant letter(s) and number of the relevant clause of the standard specifications. This will replace, amend or add to the standard specification with the same number. For a new clause, the numbers follow on from the last clause number used in the relevant specification.

Any clause referred to in the standard specification will also include the relevant Specification Data.

The Particular Specifications are the Environmental and Health & Safety Specifications.

C 3.5: **MANAGEMENT** covers the applicable standards and the methods and procedures to be followed in managing the works to the requirements of the Engineer and the Employer.

C 3.6: **ANNEXURES** covers the drawings issued to the Tenderers, project labour report and the Robben Island Museum Preferential Procurement Policy.

C3.1 Description of the Works

C3.1 DESCRIPTION OF THE WORKS

C3.1.1 Background and Intent

Robben Island is currently being supplied with potable water from a reverse osmosis (RO) desalination plant situated on the island which was constructed in 1998. The plant is currently the only source of potable water on the island.

The existing desalination plant is old and is currently being operated manually and without energy recovery. It shall be replaced with a new desalination plant with upgraded technology that shall be automated to ensure ease of operation and will have an energy recovery system installed.

C3.1.2 Overview of the works

This tender relates to the design, manufacture, installation, 28-day commissioning and acceptance period and 6 months trial operation of an appropriate desalination system that would satisfy this requirement of the Employer.

The requirement is for a reverse osmosis (RO) desalination facility that could produce desalinated water at a rate of 220m³/day (instantaneous production capacity of 12.22 m³/h), but with supporting infrastructure such as electrical supply, MCC, LV installation, HVAC, sea water abstraction pump and manifold replacement.

The new desalination plant has the following limitations:

- It must be constructed within the existing desalination plant structure so that an Environmental Impact assessment (EIA) will not be required; and

- It must be constructed while the existing plant remains in operation in order to ensure that the residents of the Island have sufficient water during the construction phase.

C3.1.3 Description of the site and access

The works will occur on Robben Island, the island is situated in Table Bay, approximately 13km by sea from Table Bay Harbour, Cape Town.

The Site of Works will be as defined by the limits of construction shown on the drawings, plus any additional space required for the erection of a site camp. An area at the Murray's bay harbour will be made available to the contactor for his site camp. This site at the Murray`s Bay harbour will be necessary for offloading and stockpiling of materials. All surplus or excavated material will be stockpiled at the site camp before being shipped to the mainland to spoil/waste facilities.

Access to the site is subject to rules and regulations of the Robben Island Museum (RIM). Strict adherence by the Contractor and all his staff to RIM rules and regulations is obligatory.

The climatic conditions are similar to those of the greater Cape Peninsula area which is typically a winter rainfall region and a mild summer with limited rainfall. Wind conditions are primarily south-easterly in summer and north-westerly in winter.

C3.1.4 General Process Philosophy

It is a well-known fact that the sea water at the West Coast of South Africa:

- is relatively cold, with minimum temperatures around 9°C;
- often experiences population explosions of microscopic algae (especially reddish-brown phytoplankton – "red tide"), which result in high concentrations of biological matter, subsequent oxygen depletion and related release of neurotoxins into the water;
- can also contain sulphur and H2S because of the reduction of SO4 by anaerobic sulphate-reducing bacteria during red-tide.

Therefore, apart from the normal fluctuations in salt content and temperature, significant variations can occur in the concentrations of suspended bio-matter and organic components. In the case of Robben Island, the plant capacity will be relatively small, so that water intake will be through a beach wells and tidal pool. The contractor should however take notice of this when completing their designs and make allowance for intake screening and clarification in order to accommodate low temperature, algae blooms and high sulphur and H2S. The design must be based on previous experience in the area.

The proposed pre-treatment train entails a micro screen for larvae, flocculation, dual media filtration and cartridge filtration, while making provision for pH adjustment, shock disinfection (with either chlorine or non-oxidising biocides), anti-scalant dosing and SMBS dosing. Although ultra-filtration would be a strong technical alternative for the above conventional pre-treatment, it is expected that related capital costs would be higher and that overall water recovery at the plant could be lower than with the proposed media-filtration option. However, the Contractor is most welcome to offer ultra-filtration (UF) as an alternative option (i.e. in addition to the default media filtration option). Such an ultra-filtration system shall not offer less process functionality (including monitoring and control requirements) than specified for the media filtration system and the selection of an over-ambitious design flux through the UF membranes (for example) will have an adverse effect on the technical evaluation of such a proposal.

The permeate, as generated from the RO plant via high-rejection SWRO membranes shall have recoveries in the order of 40-50%. Furthermore, the RO permeate needs to be stabilised before it is transferred to the potable water storage facilities. The stabilised permeate shall have a calcium carbonate precipitation potential between 3 and 5 mg/litre CaCO3.

The overall water recovery (including pre-treatment and RO) shall be 40%. For the initial 220m³/day capacity the instantaneous permeate production rate shall be minimum 12,22m³/h. Acceptable and approved environmental practices must be followed.

C3.1.5 Scope of Contract

C3.1.5.1 Design, supply and installation of SWRO plant

The Contractor shall offer a new and fully functional sea water RO plant, including auxiliary equipment, in accordance with the requirements and specifications stipulated in this enquiry document to satisfy the requirements of the Employer.

C3.1.5.2 Exclusions

The following components are specifically excluded from the scope of supply:

- Feed transfer pipeline between beach wells and the desalination plant.
- Brine transfer pipeline between the desalination plant and the sea.
- Supply and construction of electrical supply lines to the site, i.e., high voltage lines and step-down transformers.

Although the above items are outside the scope of supply, plant layouts and requirements (as specified by the Contractor in accordance with these process specifications) that minimise related capital costs will be favoured in the adjudication process.

C3.1.5.3 Inclusions

The following components are **included** in the scope of supply:

- Project management of Contractor's own project component, also making provision for regular and structured interaction with the Engineer's project management team and associated contractors on site, to allow effective specification and transfer of civil and electrical requirements, as well as for evaluation and approval of design documentation.
- Installation of a submersible pump and electrical connection at the existing beach well;
- Replacement of the existing stainless steel manifold at the tidal pool intake;
- Complete process design (basic, detail and as-built). This includes the supply of design documentation such as:
  - complete process flow diagrams (PFD);
  - complete process and instrumentation diagrams (P&ID);
  - complete mass balances;
  - general arrangements drawings (GA); pipe isometric drawings and pipe schedules, clearly specifying materials of construction;
  - utility line-distribution drawings;
  - equipment schedules and complete data-sheets;
  - control philosophies;
  - operating and maintenance manuals;
  - spare parts lists (SPIR);
- Electrical and Control design and specifications, including:
  - MCC design and supply, including layout drawings and material compliance specifications;
  - A suitable connection terminal and protocol for the telemetry links must be available.

  - Duplicate isolated signals for all plant control infrastructure i.e. pumps, motor status, flow meters, pressure sensors, TDS, etc. to be provided on a separate terminal rail suitably labelled, for future connection to the client Telemetry and SCADA system.
- Comprehensive HAZOP study, properly documented and also attended by the Engineer or his representative. The Contractor shall make provision for a contingency as may be required for equipment additions that may be identified during the HAZOP study.
- Early, but accurate designs and specification of all civil infrastructure requirements inside the battery limits, including:
  - plant layout;
  - dimensions and special requirements for tanks;
  - dimensions and miscellaneous requirements for existing building;
  - location and size of appropriate trenches and floor sumps;
  - plinths and related civil loads;
  - bunded areas and protective coatings;
- Complete design, supply and installation of all process, mechanical, electrical and control equipment inside the battery limits. This shall include all pumps, pipes, bellows, valves, instruments, vessels, mixers, dosing systems, non-civil tanks, pipe racks and supports, electrical and control cabling, cable racks, switchgear, PLCs, MCCs, terminals, conduits, cat ladders, corrosion protection, protective boxes, utility lines, etc.
- Supply of all utility and instrument air (including duty and standby compressor with air filter and drying facility), including an acoustic hood to limit sound pollution to less than 85 dB.
- Quality control and quality management during design, manufacturing and construction.
- Safety control and management of own staff on site in full compliance with the OSH Act n0, 85 0f 1995.
- Supply of statutory safety equipment and signs, e.g. safety showers, eye wash, safety signs, heat protection, protective shields at exposed rotating equipment, fire extinguishers, etc. as required to ensure safe plant operation.
- Supply of own portable site office and site toilets as would be required during installation and commissioning.
- Supply of all special construction tools, safe cranage and scaffolding as required during installation and commissioning.
- Provision for commissioning spares as may be required to minimise delays during commissioning and start-up before hand-over.
- Supply of filter media and other consumables as required for effective plant operation, including sand, anthracite, cartridge filters, RO membranes, gloves, sampling bottles, etc.
- Supply of chemicals and replacement cartridge filters for 28 day commissioning and 6 month subsequent continuous operation.
- Commissioning and operation of the plant during a 28 day acceptance period and 6 month trial operational period, as allowed for in the Contract.
- Training of the Employer's operating staff during the full commissioning and 6 months operational period.
- Demonstration of a full CIP cycle on all RO units at the end of the 28 day acceptance period, even if the level of membrane fouling may not require CIP.
- Process guarantees.
- Equipment guarantees.
- Financing, retention bonds and performance bonds as required for full execution of the project according to the contractual agreement signed between the Employer and the Contractor.

C3.1.5.4 Battery limits

The **battery limits** are as follows:

- Process and mechanical:
  - Raw feed water:
    Flange-with-gasket connection at feed tank.
  - RO permeate:
    Tie-in point at the existing potable water feed line to the existing reservoir at pressure of 1 bar(g).
  - RO concentrate (brine):
    Discharge point and tie into existing brine disposal pipeline.
  - CIP effluent:
    Drain outlet (after drain valve) at spent CIP effluent tank to into existing brine disposal pipeline.
  - Drain and flush points:
    At discharge points into trenches/pipes and/or floor sumps.
- Utility water and air:
  - Instrument and utility air:
    A fully functional compressor (duty and standby units, with acoustic hoods) and all air distribution lines shall be included in the scope of supply to make provision for all utility and instrument air requirements.
  - Utility water:

Utility water lines shall be included in the scope of supply, with tie-in to existing utility supply point at the existing water network.

- Electrical cabling and wiring
  Termination point at the power-supply side of the MCC (MCC included in scope of supply). A separate 60 Ampere 3 Phase DB for the general supply (lights and plugs) will be supplied.
- Control cabling and wiring
  All included. Note that all instruments in/on the abstraction pumps, feed water tank, as well as in/on the existing product reservoir – as required to operate the desalination plant in a reliable and automated fashion - are included in the scope of supply.

C.3.1.6 Construction Program & Methods

C3.1.6.1 Time for Completion and Programme

The contract period must include the normal days of inclement weather as specified in the Specification Data and special non-working days listed in the Contract Data.

The Contractor will be required to develop and maintain for the full duration of the contract, a works programme whose purpose will be to ensure that the work is carried out and controlled in such a way that the contract is completed within the time stated in the tender or in the time extended by the Engineer in writing.

The Contractor shall take all aspects regarding the conditions on site, access, transportation, restricted working space, the availability of material, machines and labour into account during the tender stage and the compiling of a construction programme.

C3.1.7 Known services

The Contractor shall make himself acquainted with all existing works. Under no circumstances shall the Contractor alter or in any way interfere with the existing works or underground services unless authorised by the Engineer.

Where existing works are of such a nature that the Engineer may require them to be moved by the Contractor, the cost of such work will be paid for at scheduled rates or on day works, plant and materials basis. The Contractor will be held responsible for damages to any existing works and any damages caused shall be made good at his own cost without delay.

The Contractor is to exercise care when the proposed work is to cross an existing service, or work is to be performed close to an existing service. Prior to commencement of the relevant portion of the proposed works the Contractor with the Engineer or his duly appointed representative shall also perform a visual inspection of the area in question. This inspection will not waive the Contractor of his obligations with respect care of the works referenced in the General Conditions of Contract.

C3.1.8 Damage to services

Damage that occurs to unknown services during construction will be paid by the Employer. However, all services that have been located and exposed, and are subsequently damaged by the Contractor or his subcontractor, shall be reinstated to the same state as it was before the damage occurred at the time and cost of the Contractor.

C3.1.9 Reinstatement of services and structures damaged during construction

The Contractor shall inform the Engineer immediately when a service or structure is damaged. The extent of the damage and a proposal how to reinstate the service or structure shall be submitted to the Engineer on a sketch with dimensions and time frames.

The Contractor shall not be allowed to reinstate any service or structure unless indicated so by the Engineer. The Contractor shall render all reasonable assistance to the service or structure owner with the reinstatement of the service or the structure if required.

The Contractor shall be liable to reinstate the service or structure to its original state or for the full cost thereof if reinstated by others.

C3.1.10 Services and Site Facilities Provided by the Employer

C3.1.10.1 Water Supply

The Contractor may use desalinated water of potable quality from Robben Island for construction purposes provided that the quality of water is tested as required by the Contractor and found to be acceptable. It shall be

the Contractors responsibility to test the quality of the water and he shall organise sampling, testing and submit test results to the Engineer for acceptance.

The contractor shall confirm the available quantities of desalinated water that can be supplied to the contractor on Robben Island.

If the quality of water is found to be unacceptable, the contractor shall make his own arrangements regarding the conveyance and storage of water from the mainland or for further treatment of the desalinated water for quality to be acceptable.

The rates tendered for the relevant items in the Preliminary and General Section of the Schedule of Quantities shall include all costs for the establishing and maintaining of a water supply to the Site of Works.

C3.1.10.2 Electricity Supply

No electricity supply is available at the site. Power is to be sourced from a generator which the contractor will bring from the mainland. Safety with respect to the electricity supply remains the responsibility of the Contractor.

The Contractor shall make his own arrangements regarding the supply and distribution of power to the Stockpile/Storage/Laydown Working Site area in Murray`s Bay harbour and to the construction site where the works will take place.

The rates tendered for the relevant items in the Preliminary and General Section of the Schedule of Quantities shall include all costs for the establishing and maintaining of a source of power to the Site of Works.

C3.1.10.3 Fuel

Limited amount of diesel can be obtained on Robben Island, but arrangements regarding the expected quantities required and payment thereof will have to be made with RIM. Should these quantities not be sufficient for the contractors needs or no longer available, fuel quantities shall be imported by the Contractor from the mainland at his own cost.

C3.1.11 Services and Site Facilities Provided by the Contractor

C3.1.11.1 Facilities provided by the Contractor

The Contractor shall provide, maintain and remove his own facilities to the satisfaction of the Engineer. The Contractor shall provide the area around his office, stores and sheds (i.e. the “Camp”) with adequate security fences to ensure that unauthorised persons do not enter the camp area and security personnel should he deem it necessary.

The tendered sums as scheduled by the Contractor, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for his own purposes

C3.1.11.2 Location of Camp Site

An area at the desalination plant will be made available to the contactor for his site camp. This site will be necessary for offloading and stockpiling of materials.

The whole site in terms of the conditions of Contract consists of the following area:

- The existing desalination plant site
- Stockpile area at the existing desalination plant site
- Spoil site (to be identified before commencement of contract)
  All roads used to haul materials to and from the works

The type and size of construction vehicles that the Contractors intends using on the existing road is subject to the approval by RIM prior to importing to the Island. Any damages caused to the roads used during the construction shall be repaired to the satisfaction of RIM and the Engineer and at the cost of the contractor. The island has a speed limit of 40km/h.

The camp site shall be properly and neatly fenced using temporary fencing with secure access control. The Contractor shall be responsible for providing and maintaining his own security arrangements for the duration of the Contract.

On completion of the Works, or when ordered by the Engineer, the Contractor shall remove all temporary buildings and latrines and restore the Site to a clean and sanitary condition to the satisfaction of the Engineer and rehabilitate the area in accordance with the EMP.

C3.1.11.2 Ablution facilities

The Contractor shall provide portable toilet facilities for all his employees and shall maintain them in a clean and hygienic state at all times to the satisfaction of the Council's Medical Officer of Health. The cost of establishing and maintaining of portable toilets is provided for in the Bills of Quantities. The requirements of the Construction Environmental Management Plan (CEMP) must also be followed.

C3.1.11.3 Housing for Contractor's employees

The Client will make available 3 x 3 bedroom houses with no furniture if required.

C3.1.12 Facilities for the Engineer

C3.1.12.1 Office accommodation

No office facilities are required for the Engineer.

C3.1.12.2 Survey equipment and assistants

Both are required for the Contract.

C3.1.12.3 Site instruction book and Site diary

The Contractor shall keep a triplicate book for site instructions on the Site at all times and provide a Site diary for daily completion by the Contractor.

C3.1.13 Laboratory Facilities

The Contractor shall provide and allow for his own facilities, apparatus and procedures for the testing of materials and the process control testing of materials and workmanship in order to ensure compliance with the requirements of the Specifications. The Engineer shall only carry out control tests.

C3.1.14 Other facilities and services

C3.1.14.1 Waste Disposal

The Contractor shall make arrangements for solid and liquid waste disposal with Robben Island Museum. Disposal will take place at an approved Site.

C3.1.14.2 Telephone Facilities

There are no telephone facilities available, but there is normally cellular reception.

C3.1.15 Notice boards, signs, barricades and advertisements

All notices, signs and barricades may be used only if approved by the Engineer. The Contractor shall be responsible for their supply, erection, maintenance and ultimate removal and shall make provision for this in his tendered rates.

The Engineer shall have the right to instruct the Contractor to move any sign or notice to another position, or to remove it from the Site of the Works if in his opinion it is unsatisfactory, inconvenient or dangerous.

C3.1.16 Dealing with water

The Contractor shall make provision and allow for all dewatering and temporary management of storm water. All costs for this operation for the duration of the contract shall be deemed to be included in the Fixed and Value related charges.

C3.1.17 Dealing with high winds

The site is situated in a region where high winds and seasonal rain can be expected and with strong south-easterly winds during the summer months.

All heaps of materials either forming part of the excavations or imported for use in construction shall be kept covered during high winds to prevent contamination of surrounding in-situ soils.

C3.1.18 Alterations, additions, extensions and modifications to existing works

The Contractor shall within 20 days or 10% of the construction period after taking possession of the site (whichever is the lesser), satisfy himself that the dimensional accuracy, alignment, levels and setting out of existing structures or components thereof are compatible with the proposed works and shall notify the Engineer of any areas of dissatisfaction.

C3.1.19 Wayleaves, Permissions and Permits

The Contractor shall be responsible for obtaining all of the necessary wayleaves, permissions or permits applicable to working near any existing services or other infrastructure on Site, and shall ensure that any wayleaves, permissions or permits obtained by the Employer's Agent prior to the award of the contract are transferred into the Contractor's name.

The Contractor shall abide by any conditions imposed by such wayleaves, permissions or permits.

The Contractor shall ensure that all wayleaves, permissions and permits are kept on site and are available for inspection by the relevant service authorities on demand.

The Contractor shall also ensure that any wayleaves in respect of electricity services are renewed timeously every three months.

C3.1.20 Construction in restricted areas

All working space will be deemed restricted. The construction method used in these restricted areas largely depends on the Contractor's Plant. Notwithstanding, measurement and payment will be strictly according to the specified cross-sections and dimensions irrespective of the method used, and the rates and prices tendered will be deemed to include full compensation for any difficulties encountered by the Contractor while working in restricted areas. No extra payment or any claim for payment due to these difficulties will be considered.

C3.2 Engineering

C3.2.1 Design Services and Activity Matrix

Works designed by, and per design stage:

Concept, feasibility and overall process	Employer
Basic engineering and detail layout to tender stage	Employer
Final design to approval for construction	Contractor
Temporary Works	Contractor
Preparation of “as-built” drawings	Contractor

C3.2.2 Design brief

The Contractor, in terms of Clause 5 of the Conditions of Contract, is responsible for the design of the Works. If a specific duty for a piece of equipment is provided in this document, for example a pump duty point, the Contractor may use the specified duty for tender purposes but shall check and confirm that all equipment specifications and duties are correct prior to ordering equipment. Sub-clause 5.1 of the Conditions of Contract shall apply in this regard.

The Engineer has indicated on the drawings and in the specifications in broad detail the envisaged desalination plant. The Contractor will be responsible to provide a totally fit for purpose design and installation and hence will be allowed to, in consultation with the Engineer, propose amendments to the Engineer’s design in order to optimise the plant and to ensure full functionality.

NOTE: All the Contractor’s design documents and drawings shall be submitted to the Engineer for acceptance so as not to delay the Works. Unless specified for payment items or specifically included in their descriptions, the costs for the design responsibilities shall be deemed to be included in the rates of other relevant payment items.

Where the Contractor is to supply the design of designated parts of the permanent Works or temporary Works he shall supply full working drawings supported by a professional engineer’s design certificate.

C3.2.3 Drawings

The Contractor shall use only the dimensions stated in figures on the Drawings in setting out the Works, and dimensions shall not be scaled from the Drawings, unless required by the Engineer. The Engineer will, at the request of the Contractor in accordance with the provisions of the Conditions of Contract, provide such dimensions as may have been omitted from the Drawings.

The Contractor shall ensure that accurate as-built records are kept of all infrastructure installed or relocated during the contract. The position of all underground infrastructures shall be given by either co-ordinates or stake value and offset. Where necessary, levels shall also be given. The Contractor is responsible for supplying “As-built” drawings on completion of the works.

The complete as-built/record drawings, must be submitted to the Engineer's Representative before a Certificate of Completion will be issued.

The Sherriffs listed below are issued with the tender document in order to give an overview of the project.

Drawing Number	**Title**
D22009DWG-C001-04DT	Locality Plan
D22009DWG-C002-04DT	Existing Plant Layout
D22009DWG-C003-04DT	Desalination Plant Typical Flow Diagram

C3.3 Procurement

C3.3.1 PREFERENTIAL PROCUREMENT

The works shall be executed in accordance with the conditions associated with the granting of preferences detailed in Form SBD 6.1: Preference Points Claim Form in Terms of the Preferential Procurement Policy Framework Act 2017, where preferences are granted in respect of B-BBEE contribution. In particular, the Contractor may not sub-contract more than 25% of the value of the contract to sub-contractors that do not have an equal or higher B-BBEE status level than the Contractor, unless the sub-contractors are exempted micro enterprises that have the capability and ability to execute the sub-contract works.

C3.3.2 SCOPE OF MANDATORY SUBCONTRACT WORK

No mandatory subcontract work is envisaged under this contract.

C3.3.3 SUBCONTRACTORS

C3.3.3.1 Procedure for the selection of sub-contractors/suppliers

Where monetary allowances for provisional sums or prime cost items have been provided in the Bills of Quantities, and where the work is to be executed/supplied by sub-contractors/suppliers then the following selection process shall be followed in respect of the required sub-contractors/suppliers:

The Contractor shall invite three quotations from suitably qualified sub-contractors/suppliers, the selection of which shall be in consultation with, and to the approval of the Engineer, for the required work or items.

The evaluation of the quotation received must include a preference points system as described in 5.11 of the Tender Data.

C3.3.3.2 Attendance on subcontractors

Approval given in terms of subcontracting shall not relieve the Contractor of any responsibility, duty or obligation imposed upon him by the Contract, and the Contractor shall in particular be and remain solely liable and responsible for all acts, omissions, negligence or breaches of contract on the part of the assignee or any of his employees, and for all acts, omissions or negligence of any Sub- Contractor or any of his employees.

C3.4 Construction

C3.4.1 Applicable Employers Requirements: Process and Materials Specifications

The Employers Requirements with regard to the Process and Materials Specifications can be found under Part C3.4. The specifications provided here take precedence over any specifications that follow in the relevant general specifications.

C3.4.2 Applicable Standard Mechanical Specifications

For the purpose of this contract the following Standard Mechanical Specifications shall apply and can be found under Part C3.4:

These specifications can be found under Part C3.4. The Detailed Mechanical Specifications can be found under part C3.4.

C3.4.3 Applicable Standard Electrical and Electronic Specifications

The standard Electrical and Electronic Specifications can be found under Part C3.4.

C3.4.4 Particular specifications applicable to this contract

For the purpose of this contract the following Particular Specifications shall apply:

- Health and Safety Specification, included in Part C3.4.
- Construction Phase Environmental Management Plan (CEMP), included in Part C3.4.

C3.4.5 Travelling arrangements

C3.4.5.1 Transportation and Handling of Workmen and Materials between Cape Town and Robben Island

The Contractor shall conform to any relevant Code of Conduct for Contractors working on Robben Island.

C3.4.5.2 Workmen

RIM is prepared to transport only workmen, (no materials, plant and equipment) at no charge to and from Robben Island under the following conditions:

a) It will be expected from the Contractor to draw up a programme for the transportation to and from Robben Island in liaison with the port authorities at Robben Island.

b) RIM accepts no responsibility for any delays in the transportation of workmen due to weather conditions and/or breakdowns.

c) Admission of personnel to Robben Island is on a permit system. The necessary arrangements must be made timeously with the appointed liaison officer at Robben Island Museum.

d) Small and light items may be transported on the passenger boat provided that prior arrangement have been made with RIM, and space is available on the passenger boat.

e) The Contractor may bring his own craft into Murray's Bay Harbour provided that prior arrangement is made with the RIM.

f) The present ferry departure times from Table Bay Harbour and from Robben Island are available from RIM.

g) All vehicles used on the island must have a valid registration.

C3.4.5.3 Transportation of passengers, wearing of ID cards and Conditions applicable

a) Daily visitors to the site must arrange for permits three days prior to any such visit. Late bookings will only be considered in very exceptional cases.

b) The procedures for entry to the island for the compulsory site inspection are set out in Rules for Visitors and Code of Conduct for Contractors working on Robben Island.

c) The Contractor is to provide each of his workers on the island with an ID-card with the following information displayed on said card:

- Surname and initial(S) of employee
- ID-number
- Photograph (passport type)
- Name of Firm (employer)

d) Cards must be worn in a conspicuous place on the person's body/clothing at all times when outside the camp site.

e) The general rules applicable to Robben Island as set out by RIM must be strictly adhered to. Every worker will be issued with a set of rules on arrival at Robben Island.

f) Employees of the Contractor must at all times comply with the following rules during boat trips:

g) Persons must be neatly dressed.

h) Behaviour and language must not be offensive to other passengers.

i) Alcohol or other drugs may not be used on the boat and on the island in general, and no person under the influence of alcohol or drugs will be allowed on the boat or on the island. Any personnel found under the influence of alcohol and/or drugs will be removed from site.

j) All other rules as stated on the permit must be complied with.

k) Non-compliance with the rules may result in the prohibition of persons to work on Robben Island.

C3.4.5.4 Contractor's Plant and Construction Materials

The Contractor is responsible for all plant and equipment required for the works which will need to be imported by the Contractor from the mainland at his own cost.

All material will also be imported by the Contractor from the mainland at his own cost.

SECTION 1: PROCESS SPECIFICATIONS

Contents

1. PROCESS SPECIFICATIONS

1.1 FEED WATER QUALITY AND VARIATION

Feed water to the desalination plant is currently sourced from the surface of the sea on the south side of the island and pumped to an existing 250 kℓ ground reservoir located at the Desalination Plant. Table 1 provides information on the feed water quality and the design values specified for design of the new desalination plant. Please note that no historical results were available and that only limited samples were taken and tested for purposes of this tender. **The Contractor must therefore ensure that he satisfies himself with the design values used as it will remain the Contractor's responsibility to ensure that the desalination plant, including pre- & post-treatment, is fit for purpose and that the guarantee values with regard to water quality and energy consumption, as well as membrane life expectancy can be met.**

"Upwelling" and associated algal blooms and elevated Total Organic Carbon (TOC) and Dissolved Organic Carbon (DOC) may be common occurrences in the surrounding waters. The seawater may therefore both nutrient rich and of very variable quality. Pre-treatment processes to provide water suitable as feed to RO membranes must be designed to accommodate the full range of physical and biological quality expected, while retaining the capability of producing consistent high quality feedwater to the seawater RO system. The pre-treatment systems therefore need to be reliable and robust.

Table 1: Feed Water Quality and Specified Design Values

Parameter	Units	Minimum Measured Value	Maximum Measured Value	Design Value to be used	Comment
pH		8.1	8.3	8.1	
Temperature	°C	10	20	10-20	
TDS	mg/ℓ	32 332	36 808	36 700	
EC	µS/cm	50 000	54 000	52 000	
TSS	mg/ℓ	5	11	**40**	Design for a higher value than measured due to concerns over seasonal variability as a result of surface intake
Turbidity	NTU	2.0	7.4	**20**	Design for higher value than measured due to concerns over seasonal variability as a result of surface intake
DOC	mg/ℓ	1.6	2.2	**6**	Design for higher value than measured due to concerns over possible high DOC/TOC/algal levels due to possible algal blooms
TOC	mg/ℓ	1.9	2.4	**6**	Design for higher value than measured due to concerns over possible high DOC/TOC/algal levels due to possible algal blooms

Parameter	Units	Minimum Measured Value	Maximum Measured Value	Design Value to be used	Comment
Algal counts	cells/mℓ	33	460	**30,000**	Design for higher value than measured, possible algal blooms
M-Alkalinity	mg/ℓ as CaCO3	116	142	130	
Boron (B^{3+})	mg/ℓ	4.1	4.3	4.3	
Calcium (Ca^{2+})	mg/ℓ	410	441	420	
Magnesium (Mg^{2+})	mg/ℓ	1 280	1 310	1 295	
Potassium (K^{+})	mg/ℓ	372	400	385	
Sodium (Na^{+})	mg/ℓ	10 800	11 500	11 200	
Strontium (Sr^{2+})	mg/ℓ	6.8	7.0	6.9	
Iron ($Fe^{2+/3+}$)	mg/ℓ	<0.05	<0.05	0.1	
Ammonium (NH4)	mg/ℓ	0.029	0.048	0.040	
Barium (Ba)	µg/ℓ	6	9	7.5	
Manganese (Mn)	µg/ℓ	1	15	4	
Sulphide	mg/ℓ	<1	<1	1	
Bromide (Br^{-1})	mg/ℓ	46.8	50.9	48.3	
Fluoride (F^{-})	mg/ℓ	0.95	1.0	0.98	
Chloride(Cl^{-})	mg/ℓ	19 265	21 100	20 200	
Sulphate($SO4^{2-}$)	mg/ℓ	2 590	2 740	2 675	
Nitrate (N)	mg/ℓ	<0.005	0.045	0.020	
Nitrite (N)	mg/ℓ	<0.001	0.002	0.005	
Orthophosphate (P)	mg/ℓ	0.007	0.021	0.017	
Silica	mg/ℓ	<0.1	0.2	0.1	
Al	µg/ℓ	<5	15	10	

The design values in Table 1: Feed Water Quality and Specified Design Values shall be used by the Contractor to predict plant performance and to design the plant, while bearing in mind that variations will be observed in practice, depending on seasonal effects and beachwell performance.

1.2 PRODUCT WATER CAPACITY AND QUALITY REQUIREMENTS

For this contract, reverse osmosis permeate shall be produced at an instantaneous flow rate of 12.22m³/h during normal operation (equivalent to a daily production capacity of 220m3/day.

The quality of product water from the desalination plant (before stabilisation) shall always comply with SANS 241:2006 Class 1 specifications (ignoring pH, Ca and Alkalinity that will be adjusted during subsequent stabilisation).

The Contractor shall clearly state the following in the tender documents, in order to enable proper evaluation of the Contractor's technical offer:

- Permeate water quality (especially TDS, chloride, sodium and boron) guaranteed at minimum and maximum design temperatures after:
  - commissioning (demonstrated during acceptance test);
  - one year (6 months) of operation (continuously demonstrated over a 168 h period);
- Make and model of the membranes offered, with salt rejection at defined water recovery, mg/litre NaCl feed solution, pressure and temperature.

A water quality adhering to SANS 241 Class 1 shall be guaranteed after stabilisation, with the following additional specifications:

- CaCO3 precipitation potential (CCPP) between 2.5 and 5 mg/litre CaCO3.
- pH between 8.0 and 9.0.
- Calcium (Ca) between 20 and 40 mg/litre.

1.3 OVERALL PROCESS LOGIC

The concept process flow diagram on *Drawing D22009DWG-C003-04DT Simplified process diagram indicating suggested process train and main process equipment* depicts the envisaged process train and indicates the main equipment related to the proposed desalination facility. The process train shall include the following:

1.3.1 Pre-treatment system

- shock dosing of chlorine or alternative biocide;
- pH adjustment of feed water with sulphuric acid;
- dosing of coagulant and/or flocculant (typically ferric chloride or ferric sulphate) with effective in-line flash mixing;
- filtration through appropriate dual media (anthracite and quartz sand) pressure filters;
- filtered water storage tank with bypass;
- recycle system that would enable maturation of the filter bed after the backwash-rinse;
- cartridge filtration;
- dosing for reduction of chlorine;
- dosing of appropriate antiscalant.

1.3.2 Desalination system

- appropriate high-pressure pumps;
- a single-pass membrane desalination unit with appropriate manifolding, pressure vessels and membranes to suit specifications and to recover at least 40-50% of the pre-treated water as permeate;
- an appropriate energy recovery system to minimise power consumption;
- a CIP system, including CIP tank, pump and cartridge filters;
- a facility to properly flush the membranes with permeate, as part of shut-down routine.

1.3.3 Filter backwash and effluent treatment system

- backwash pumps and blower for proper backwashing of media filters, including an air-scouring facility;
- backwash effluent containment (tank) with mixing;
- coagulation, flocculation and clarification of filter backwash effluent;
- controlled sludge discharge from clarifier to civil sump (by others) with mixer;
- CIP effluent neutralisation and containment tank;
- RO concentrate (brine) discharge to tank.

1.3.4 Permeate transfer and stabilisation

- appropriate monitoring of conductivity and pH of the permeate;
- a stabilisation system;
- a chlorination system that will ensure residual disinfection of the product water;
- final transfer of the potabilised permeate to the existing potable water reservoir with appropriate monitoring.

1.4 MINIMUM PROCESS REQUIREMENTS FOR INDIVIDUAL UNIT OPERATIONS

Although the Engineer has no intention to be over-prescriptive or to limit innovative proposals, the Contractor is requested to adhere to the specified process requirements, for three reasons:

- By doing so, the Employer's specific needs are considered and addressed.
- It limits the risks related to potential over-ambitious and/or improper or unsafe process offers.
- It enables a sensible and accurate comparison of tenders.

However, should the Contractor disagree with certain specifications and/or have significantly better suggestions, then such suggestions shall be clearly motivated along the following lines:

- Technical benefits and/or minimisation of process risk.
- Financial benefits (capital and operating).
- Plant reliability, operability and serviceability.

Note that the minimum process requirements are stipulated below and that the Contractor's offer shall include all additional equipment as required to ensure full functionality and reliable plant operation with minimal fouling of the RO membranes.

1.4.1 Feed buffer tank

A filtered water tank (civil concrete structure outside scope of supply) shall form part of the process train in order to:

- provide buffer capacity before the pre-treatment system;
- enable recycling of out-of-spec filtered water (making provision for maturation or ripening of a media filter after backwash).
- Provision shall be made for all instrumentation, piping and control systems that would fully integrate this tank into the process train.

1.4.2 Pre-treatment system

A complete pre-treatment facility shall be provided with the specific objective to protect the integrity and useful life of the downstream processes, specifically to ensure reliable and consistent performance of the RO membrane system.

a) Disinfection

Provision shall be made for intermittent shock-dosing of chlorine or an alternative non-oxidising biocide into the feed water in order to control and minimise biological growth. A chlorination system shall be complete with chlorine gas bottles on load cells, motive water pumps and gas injection unit with related sensors and controls, as well as dosing lines to points of use.

Potential dosing points shall be:

- o into the feed water pipeline before the feed buffer tank;
- o into the feed water line between the feed buffer tank and the media filters;
- o into the filter backwash line.

Alternative non-oxidising biocides, compatible with TFC poly-amide membranes, may be proposed, but the Contractor shall include information in the proposal document to clarify potential environmental concerns related to the use of such biocides.

b) pH adjustment

Although the plant could probably be operated without pH control, variations in pH and alkalinity of the feed water may have a detrimental effect on the controllability and reliability of the flocculation process. Therefore, provision shall be made for pH adjustment with an acid before dosing of flocculant. The acid dosing system shall include:

- o Diluted acid dosing tank. Dilution shall be properly controlled and provision shall be made to handle heat generation during such dilution and to protect equipment from physical damage and/or corrosion.

- Duty/standby diluted acid dosing pumps.
- In-line material protection at dosing point to prevent potential localised corrosion and/or material failure.

The pH of the feed water shall be measured on-line by a pH meter installed sufficiently down-stream from the dosing point and the acid dosing rate shall be controlled accordingly via the acid dosing pumps.

c) Coagulant/flocculant dosing

A non alum-based coagulant shall be dosed into the feed line well before the media filters, in accordance with the feed water flow rate and pre-determined (optimised) dosage settings. Provision shall be made for proper and effective flash mixing. The following shall be considered in the proposal:

- Type of flocculation chemicals.
- Chemical concentration as purchased and method of delivery and storage on site.
- On-site dilution requirements and equipment offered to do so.
- Dosages, dosing points and dosing rates.
- Method of dosing control.
- Flash mixing and flocculation control.
- Expected chemical consumption (as purchased and diluted).

The coagulation/flocculation system shall include:

- Dosing tank;
- Duty/standby dosing pumps; and
- Ancillary pipework, valves, controls and instrumentation to allow the dosing system to function automatically.

d) Media filters

Pressure media filters shall be installed, with the following minimum requirements:

- Filter vessels shall be designed according to ASME VIII Div 1 design code to ensure a useful structural life of at least 20 years.
- Dual media (high-quality quartz sand and anthracite) with appropriate grain size and uniformity coefficients shall be used to maximise filtration performance in combination with flocculant.
- Operating philosophy shall allow for controlled constant down-flow rate through filter beds.
- Superficial down-flow rate shall not exceed 8 m3/(h.m2) – even when one filter is backwashed.
- Both vertically or horizontally-installed pressure filters would be acceptable.
- When one filter is backwashed, the remaining filters shall deliver a minimum of two thirds of the required gross filtered water capacity.
- Proper backwashing facility shall including effective air scouring. Backwash rates and air scouring rates shall be sufficient to enable proper cleaning of the selected filter media.
- Provision shall be made for forward rinse to waste or back to feed buffer tank.
- Properly supported nozzle plate at the bottom with appropriate distribution nozzles and mechanism to ensure an even level throughout (critical for good air and water distribution during backwash).
- Effective feed water distribution mechanism that would optimise flocculation conditions and ensure an even distribution of water over the filter bed.
- Filter vessels shall be equipped with manholes that would enable effective servicing of the internals and loading/un-loading of media.
- Filter vessels shall be equipped with all the necessary manifolds, air release valves, isolation valves, controls valves and instrumentation that would render them fully functional for continuous, effective filtration and auto-backwashing.
- All internal surfaces of the filter system shall be rubber-lined to prevent corrosion. Any non rubber-lined equipment attached to the internal structure and in contact with sea water shall be either of polymeric material (e.g. HDPE, PVC, PVDF, PTFE, etc.) or duplex steel. Outer surface shall be properly painted as per the manufacturer's specifications or as approved by the Engineer.

Each of the items above, as well as the operating philosophy, shall be fully described in the proposal, while incorporating the Contractor's expertise and specific product features. Furthermore, the minimum size requirements for the feed buffer tank and the filtered water tank shall be clearly specified in the proposal.

e) Cartridge filtration and final chemical conditioning

Low pressure (VSD) pumps shall transfer the filtered water from the filtered water tank, via cartridge filters, to the RO high pressure pump. The following minimum requirements apply to the cartridge filter system:

- Filter vessels shall contain cartridge filters with a nominal pore size of not more than 5 µm;
- The vessel set shall be sized such that filter replacement in one vessel can be performed while the RO system is in operation;
- Vessels shall be manufactured out of super duplex steel, PVC, GRP, or other appropriate polymeric material and adhering to ASME VIII Div 1 design code with sufficient mechanical strength for a 20-year plant life, while considering the maximum pressure that these filters can be exposed to (depending on the selection of booster pumps);
- The design shall allow for a proper cartridge seal mechanism that is tight and reliable to prevent bypass.
- Filter vessels shall be equipped with all the necessary manifolds, supporting platforms, air release valves, isolation valves and instrumentation that would render them fully functional for effective operation and maintenance and that would allow easy and faultless replacement of filter cartridges.
- Filter vessels shall be equipped with sampling ports in both the feed and discharge chambers.
- Any steel structures around and underneath these filters that may potentially be exposed to sea water when filters are replaced shall be appropriately protected against corrosion (e.g. galvanising).

Each of the items above shall be described in the proposal, while incorporating the Contractor's expertise and specific product features. Schematic drawings of the filter vessels shall be provided to enable proper assessment of the proposal and references shall be offered where similar units are used successfully in sea water applications. Attention shall be given to the filtration rate (flux) through the filters and expected replacement frequencies shall be clearly indicated.

Final chemical conditioning of the feed water shall be performed by the dosing of anti-scalant. Related dosing systems and point of dose shall be properly described in the proposal, including aspects such as:

- Chemical product.
- Chemical concentration as purchased and method of delivery and storage on site.
- On-site dilution requirements and equipment offered to do so.
- Dosages, dosing points and dosing rates.
- Method of control.
- Mechanisms to prevent injection of grit and other fine impurities into the process line.
- Expected chemical consumption (as purchased and diluted).

The anti-scalant dosing system shall include:

- Dosing tank;
- Duty/standby dosing pumps; and
- Ancillary pipework, valves, controls and instrumentation to allow the dosing system to function automatically.

f) Sensors and instrumentation

The Contractor shall ensure that all sensors and control systems are supplied to enable automated and reliable operation and monitoring of the pre-treatment system and to protect pumps, other equipment and especially the down-stream RO system from being operated under abnormal conditions. Process instrumentation shall include, but shall not be limited to the following:

- Level transmitter and low-level switch in feed buffer tank.
- Level transmitter and low-level switch in filtered water buffer tank.
- On-line turbidity measurement of the feed water before flocculation.
- On-line turbidity measurement of the filtered water after each media filter. Filters may share a single meter with timer-based solenoid switching between measuring points, but not more than three measuring points per turbidity meter.
- pH transmitter to enable pH control.
- pH transmitter in the feed line to the RO unit.

- Magnetic flow meters where required to enable flow measurement and control over filter beds and to enable final feed measurement and control to the RO unit.
- Magnetic flow meter in the filter backwash line to ensure effective control of backwash velocities.
- Pressure transmitter in the feed line before the media filters.
- Pressure transmitters in the RO feed line before and after the cartridge filters.
- Pressure transmitter in the backwash air-scour line.
- Differential pressure transmitters across each media-filter bed.
- Glycerine-filled pressure gauge at the discharge of each centrifugal pump, across filter beds and across cartridge filters.
- Temperature transmitter in the feed line to the RO unit.
- ORP transmitter in the feed line to the RO unit.
- Conductivity transmitter in the feed line to the RO unit.
- Level switches in floor sump(s) if and where required.

Connection ports for gauges and other instruments that require hydraulic connections shall by isolated with ball valves with pressure ratings similar or higher than the pressure rating of the relevant process pipe and with materials of construction fully compatible with the process piping corrosion requirements.

g) Pre-treatment piping and valves

Materials of construction for low-pressure pipes and manifolds in contact with sea water in the pre-treatment system shall be either:

- HDPE, GRP, or duplex stainless steel wit PREN/W number ≥ 40 for process piping above 250 mm diameter.
- uPVC or HDPE (nominal pressure rating (PN rating) of minimum 4 bar above the close-valve pressure of related feed pumps), or duplex stainless steel (PREN/W ≥ 40) for process piping at or below 250mm diameter.

Piping for chemical systems and chemical solutions shall be PN16 uPVC.

Note that uPVC piping shall *not* be exposed to direct sunlight.

Valves used in main process pipelines in the pre-treatment system shall adhere to the following:

- All exposed wetted metal surfaces and shafts shall be standard duplex stainless steel.
- Alternatively, metal bodies shall be fully protected by an elastomeric liner.
- Manual isolation and actuated valves shall be flanged butterfly with the disc sealing on a non-metallic seat.
- Electric actuators shall be as per the Employer's Requirements.

Valves used for chemical service shall be non-metallic, uPVC, union ball valves with seats and seals of elastomeric material compatible with the chemical being handled. Alternatively, if part of a proprietary vendor package, the vendor shall carefully describe the nature, availability and applicability of the specific valves for the relevant service.

All raw feed, filtered water and backwash pumps shall, as a minimum, be equipped with manual isolation valves (inlet and outlet) and check valve.

h) Requirements for pre-treated water

The pre-treatment system shall be designed and operated to meet the following specifications:

Parameter	Value
Recovery of water over pre-treatment system	>95%
Turbidity, NTU	≤0.1 (95% confidence) 0.15 maximum
SDI_{15}	≤3.0 (95% confidence) 3.2 maximum

1.4.3 Reverse osmosis system

The RO system shall receive water from the pre-treatment system as per the specifications in Section 1.4.2, containing anti-scalant and free of chlorine or other oxidants that could harm the poly-amide membranes. The RO system shall be operated at a water recovery ≥ 40-45%.

Each reverse osmosis unit (if more than one) shall be properly equipped as described in the sub-sections below:

a) High pressure RO feed pump

Wetted parts of high pressure pumps shall be manufactured of duplex stainless steel with $PRE_{N/W}$ number ≥ 40 or as a minimum, stainless steel 904L and the pumps shall be:

- multistage centrifugal;
- selected for high efficiency and reliability and, most importantly, a well-proven performance in sea water RO plants while operated at similar delivery pressures and capacities;
- controlled to maintain a constant permeate flow rate and therefore equipped with a variable speed drive to compensate for variations in feed water conditions and membrane performance;
- selected (sized) to allow for potential permanent loss of flux after 5 years membrane life, as well as a minimum of 15% loss in normalised membrane flux between CIP-events, while being operated at minimum temperature.

The proposal document shall provide detailed information regarding the selected high-pressure pump, also providing pump curves to demonstrate the pump's ability to handle various feed conditions and membrane performance.

Special provision shall be made for proper mounting and alignment during installation to ensure vibration-free and smooth operation of high-pressure pumps.

Acoustic hoods shall be supplied to reduce noise levels to less than 80 dB. Alternatively, the plant layout shall be such that the high pressure pumps are installed in a separate sound-proof room, but related civil cost implications will then be considered during tender adjudication.

b) Energy recovery unit

The system shall contain a reliable energy recovery unit. Either pressure exchangers (preferred) or hydraulic turbines may be installed, but clear reference shall be given where the specific models have been installed before in sea water applications. Although pressure exchangers tend to be more energy efficient, life-cycle cost and operational considerations may dictate differently. Therefore, the following shall be fully described in the proposal document:

- Type of energy recovery system and reason for selection.
- Vendor and model.
- Guaranteed efficiency (at design flow rate, as well as 10% above and below design flow).
- References of previous installations of similar units.
- Operating and maintenance schedules and costs.
- Life cycle cost compared to alternatives.

c) Pressure vessels and manifolds

Preferred pressure vessels are Codeline, Protec or BEL, or an equivalent approved by the Engineer. Each pressure vessel shall be fabricated out of filament-wound fibreglass reinforced plastic (FRP) and designed:

- with side-entry ports for feed and concentrate;
- a maximum working pressure of not less than 82.7 bar at a temperature of 48oC;
- complete with integrated locking ring grooves, end caps, adaptors, seals and other connectors matching the selected membrane elements (any cutting or grinding of fibres to form locking ring grooves is not acceptable);
- with an interior surface that is absolutely smooth and free of small voids;
- to pass a hydrostatic leak test at 1.3 times rated pressure;
- and constructed according to ASME pressure vessel coding, inspected and stamped by a third party inspector.

It is important that any and all wetted components in continuous contact with water inside these vessels shall be of polymeric material or metals that can withstand long-term decay and corrosion effected by sea water and CIP solutions. The proposal document shall give a clear description of the above and shall clearly indicate the chosen manufacturer and lifetime guarantees offered by the manufacturer.

Permeate sample ports shall be provided for each pressure vessel and an appropriate sample board shall be provided (rigid polymeric material, with 316 stainless steel supports, or better) to ensure easy sampling access.

d) SWRO membranes

The SWRO membrane elements shall be brand new spiral wound thin film composite poly-amide membranes, with the following specifications:

- Reliable manufacturers such as Dow Filmtec, Toray, Hydranautics, or Koch.
- Each membrane element shall reject a minimum of 99.75% NaCl with a test solution of 32 000 mg/litre NaCl at a pressure of 55 bar, temperature of 25oC and 8% water recovery, demonstrated after at least 30 minutes of stable operation.
- Maximum boron rejection shall be considered during membrane selection (and final selection of pre-treatment pH shall also consider downstream boron rejection at the RO system).

The RO unit design shall be such that the average membrane flux is ≤12.5 litre/(m^2.h) in order to operate the system at acceptable pressures at the minimum design temperature of 9 ^oC after 5 years of membrane life. Proper consideration shall be given to a design that prevents excessive flux through the lead elements (either by the selection of limited number of elements per vessel, or use of two element types), especially at higher temperatures. The technical proposal shall offer clear descriptions in this regard.

e) Membrane flushing facility

On shutdown of an RO train, permeate shall be flushed through the RO train for a period sufficient to fully replace sea water from the high pressure pump, pressure exchanger feed pump (if any), membrane elements and concentrate manifolds. Flush water shall be clean permeate, free of any fine grit or tank residue. It is acceptable to use the CIP tank as flush tank, but gravity-driven flush systems are not acceptable. The flush pumps (duty/stand-by) shall be centrifugal with 316 stainless steel wetted parts. Piping shall be either 316 stainless steel, or uPVC.

f) Membrane vessel support structure

The skid frame shall be manufactured of GRP powder-coated carbon steel, or marine grade aluminium with poly-urethane surface finish. Furthermore:

- The frame shall be robust enough to provide rigid support and to carry the total static and dynamic loads imposed upon it during operation for a minimum life of 20 years.
- The frame shall be positioned and mounted on an appropriate concrete slab, with dimensions and load requirements fully specified by the Contractor during plant design. Final and proper levelling of the skid shall be performed by the Contractor during installation.
- Pressure vessels shall be properly supported at a minimum of three points.
- The structure shall be equipped with sufficient supporting and anchoring points to allow for effective installation of distribution manifolds, peripheral piping, valves, instrumentation and control boxes. All attachment points and brackets shall be pre-fabricated before application of surface coatings. Field modifications or attachments that damage, penetrate or destroy such coatings will not be permitted.
- All brackets, fasteners, straps, bolts, washers and nuts used to mount the pressure vessels and other equipment onto the frame shall be of 316 stainless steel (or better).

Each of the above items shall be clearly described in the proposal document.

g) Instrumentation and control

Each membrane train shall at least be equipped with the following instrumentation:

- Pressure indications for high-pressure pump feed, RO feed, RO concentrate and RO permeate.
- Pressure indications for energy recovery unit's high and low pressure points.

- Pressure indicating transmitters for RO feed and RO concentrate and feed-concentrate differential pressure.
- Flow indicating transmitters for RO concentrate and permeate.
- Conductivity indicating transmitter for RO permeate.

A local control panel shall, as a minimum, display the following on a touch-screen interface:

- Pressure, flow and conductivity readings as received per above-mentioned transmitters.
- Water recovery over RO unit.
- Salt rejection over RO unit.

The adjustment/control of RO flow and recovery must be possible via this control panel. The instrument panel shall be fabricated from passivated 316 stainless steel, or rigid PVC or GRP, and mounted next to the RO train at typical and convenient eye level (i.e. not less than 1.5 m above floor level).

h) RO system piping and valves

The materials of construction for high-pressure piping and manifolds shall be duplex stainless steel with $PRE_{N/W}$ number ≥ 40 or as a minimum, stainless steel 904L. All high-pressure piping shall be shop fabricated and in accordance with the appropriate SABS or welding standards. Certified coded welders shall be used to perform such welding and the Engineer shall verify and approve the appointment of such welders before commencement of shop fabrication.

Low-pressure piping shall be uPVC or 316 stainless steel (only if water has low salt content). uPVC piping shall have a nominal pressure rating (PN rating) of 4 bar above the maximum operating pressure. Note that uPVC piping shall not be exposed to direct sunlight.

Butterfly valves (if any) shall be fully lugged wafer type with disc and shafts of standard duplex (or better). Similarly, flow control valves on the feed, concentrate or energy recovery pipelines shall have wetted parts of standard duplex (or better).

Connection ports for gauges and other instruments that require hydraulic connections shall by isolated with ball valves with pressure ratings similar or higher than the pressure rating of the relevant process pipe.

1.4.4 Membrane CIP system

An appropriately sized membrane cleaning-in-place (CIP) system shall be provided, including (but not limited to) the following:

- One CIP tank (non-metallic materials of construction). The tank material must be able to withstand pH variations between 2 and 12 and operating temperatures up to 45 oC for a plant life of at least 20 years.
- Heating facility to increase the temperature of the CIP solution as per possible cleaning requirements.
- Chemical make-up facilities, including chemical handling equipment, platforms, etc.
- Duty + standby CIP solution transfer pumps.
- Cartridge filter vessel fabricated from 316 stainless steel, with 5µm (nominal) aperture cartridge filters.
- Instrumentation required to operate and control the system in a safe and reliable manner (i.e. level indication, flow measurement and control, temperature monitoring, pH, pump discharge pressure, low-level switch, etc.).
- CIP piping with uPVC as materials of construction and nominal pressure rating of 4 bar above the maximum operating pressure.
- One separate, non-metallic, tank for storage of residual spent CIP solution, for off-site removal by others. This tank shall be similar or larger in size than the CIP tank and shall, as a minimum, be equipped with a drain valve and connector, protected sight-glass type level indication and safe overflow.
- Piping (uPVC) and controls allowing for easy transfer of spent CIP solution to the CIP effluent tank.
- Safety equipment required for chemical handling.

All permeate must be returned to the CIP tank during a CIP cycle and isolation valves shall prevent any transfer of CIP solution to the process permeate tank.

The CIP tank and pumps may also be used to serve as flush facility on normal plant shutdown, but integration of this dual functionality shall be properly incorporated into the control system. The CIP/flush tank and pumps shall be sized to allow a feed rate per pressure vessel of not less than 9 m3/h, while making provision for the residual CIP liquid volume in piping, pressure vessels and the cartridge filter and avoiding pump cavitation at all times. The bottom of the tank shall be sloped, or conical, to allow for complete drain-down and removal of the

spent CIP solution. Similarly, the piping shall be equipped with drain-down valves at appropriate locations to enable removal of CIP solution from the pipework.

Operators must be able to initiate and stop a CIP cycle from a local control panel, but with remote monitoring from the control room.

Apart from a description of the above-mentioned facilities – as offered, the proposal document shall also provide comprehensive information on the following:

- Expected CIP frequency (Note: the pre-treatment system must be sufficient to ensure that, with continuous plant operation, CIP is not required more often than once every 50 days).
- All CIP chemicals that may be used, including CIP solution pH, temperature and concentration, as well as chemical composition
- Description of potential environmental impact of each of the proposed CIP chemicals.
- Quantity (mass and volume) of CIP chemicals per CIP event.
- Quantity and nature of CIP effluent volume (for final discharge).
- Packaging (as delivered to site) and special storage requirements of CIP chemicals.
- Operation integration of CIP and permeate flush (on shut-down) functionalities (unless a separate flush facility is offered).
- Tie-in points and envisaged method of integration CIP facility with future, newly-installed RO trains.

1.4.5 Permeate stabilisation, disinfection and product transfer

The SWRO permeate shall be stabilised and disinfected in accordance with the final product water requirements. Any of the following three methods could be considered for stabilisation: CO2-limestone-NaOH, CO2-Ca(OH)2, CaCl2-Na2CO3.

Although the three-step CO2-limestone-NaOH method would usually have the lowest chemical cost (due to the low cost of bulk limestone) related infrastructure typically includes limestone filter vessels, which also require pebble loading equipment and a backwash system for proper operation. On the other hand, the CaCl2-Na2CO3 system is a mechanically simple two-step process, but with relatively high chemical cost. It also has an added disadvantage related to the increased chloride and sodium concentrations after stabilisation, i.e. the corrosivity index (e.g. Larson-Skold) increases with higher chloride concentrations. Therefore, the Engineer favours the CO2-Ca(OH)2 process, which is a two-step process, but slightly more complicated/sensitive with respect to CO2 dissolution/absorption and final pH control.

To support the selection of process, the Contractor shall provide clear reasoning for such choice by comparing and summarising the 20-year life-cycle cost of the system, including: chemical cost, capital redemption at 12% interest rate and maintenance.

Chemical storage, make-up and dosing systems shall be in accordance with the general specifications described in Section 1.4.7. CO2 can either be generated on site (e.g. LPG burner) or sourced as bulk chemical from gas suppliers, but care shall be taken in the design to ensure effective and complete dissolution of the CO2, typically at a pre-set mg/litre dosing rate. If limestone vessels are offered, they shall be in general accordance with the following specifications:

- Include a robust, reliable, user-friendly and safe limestone loading facility.
- Include a backwash mechanism (single pump and piping) to clean and stabilise the filter bed after recharging.
- The limestone bed height shall not be less than 3.5 metres and recharging of a filter vessel shall not be performed more frequently than once every 7 days.
- Superficial flow velocities through a filter shall not be more than 18 m3/(m2.h).
- Mechanical construction of the vessels shall be according to ASME VIII Div 1 design code.
- Materials of construction for the filter vessels shall be carbon steel with rubber-lining of wetted surfaces, stainless steel 316, or GRP.

After stabilisation, the product water shall be chlorinated. The Contractor shall design, supply and install all chlorine storage, transfer, dosing and monitoring systems that would allow controlled dosage of chlorine into the stabilised water. An in-line ORP measuring device shall be installed sufficiently down-stream of the point of chlorination.

After chlorination, the potabilised water shall be transferred to the existing reservoir, with tie-in point into the existing feed water line at a flow meter chamber. Provision shall be made for 1 bar(g) delivery pressure at this point.

The proposal document shall provide clear information on the following:

- Method of potabilisation and clear description of equipment.
- Dosing control and related instruments offered (including sensors to measure pH, EC and ORP of the final product).
- Chemicals and delivery (purity, delivery batch size and packaging, pebble size, etc.) and related handling and storage on site.
- Chemical dosing rates, in mg/litre, for both pure chemical and chemical as supplied.
- Cost of each chemical (in Rand/kg - as supplied on site).
- Cost of treatment (in Rand/m³) related to chemicals only.
- Capital cost of related equipment and infrastructure.
- Water quality guaranteed after potabilisation, defining at least:
  - CCPP (as mg/litre CaCO3)
  - pH
  - Alkalinity
  - TDS
  - Calcium (Ca)
  - Magnesium (Mg)
  - Chloride (Cl)
  - Sodium (Na)
  - Turbidity (NTU)
  - Residual chlorine (mg/litre)

1.4.6 Backwash effluent handling and discharge

Backwash water from the media filters shall be discharged to an appropriate effluent buffer tank.

a) Backwash effluent buffer tank

The maximum operating capacity of this tank shall be at least 135% of the total volume of effluent discharged during the upward backwash stage of one media filter. The Contractor shall identify the exact tank volume required to ensure constant and trouble-free operation of the full media filtration bank (part of scope of supply) or a design and operational feature – approved by the Engineer - that would prevent a build-up of sludge in the tank. All level transmitters and switches, as well as all mechanical devices fitted into or onto the tank, shall be part of the scope of supply.

Effluent from the buffer tank shall be transferred to and connected to the existing brine discharge pipeline:

The proposal document shall fully describe each aspect listed above, as well as the clarifier dimensions, and effective up-flow rate ($m^3/h/m^2$). Specific references shall be provided of installations where the design is successfully used in similar applications.

1.4.7 Chemical storage and dosing systems

Chemicals, as required for daily operation and/or routine maintenance and membrane cleaning, shall be stored on-site, to make provision for a minimum of one (1) month's operation plus 20%. All chemicals shall be handled, stored and dosed as per legally approved safety procedures and according to environmentally responsible methods, while also adhering to the following minimum requirements:

a) Bulk tanks and dosing tanks

- An ergonomically sound plant layout, where most chemical dosing systems are located in/around a centralised and accessible dosing bay, is preferred.
- Bulk storage tanks are preferred for liquid chemicals such as sulphuric acid and ferric salt solutions.
- Separate day tanks (dosing tanks) with appropriate transfer systems – manually isolatable but automatically activated on low level in day tank – shall be provided for liquid chemicals stored in bulk tanks.
- Bulk storage tanks shall be positioned as close as practically possible to point of use while allowing for clear and direct access for bulk delivery by road truck. Similarly, the plant layout shall allow for easy and appropriate access to all dosing tanks to enable effective fill-up or chemical make-up.
- Bulk tanks and dosing tanks should be installed inside bunded areas.

- Chemical bunded areas shall be able to contain 120% of the chemical volume in related tanks and shall have no direct connection to floor trenches or sumps.
- Bulk and dosing tanks shall be protected from direct sunlight (requirements to be specified).
- Day tanks and dosing tanks shall be non-metallic and of a material that would fully resist chemical attack by the relevant chemical. Each tank shall be equipped with a cover, drain point, fill connection/couplings and process connections of material fully resistant to related chemical degradation.
- Dosing tanks (excluding auto-filled day tanks) shall have an operational capacity that would not require fill-up more frequently than once per week (7 days).
- Bulk and dosing tanks shall be equipped with level switches and other control sensors and devices as required for effective and automated plant operation. This shall at least include low-level switches or sensors that would firstly provide an early warning for chemical preparation and secondly protect dosing pumps from running dry.
- All bulk and dosing tanks shall be equipped with a robust and protected sight glass. Sight glasses that are fully exposed and unprotected are not acceptable.
- The correct and appropriate piping and connection points, as well as supports and stabilising/lifting devices, shall be provided at bulk tanks and at dosing tanks to enable easy and safe transfer of newly delivered (or prepared) chemical solutions. Such connections and supports shall consider operator safety, diluting requirements, minimisation of spillage and long-term mechanical reliability. Connection/transfer points shall be inside the bunded (containment) area and the transfer facility/method shall prevent overflowing of the relevant tank.
- Safety showers and eye-wash kits shall be provided according to the latest OSH Ac requirements.

b) Chlorine – specific requirements

This tender shall make full provision for the supply of chlorine gas bottles (with mass monitored by load cells), motive water pumps and gas injection units with related sensors and controls, as well as dosing lines to points of use, while clearly indicating the monthly demand (kg/month) of chlorine gas. A non-oxidising biocide may be used as alternative disinfectant in the pre-treatment system, but only when it is environmentally acceptable product also certified for use at plants producing potable water.

c) Sulphuric acid – specific requirements

The concentration of the bulk acid sulphuric acid – as delivered - shall be between 93 and 95 mass% (thus with lower freezing temperature than 98% acid). The bulk sulphuric acid tank would most probably have a capacity of less than 3m³ and therefore the materials of construction could be of an appropriate cross-linked poly-ethylene, specifically compatible with 93% sulphuric acid. Apart from the general requirements specified in Section 1.4.7(a), provision shall also be made for the following:

- Piping and connectors that would allow for safe transfer of the acid into the bulk tank during delivery. Such piping shall be mechanically robust (to prevent mechanical failure and related safety hazards) and lined (if steel) to prevent any corrosion.
- During delivery, acid transfer to the bulk tank shall preferably be performed under gravity.
- The bulk tank shall be equipped with an appropriate, u-shaped open vent (PVC or other appropriate material).
- The tank shall be installed inside a civil bunded area (dimensions and surface coating requirements to be specified, but civil works outside scope of supply) with containment volume equivalent to 120% of the bulk tank volume.
- The tank shall be fixed to the bunding structure with acid proof brackets/straps/connectors/supports, while always ensuring full integrity of acid proof coatings.

d) Ferric salt solutions – specific requirements

Ferric chloride or ferric sulphate (if proposed as main coagulant) shall preferably be delivered in bulk (typical solution strength of 43% in the case of FeCl3). However, if the Contractor is of opinion that on-site preparation would be more cost effective and/or practical, then proposed make-up facilities shall carefully consider all health and safety aspects and the final storage facility shall adhere to similar specifications as highlighted in Sections 1.4.7(a) and (b) above (similar than sulphuric acid).

e) SMBS – specific requirements

The SMBS dosing system shall consist of a separate make-up tank and a storage tank:

- The make-up tank shall be equipped with a fully rubber-lined mechanical mixer.

- Transfer piping, valves (isolating both tanks from the transfer pump) and transfer pump internals shall offer full resistance to corrosion.
- The make-up capacity of the make-up tank shall be between 50% and 60% of the volume of the final dosing tank.
- The dosing tank shall be equipped with an overflow pipe returning to the make-up tank, thus preventing potential spillage during transfer of an excessive volume of solution.
- Both tanks shall be equipped with effective proper covers/lids to prevent accidental inhalation of fumes by operators.
- Both tanks shall be positioned in a well-ventilated area and make-up procedures shall adhere to safety regulations, including the use of applicable respirators/masks, rubber gloves, etc.

f) Chemical metering pumps and injection systems

Metering pumps shall be by Prominent or Grundfos (Alldos), or equivalent approved by the Engineer, and the following shall be offered for dosing and injection systems:

- One fully-installed standby metering pump shall be supplied for each dosing application.
- Manual ball valves shall be installed between the dosing tank and the pump to enable proper isolation for maintenance purposes.
- Automatic and remote speed control shall be provided for metering pumps to enable effective dosing control according to relevant measured process variables.
- A clear calibration tube (Pyrex, with engraved calibration scale) shall be installed between the dosing tank and relevant metering pumps. Appropriate ball valves and piping shall be provided for gravity fill from the dosing tank and subsequent isolation of the dosing tank for pump calibration via liquid supply from the calibration tube.
- Chemical injectors shall be of Teflon or PVDF and screwed into the static mixer body or other appropriate dosing point on prices pipelines.
- Each injection point shall be equipped with an external back pressure (check) valve in the chemical dosing line. This valve shall have a pressure rating compatible (and higher) than the relevant maximum process pressure and shall be of a plastic material fully suitable for the relevant chemical.
- Process piping at chemical injection points (especially sulphuric acid and ferric salts) shall be fully resistant to possible chemical attack or localised high temperature spots. Where necessary, PTFE-lined pipe sections or static mixers shall be installed.

1.4.8 General environmental and safety aspects

Energy consumption: Plant layout and pipe routing shall focus on minimisation of energy consumption and capital expenditure, while always providing acceptable and safe access to equipment for general operation and maintenance. Maximum linear flow velocities of 1.8 m/s and 2.8 m/s shall be allowed through process pipelines on the suction and delivery sides of pumps respectively and the design shall be done with due caution to prevent potential water-hammer effects.

Effluent generation and control: The overall plant design and methods of discharge to drains, floor sumps and trenches shall fully adhere to an environmentally responsible philosophy where potentially hazardous chemicals (spillage, etc.) shall be contained and not discharged into the brine (RO concentrate) discharge system. Similarly, process effluent that may harm the environment shall be neutralised or appropriately treated before final discharge.

Safety and health considerations are paramount and provision shall be made for full compliance with the OSH Act. For example: Moving machinery and rotating equipment shall be protected. Walkways, Cat ladders, steps, shall minimise tripping hazards and provide firm and rigid hand railings and supports.

The Engineer will carefully assess the design, layout and overall operating philosophy proposed by the Contractor. Non-compliance with critical safety and environmental requirements shall disqualify the offer.

1.4.9 General stand-by philosophy and requirements

- 50% standby unit for all centrifugal pumps (feed, booster, CIP, etc.), but not for the high-pressure pump.
- No installed stand-by for high-pressure pump or energy recovery unit– but full spare pump and full maintenance/spare kit in store).
- 50% standby unit for all dosing pumps.
- 50% standby unit for backwash blower.

1.4.10 General instrumentation and control requirements

See Electrical and Electronic technical specifications.

1.4.11 Plant layout requirements

1.4.11.1 Layout

Easy access to pumps is essential to allow for removal/replacement during maintenance. Specific attention shall be given to access and maintenance requirements for the high-pressure pump and energy recovery units. Similarly, effective and safe operator-access to dosing stations, cartridge filters and the CIP system is essential.

Plant and pipe layout (as per pipe isometric drawings) shall consider:

- health and safety, including noise levels;
- environmental responsibility;
- minimisation of energy requirements;
- minimisation of capital cost – including all civil and electrical works specified, but excluded from scope of supply – without sacrificing plant reliability and operability;
- general ergonomics related to plant operation and maintenance.

The proposal document shall specifically describe maintenance/removal procedures for the high pressure pump and energy recovery devices, as well as the overall design and layout philosophy followed to address each of the aspects highlighted above.

1.4.12 Process guarantees and verification

The Contractor agrees to design and construct the Robben Island desalination plant so that it can achieve the process guarantees outlined in this section. After hot commissioning, the production capacity, water recovery, water quality, power consumption, chemical consumption and consumable consumption shall be verified – and audited by the Engineer or his representative - during continuous operation of the plant at full design capacity for an acceptance test period of 28 days. As a minimum, the following shall be measured and recorded at a frequency agreed upon between the Engineer and the Contractor during commissioning:

- NTU of raw feed water.
- NTU of filtered (pre-treated) water before and after cartridge filtration.
- SDI15 of filtered pre-treated water before and after cartridge filtration.
- Temperature, conductivity and pH of raw and pre-treated water.
- Conductivity and pH of RO permeate.
- NTU of clarifier (treating backwash water) overflow.
- Solid contents of clarifier (treating backwash water) sludge.
- Chemical consumption, cartridge filter replacement and all maintenance functions.
- Peak power demand and average power demand per permeate produced (kWh/m3).
- CIP frequency (note any need to perform a CIP in the 500-hour acceptance test period would violate the 50-day CIP guarantee)
- Composite and spot samples shall be drawn – in the presence of the Engineer or his representative - from the RO feed tank, the RO unit's permeate discharge line and the permeate tank. Samples shall submit such samples to an approved and reputable laboratory (e.g. CSIR) for analysis that will at least include TDS, Na, Ca, Mg, B, Cl, SO4 and Br. A minimum of ten sample sets (for both composite and spot samples) shall be submitted for each sample point during the acceptance test period.

Mechanical, electrical and equipment guarantees are required and must be in accordance with the relevant employer's requirements. In addition, the commissioning certificate for the plant shall only be granted when the complete system achieves the following process guarantees on a continuous basis and at full design capacity:

- Permeate production:
  - Steady and reliable production of 220m^3/day RO permeate, with a normal production capacity of 12.22m^3/h RO permeate.
  - Ability of the plant to operate at minimum and maximum feed water temperatures as specified in Section 1. (prevailing temperatures during the acceptance test period shall be used to predict membrane performance at minimum and maximum temperatures).
- Process efficiency and water quality:
  - Water recovery over the full pre-treatment system ≥ 95%.
  - Water recovery over the RO train ≥ 40-45%.

- Overall plant water recovery ≥ 40%.
- RO permeate quality and stabilised water quality as outlined in Section 1.2. Note that the proposal document shall clearly specify the permeate water qualities consistently guaranteed with (i) new membranes (ii) 1-year old membranes (iii) 3-years old membranes at both maximum and minimum feed water temperatures. Amongst other, guaranteed pH limits and concentrations of TDS, Na, Ca, Mg, B, Cl, SO4 and Br shall be clearly indicated.
- Pre-treated, filtered water quality as specified in Section 1.4.2(h).
- Sludge consistency from clarifier (treating filter backwash water) of not less than 0.75% solids.
- Clear overflow from clarifier (treating filter backwash water) with turbidity not more than 4 NTU.
- Not less than 50 days between consecutive CIP events (per membrane unit), while operating the plant continuously according to guaranteed capacity requirements.

- Chemicals and consumables:
  - Chemical consumption for each chemical as predicted and less than (or equal to) the quantities guaranteed in the Contractor's proposal document.
  - SWRO membrane element life of minimum 4 years.
  - Cartridge filter replacement not more often than predicted and guaranteed in the Contractor's proposal document.
- Electrical power:
  - Peak power demand and power consumption per permeate production (kWh/m3), based on overall measurement of electricity demand and permeate production at the plant, shall be equal or less than related guarantees described and offered in the Contractor's proposal document.
  - Measurement of electricity consumption shall happen at the following three points:
  - Bulk Supply to the Plant;
  - General supply to building – Municipal Business Tariff measured in transformer room next to plant building;
  - Abstraction Raw Water Supply – Eskom Nightsave rural Tariff measured at the Eskom Supply transformer.
  - Upon completion of the 28 day test period a 6 month trial operational period will start.

1.4.13 Documentation requirements for process proposal

In order to allow for thorough process evaluation of tender proposals, the Contractor's process proposal shall at least include the following in written and tabular format:

- Clear and non-ambiguous written description of the proposed overall design and operation of sub-sections, commenting on the specific process requirements and providing all information requested in sub-sections of Section 1.4.
- Process flow diagrams, including mass and energy balance, pipe sizes and flow rates.
- Preliminary P&ID's, indicating instrumentation as offered and related measuring points.
- Preliminary plant layout.
- Equipment schedule, describing:
  - special technical features and specifications;
  - dimensions;
  - materials of construction for wetted and non-wetted surfaces;
  - reference to similar applications where such equipment is successfully used.
- Pipe and valve schedules with clear indication of materials of construction and corrosion allowances.
- Technical specifications of pumps and energy recovery systems with clear indication of:
  - supplier, make and model;
  - pump curves;
  - materials of construction (wetted and non-wetted);
  - corrosion resistance and related guarantees;
  - energy efficiency;
  - seal mechanism;
  - motor voltage and phases;
  - rotational speed (r.p.m.);
  - installed power.
- An outline of the general control philosophy for a fully-automated plant, including:
  - pre-treatment system;
  - RO unit and CIP system;
  - permeate stabilisation system;
  - backwash effluent clarification;
  - chemical dosing systems.
- Clear summary of the technical specifications of the media offered for the media filters, including:
  - uniformity coefficients;
  - effective grain size (d10, or 10% passing size);

  - acid resistance and maximum carbonate content.
- Clear summary of SWRO membrane type and model, number of elements per pressure vessel, number of pressure vessels, new-membrane salt rejection, guaranteed membrane performance, etc.
- Clear description of permeate stabilisation system, including all information as requested in Section 1.4.5.
- Clear description of membrane life guarantees.
- Clear description of performance guarantees.
- Clear summary of chemical bulk tanks and dosing tanks, including tank volumes, materials of construction, fill-up and chemical transfer method, peripheral piping and connections, etc.
- Clear summary of chemical consumption, highlighting the chemical type, delivered form (e.g. liquid, solid, gas) and concentration, dosages and, specifically, the daily consumption (in form as delivered to site) in kg/day of each.
- Summary of other operating consumables (excluding SWRO membranes and dosed chemicals), e.g. cartridge filters, sampling and monitoring filters or chemicals, and frequency of replacement/use.
- General description of overall corrosion control and related corrosion guarantees.

Failure to comply with specific process, mechanical, electrical and control requirements, or offering alternatives without offering the related specified options could disqualify the tender.

SECTION 2: OPERATION AND MAINTENANCE REQUIREMENTS

Contents

2. OPERATIONS AND MAINTENANCE REQUIREMENTS

2.1 INTRODUCTION

The Scope of Works includes the on-going management, operation and maintenance of the completed Works by the Contractor. These services shall commence during the plant performance testing phase until handing over of the completed work to the Employer.

The Contractor shall ensure that the Works are effectively managed, operated and maintained during this period, and that the required quality and performance standards are satisfied.

As part of these obligations, the Contractor shall:

a) provide all resources and suitably qualified personnel during the commissioning and performance testing phase;
b) provide all necessary personnel including the key staff for the managerial, technical, supervisory and administrative responsibilities and labour necessary to ensure the proper, safe and efficient operation and maintenance of the Works, on a continuous 24 hour basis;
c) develop and implement an approved Operations and Maintenance Plan to optimize and control the operation of the Works, in full compliance with the requirements of the Contract;
d) develop and implement an approved Asset Management Plan to ensure the Works' assets are monitored and maintained in accordance with the Contract requirements;
e) provide all chemicals, energy, fuels and consumables necessary for the effective operation of the Works
f) monitor and ensure that specified quality and environmental standards are satisfied at all times, and are in full compliance with SANS 241 requirements for potable water;
g) ensure full compliance with OHSAS and other relevant health and safety regulations;
h) provide an effective Management Information System, necessary for ongoing cost, financial and performance monitoring, control and reporting, including routine and non-conformance reporting to the Employer.

2.2 SCOPE OF SERVICES

2.2.1 Commissioning of the works

The Contractor shall provide all the necessary specialist, operational and support personnel required to effectively carry out the various commissioning phases, final performance testing and hand-over to the Employer of the completed Works.

The Contractors rates shall also include for all costs associated with the commissioning of the Works, including:

i) chemicals
ii) potable or raw water requirements
iii) energy and fuels
iv) commodities and consumables
v) on-site and external laboratory sampling tests of the various process streams and final treated water as required to demonstrate performance and quality compliance.

2.2.2 Asset management plan

During the commissioning programme, the Contractor shall compile and submit for approval a comprehensive Asset Management Plan detailing the procedures, systems, controls, specifications and standards, monitoring and reporting frameworks to be applied on the contract, as well as the KPA's and KPI's to be applied in assessing performance and compliance.

The Asset Management Plan shall incorporate:

2.2.2.1 The asset management system

The Contractor shall provide with its tender a detailed description of their asset management programme and its capabilities, these to be incorporated in its Asset Management Plan, to demonstrate effective management and reporting on its Asset Management system.

2.2.2.2 The asset inventory

A comprehensive register of all the assets within the contract, providing a unique reference, identification and description of all key technical, manufacturing, performance data for any asset provided under the Contract, including specifications. This shall be maintained and updated as required, and at least at yearly intervals to ensure it remains current and up to date. The register shall be available at all times on site to the Employer.

2.2.2.3 Maintenance and predictive maintenance

The Contractor shall cost for, and provide within its tender, a detailed description of maintenance and predictive maintenance programmes to be incorporated in the Asset Management Plan, which shall include:

i) the routine maintenance programme, in accordance with manufacturers specifications and best practice, such that the works are maintained in neat and tidy condition and sound working order, including the following:
   - mechanical plant and equipment
   - electrical installations and equipment
   - instrumentation, telemetry, PLC and SCADA
ii) predictive and preventative maintenance programmes for all electro-mechanical plant, equipment and installations.
iii) calibration and recalibration of meters and monitoring equipment
iv) the supply, storage and stock-holding of maintenance materials, consumables and spares.
v) maintenance equipment and tools to be provided, these to be handed over free of charge to the Employer at the end of the contract in sound condition, fair wear and tear accepted.
vi) maintenance personnel and resources, including organisational structure,
vii) inspection and monitoring programmes
viii) maintenance records and reporting

Tenderers shall submit with their tenders a detailed schedule of maintenance to be carried out.

2.2.2.4 Repairs and emergency repairs

Contractors must include in their rates for the risk and cost of any repairs, refurbishment or replacement of asset components, including membranes such that at all times, the plant is maintained at maximum availability, capacity and the specified performance and safety levels.

At the end of the contract, the Assets must be handed over to the Employer in sound operational condition and working order, fair wear and tear accepted.

The Contractor shall provide with its tender, a detailed description of repair and emergency repair approach to be incorporated in its Asset Management Programme, addressing inter alia:

i) local workshop, stores and equipment to be provided
ii) local resources and support structures
iii) standby and relief structures
iv) essential spare parts and stockholding kept on site (including membranes)
v) response times
vi) records and reporting

2.2.2.5 Raw water extraction and brine disposal facilities

The Raw Water extraction and brine disposal facilities have been provided by the Employer through a separate contract.

Whilst the operation and maintenance of these facilities are the responsibility of the Contractor, specialised maintenance (pipe cleaning or pigging) and repairs will be for the account of the Employer, based on an approved quotation, cost plus or daywork basis.
This will also apply to any environmental monitoring required in the vicinity of the extraction or discharge points

2.2.2.6 Membrane care

The Contractor shall include in their rates, and provide details of their membrane care programme, this to be fully aligned with the requirements of the membrane manufacturer.

2.2.2.7 Risk management

The Contractor shall provide details of its Risk Management approach, from the initial risk assessment through to the response plan per unit process for both routine maintenance and repairs, as well as operational interventions to ensure there is no disruption to the specified plant performance and outputs requirements.

2.2.3 Operating plan

Prior to the commissioning programme, the Contractor shall prepare, and maintain during the contract, a comprehensive Operating Plan, detailing the approach; resources; systems; procedures and processes for each aspect of the plant operation. Once approved, this shall form the basis upon which the effective, efficient and optimal management and operation of the Works is monitored, evaluated, corrected and reported upon.

The Contractor shall submit with its tender detail of all aspects of the Operating Plan, including:

i) the commissioning and performance testing programme
ii) standard preparatory and other start-up; shut-down and emergency shut-down procedures
iii) the organogram, with job descriptions and duties for each position
iv) Curriculum Vitae of the key staff, down to supervisor level
v) specialist and support staff and functions to be provided
vi) the operating strategy, including standard operating procedures and non-compliance interventions
vii) risk assessment and contingency plans for the various processes
viii) the preparation and maintenance during the contract of the Operation and Maintenance Manuals, and as-built drawings
ix) the Quality Management and monitoring programme, including ISO applications
x) energy, chemical and consumable management plan
xi) procurement
xii) management information and reporting systems and procedures
xiii) the Health and Safety plan
xiv) maintaining the Legal Register and procedures to ensure compliance at all times to all applicable legislation, statutory, regulatory, code, bylaws and other prescriptions by public bodies, including but not limited to the:
- Environmental Health and Safety Act, (N. 73 of 1989)
- Occupational Health and Safety Act, 1993 (no, 85 of 1993)
- Water Services Act (No. 108 0f 1997)
- National Water Act (No. 36 of 1998)
- National Environmental Management Act (No. 107 of 1998)
- Labour Relations Act (No 65 of 1995)
- Regulation R2834 of 27 December 1985 in respect of registration of Water Treatment Plant Operators
- Municipal regulations, Code and bylaws and other special requirements of the Local Authority within which the Works are located

The Operating Plan forms an essential framework for the effective management, operation and monitoring of the Works such that the quality, availability and reliability of the specified volumes of potable water are consistently achieved, and that non-compliances are immediately identified and addressed within the shortest possible timeframe, with minimal service disruption. It is expected that the Operating Plan will to the standard and detail that could be expected from an experienced and competent water services provider for a plant of this nature and the acceptance of the Operating Plan of this standard by the Employer will be an integral requirement of the commissioning programme

Specific requirements for inclusion in the Operating Plan have been expanded upon as follows:

2.2.3.1 Commissioning programme

The Contractor shall provide a detailed operational methodology and programme for the preparatory stages, cold and hot commissioning phases and the continuous, uninterrupted 28 day performance test prior to the start of the 6 month trial operational period and handover of the plant. In the event of any failure during the 28 day performance test, the test shall be restarted and all additional costs shall be for the Contractors account, until such stage as the performance test demonstrates full compliance to the performance specification.

The Employer reserves the right to call for an additional performance test, at its cost, dependent on the nature, consistency and quality of the raw water feed.

2.2.3.2 Human resources

The Contractor shall comply with all applicable labour legislation and regulations, including but not limited to the following:

- The Labour Relation Act (No. 66 of 1995)
- The Occupational Health and Safety Act (No. 85 of 1993)
- The Basic Conditions of Employment Act (No. 75 0f 1997)
- The Employment Equity Act (No.55 of 1998)
- The Skills Development Act (No. 97 of 1998)
- The Skills Development Levies Act (No. 9 of 1999)
- The Promotion of Equality and Prevention of Unfair Discrimination Act (No. 4 of 2000)

The Contractor shall include in the rates, and provide detailed information with its tender, for the following:

2.2.3.2.1 Management, administration and support structures

The Contractor shall provide all managerial, supervisory, technical, maintenance and administrative staff and support structures necessary to perform its management, operations and maintenance obligations, including, but not limited to:

- The Project Manager, based in region, as the authorised representative and with overall responsibility for the fulfilment of the Contractors contractual obligations;
- The Operations Manager responsible for the day to day management and operation of the system;
- supervisory and stand-by personnel required to ensure 24 hour management and emergency intervention, seven days a week throughout the contract period.
- administrative staff
- human resources and training
- maintenance teams for routine maintenance
- repair and emergency repair teams
- quality management and monitoring
- process management, monitoring and support

The Tenderer must also submit details of additional support structures that will be utilised for this contract.

The Tenderer shall submit curriculum vitae of the key personnel above for each of the disciplines above, as well as details of where they will be based and their availability.

Due to the nature of the Contract, particular attention will be given during the tender evaluation on each Tenderer's track record, expertise and experience, as well as that of their proposed teams. The Employer has the right to disqualify any Tenderer's tender where the detail provided is inadequate or the personnel and support profiles put forward in their tender appears inadequate.

2.2.3.2.2 specific staff

The Contractor shall provide the necessary experienced and qualified staff for the continuous 24 hour operation of the Works to the required standards. The tendered rates shall allow for all site specific staff costs including relief staff as well as standby and other allowances, such that the Works are not left unattended at any stage.

The Contractor must submit the proposed organogram, with associated job descriptions, duties and responsibilities which will adhere to all legal and operational minimum requirements.

It is assumed that all Tenderers will have fully satisfied themselves during the tender period of the full personnel requirements for the Works schemes and would have priced this section of the tender accordingly.

Should the Employer be of the opinion that the Contractor has insufficient operating personnel at any facility; the Employer will instruct the Contractor to provide such additional staff, at the Contractor's own cost.

2.2.3.2.3 Training

The Contractor shall provide within the rates and submit details with the tender on the on-going hands-on and formal training programmes and facilities to be provided to the site specific staff such that they are become competent in their positions and upgrade their qualifications to the required level. The Tenderer must, within three months of contract commencement, submit a detailed training plan, based on the prior personnel assessment and proposed organisational structure. Once approved by the Employer, the Tenderer shall carry such training, against the provisional sum provided in the tender schedule of quantities.

2.2.3.3 Quality Management

The Contractor shall submit with the tender detail of their proposed Quality Management programme, addressing:

2.2.3.3.1 Water quality management

The Contractor shall:

- provide the necessary competent and experience staff to perform water quality monitoring, process control and optimization and reporting through the various Works process streams such that the potable water from the Works meets with the requirements of SANS 241 (2000) and the Water Services Act of the Republic of South Africa (Act No 108 of 1997);
- provide the laboratory testing equipment and laboratory consumables as may be required by the Contractor for process control monitoring, such equipment to be handed over free of charge to the Employer at the end of the contract.
- ensure that daily process control testing and reporting procedures are carried out at the plants by the operating personnel to ensure operational conformance and process optimisation, in accordance with the minimum requirements tabled below;
- appoint an independent SANAS accredited external laboratory to provide a analysis and quality conformance report, in terms of the test schedule below;
- implement system performance enhancements or upgrades to ensure quality conformance
- submit detailed monthly quality monitoring reports

The Contractor must submit details with their tender on their Laboratory Quality Assurance programme and control measures to demonstrate the on-going competency of their staff, calibration of equipment through standards and participation in the SASS water check proficiency programme.

In the case of non-compliance to the required quality or performance standards of the Works for reasons attributable to the Contractor, the Employer may instruct the Contractor to carry out additional tests at more frequent intervals at the cost of the Contractor. Where such non-compliance is not attributable to the Contractor, the cost of such additional tests requested will be for the Employers account.

Additional Annual tests required by the Employer in terms of SANS requirements will be recoverable by the Contractor on a cost plus 5% basis.

2.2.3.4 Energy

The Contractor shall allow for all costs associated with the provision and consumption of energy for the plant, including but not limited to installation and connection charges; deposits, availability and demand charges; energy consumption charges; seasonal rate fluctuations and the like where applicable.

All energy costs shall be included in the variable rate for potable water produced at the Works.

2.2.3.5 Chemicals and Consumables

The Contractor shall allow for all costs associated with the provision, handling, storage, usage and wastage and all chemicals and related consumables required for the operation and maintenance of the Works, including for membrane cleaning chemical regimes.

The Contractor shall provide details of their chemical quality management programme

All chemical costs shall be included in the variable rate for potable water produced at the Works.

2.2.3.6 Meter Reading

Prove that the final volume of treated water produced is in accordance with the requirements.

2.2.4 Reporting systems

The Employer and Contractor shall agree on the reporting format to be completed and submitted on completion of the commissioning phase.

i) Operating parameters (minimum, average and maximum) through the various streams, including:
- water quality
- water quantity
- process control regimes
- laboratory test results
- performance data and trends
- stoppages and interruptions
- membrane care programmes
- power disruption, shut-down and start-up implications
- non-conformances. Corrective actions initiated and status quo

ii) meter readings, running hours and stoppages
iii) maintenance carried out
iv) repairs carried out, planned or unscheduled
v) chemical and energy consumption, disruptions and down-time
vi) Health and Safety incidents, inspections, audits, corrective actions
vii) HR and IR matters

The Contractor shall submit a monthly report incorporating the above and attend a monthly meeting with the Employer, reviewing inter alia:

- the monthly reports on the plant performance for the preceding period
- quality records
- non-conformances and corrective actions
- personnel, and outstanding issues
- the certificate claims and payment status
- instructions or queries issued
- outstanding actions and deadlines required by the various parties
- review performance against the annual budget

2.2.5 Safety requirements

The Contractor shall agree in writing on contract signature to abide by and implement the requirements of the Occupational Health and Safety Act (Act 85 of 1993) and in terms of Section 37(2) shall:

i) acquaint his employees and the seconded staff with the relevant provisions of the Occupational Health and Safety Act (Act 85 of 1993)
ii) comply or ensure compliance with all the relevant duties, obligations and prohibitions imposed in terms of this Act and Regulations and absolves the Employer from itself being obliged to comply with these undertakings
iii) immediately advise the Employer of non-conformances, safety improvements and upgrade required to ensure such compliance where these form part of the Employer's responsibilities.
iv) The Contractor shall compile a Safety Plan and submit to the Employer for approval within two weeks of commencement of appointment.
v) Appoint the necessary Safety Officer and Competent Person

2.2.6 Transport, accommodation and offices

The Contractor shall be responsible for all transport, accommodation and offices required by them in 38riples38nt of their obligations in terms of the Contract, the cost and running costs of which must be included in the tendered rates.

SECTION 3: MECHANICAL SPECIFICATION

The following relevant sections of the Specifications, as listed below, shall apply to this contract:

Contents

3. MECHANICAL SPECIFICATIONS

3.1 CONSTRUCTION

3.1.1 Scope of specification

This Specification covers the detail requirements for specific items of mechanical equipment to be designed, drawn, manufactured, supplied, delivered, erected, installed, tested on site, commissioned and maintained under this Contract. The requirements of this Specification are in addition to those specified in the Particular Specifications as contained in this Document for this Contract, and in case of any discrepancies, the detail requirements contained in this Specification shall prevail.

3.1.2 Scope of work

The scope of Work in this Contract shall be the Work in accordance with these Specifications for the acquisition of the mechanical equipment systems.

3.1.3 Information to be submitted with tenders

3.1.3.1 General

Contractors shall supply all information and technical data, as specified in the Particular Specification General Specification for Mechanical Equipment.

3.1.4 Information to be submitted after award of tender

The Contractor shall supply all information and drawings as required by the Employers Requirement for Mechanical Equipment within 21 days after receiving a written notification of the award of tender.

3.1.5 Drawings

The Contractor shall submit two sets of installation drawings (paper prints) for all equipment and pipe work, layout drawings and wiring diagrams of the control panel for approval by the Engineer. Prior to manufacturing, five sets of the approved drawings shall be submitted to the Engineer.

On completion of the works, one set consisting of all of the above drawings, updated to reflect the as built-conditions, shall be handed to the Engineer. One set of paper prints of the as built-wiring diagrams, shall be provided in suitable plastic covers affixed to the inside of the control panel doors.

3.1.6 Operation and maintenance

Two draft sets of operation and maintenance manuals shall be submitted the Engineer for approval, at least three weeks before commissioning commences. The manuals shall be in English. The manuals shall also contain a complete set of the drawings associated with the works. One copy will be returned to the Contractor not less than one week before commissioning commences, for correction and adaption on Site as necessary. Once the documentation has been corrected and adapted, three sets of the final operation and maintenance manuals shall be suitably bound and submitted to the Engineer.

3.1.7 Testing and commissioning

Testing and commissioning will be as described in the Contract and the Employers requirement and will include for example the following:

a) Test the performance of each of the following safeguards:
   - Thermal over current protection for the motor
   - Under and over voltage protection
   - Incorrect phase sequence protection
   - Phase failure protection
   - Low water level protection
   - Water flow measuring system and no flow protection
   - High and low water pressure protection system

b) Run the pumps and test for direction for rotation and verify the current drawn to set the overload relays.

c) Ascertain the pump duty point by measuring the pressure drop across the pump and verifying the flow rate on the pump curve.
d) On the successful completion of all the tests, equipment shall be commissioned.

3.1.8 Training of personnel

During the commissioning phase, the Contractor shall train appointed personnel of the Employer in the operation of the equipment and control systems. For this purpose, the draft operation and maintenance manuals shall be made available to such personnel for study. The training of personnel shall be to the satisfaction of the Engineer.

3.1.9 Commissioning certificate

The Contract Works will only be considered to be completed and the Certificate of Completion will only be issued when all of the following conditions have been met:

a) The Contract Works have been successfully tested and commissioned.
b) The as built-drawings have been provided.
c) The operation and maintenance manuals have been provided.
d) The Employer's personnel has been trained.
e) The Site has been cleared and tidied to the satisfaction of the Engineer.
f) All other conditions of the Specifications have been met.

3.1.10 Quality assurance

The Contractor shall be responsible for ensuring that the performance of equipment is in accordance with the Specifications.

The governing standards for the entire installation shall be those stated by the South African laws and regulations and the latest SABS standards.

In the absence of SABS standards, the relevant BS., DIN, Japanese or American standards will suffice.

a) Where foreign countries' standards are quoted in the Specifications, the equivalent standard from any country can be used provided that the Contractor can satisfy the Engineer that the standard is equal to the standard specified.
b) The static equipment offered shall have a lifespan of 20 years and particular attention shall be given to the corrosion aspects.
c) The dynamic equipment shall have a lifespan of 40000 hours and particular attention shall be given to the pump & motor bearings and seals, as well as the motor starter contacts and control relays.
d) The orders for pumps and motors, valves and the electrical control panels shall be approved by the Engineer before they are issued to the subcontractor/supplier by the Contractor.
e) Workshop drawings for manufactured items i.e. the pipe work and the control panel shall be approved by the Engineer before manufacture commences.

3.1.11 All equipment bought out by the Contractor shall be inspected for compliance with the order and the Specifications of the supplier/manufacturer before delivery to Site.

3.2 MECHANICAL EQUIPMENT

3.2.1 *Scope*

This Specification covers the general requirements for the detail design, manufacture, supply, delivery, erection, installation, testing on Site, commissioning and maintaining of the mechanical equipment specified under this Contract. The complete installation shall comply with this Specification.

General Specifications for specific items of mechanical equipment are covered by Separate Particular Specifications included in this document.

3.2.2 *General requirements*

3.2.2.1 Tender information and requirements

The Contractor shall submit with his Tender particulars such as outline drawings, relevant technical leaflets and brochures of all equipment offered, results of any tests on similar equipment, reference to and information on similar equipment supplied and installed by the Contractor which have been proved satisfactory by actual use and operation, supplementary specifications and other technical information as are necessary to fully illustrate and describe the equipment offered so that a proper assessment can be made of the equipment included in the Tender.

The Contractor shall also include with his Tender full details with regard to electrical wiring diagrams, electrical cabling and inter-connections between all electrical components to be supplied and erected under this Contract and electrical requirements of all motors, switchgear, cabling and other items to be provided by others.

All switchboards shall be tested after manufacturing in the factory under supervision of the Engineer. Provision shall be made for all relating costs of the switchboards as they are going to be manufactured outside Cape Town.

3.2.2.2 Detail design, planning and drawings

3.2.2.2.1 Safety

Safety shall receive the highest priority and proper attention at the design stage. Potentially dangerous equipment and infrastructure shall be designed in accordance with the relevant South African or international standards. Hazards musts be avoided or guarded against.

Moving parts shall be properly guarded to the satisfaction of the Engineer.

An emergency stop button must be installed in a convenient position next to each machine; pump etc. and the installation must be designed to provide immediate access.

3.2.2.2.2 Detail design and planning

After the award of Tender the Contractor shall be fully responsible for the detail design and drawing of all the equipment under this contract. The Contractor shall also be responsible for the programming and planning of the design, manufacturing, delivery, erecting, installation, testing and commissioning of all equipment under this contract.

3.2.2.2.3 Machine vibration levels

During the design phase of the project specific attention must be given to mechanical vibration. Mechanical vibration of machines measured at important points such as bearings shall be lower than that specified as “good” for that class of machine in BS 7854 (ISO 10816).

3.2.2.2.4 *Noise pollution and control*

The noise level of the complete installation shall not exceed the following:

a) At the site boundaries 55 dB(A) when all equipment installed is being operated;
b) At a distance of 1m from individual sound producing mechanical equipment 80 dB(A).

If the noise levels can not be limited to the maximum levels specified, the Contractor must supply alternative solutions such as acoustic hoods or provides soundproofing within rooms or buildings.

3.2.2.2.5 *Standardization of equipment and equipment types*

The contractor shall give special attention to the principle of standardization with regards to the use of equipment throughout the plant. The standardized process will be based on the equipment specified in this document. The Contractor will discuss selection of equipment if they do not agree with the proposed equipment.

The selection of equipment should also consider local support for the repair and the time for replacement of equipment. Experience with proven technology in existing local applications should also be considered when selecting equipment.

3.2.2.2.6 ***Equipment failure and replacement***

If within six months of the guarantee period, 20 % or more of any class of equipment fails, the Employer shall have the right to demand the replacement of all that class of components at the cost of the Contractor. The Contractor accepts this liability by virtue of submission of an offer for the proposed works.

3.2.2.3 ***Programme and Progress***

A detail Contract programme shall be submitted by the Contractor to the Engineer, for his approval, within 14 (fourteen) days after the Contractor has been notified in writing of the acceptance of his Tender. The programme shall list each scheduled equipment item and indicate periods and deadlines for:

a) Preparation, approval and finalization of Drawings;
b) Ordering Manufacturing of equipment;
c) Inspection and testing during manufacturing;
d) Delivery on Site;
e) Erection and installation;
f) Testing on Site; and
g) Commissioning.

The Contractor shall allocate to a senior member of his staff the responsibility to monitor and evaluate the progress of the Works in relation to the approved programme, to devise methods to overcome or prevent delay and to co-operate with the Engineer. He shall report to the Engineer and draw his attention timeously to anything, which may cause any delay in the execution of the Works.

3.2.2.3.1 **Contractor's drawings**

a) Approval of Drawings

Within the time specified in the Project Specification. Detail Specification for Mechanical Equipment after the Contractor has been notified in writing of the acceptance of his Tender, and before manufacture and supply of equipment, the Contractor shall submit to the Engineer, for his approval, 2 (two) prints of all details drawings giving full dimensions and details of the mechanical equipment included under this Contract.

All drawings shall be clearly numbered and marked with equipment item numbers corresponding to the tendered Schedule of Quantities. All dimensions shown on the drawings shall be in S.I. metric units.

The Engineer may require from the Contractor further detail drawings, calculations and/or information in order to clarify features not adequately shown on the submitted drawings. The Engineer will return to the Contractor one set of the submitted drawings which will be marked "APPROVED" or marked with changes which are deemed necessary by the Engineer. The Contractor shall immediately modify the drawings and resubmit for the approval of the Engineer. The nature and date of each modification and a distinguishing symbol shall be added to the drawings.

The approved drawings shall become part of the Contract and the Contractor shall supply 3 (three) of each such approved drawing as working drawings to the Engineer.

The Contractor shall not proceed with the purchasing, manufacturing and/or acquisition of any particular mechanical equipment item, prior to the final approval by the Engineer of all drawings detailing that specific mechanical equipment item.

The approval of drawings by the Engineer as specified above shall not relieve the Contractor of any responsibility in terms of the Contract.

The Contractor shall be responsible for any discrepancies, errors or omissions in the drawings and other particulars supplied by him, whether such drawings and/or particulars have been approved by the Engineer or not, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished in writing to the Contractor by the Engineer.

b) As-built Drawings

Upon completion of the erection and installation the Contractor shall supply one set of reproducible drawings detailing the equipment as erected and installed, including complete parts lists.

The cost of drawings, calculations, reproductions etc, as set out in this clause shall be deemed to be included in the Contract Price under the item Detail Design Planning and Drawings in the Schedule of Quantities.

3.2.2.4 *Manufacture, supply and delivery on site at point of installation*

3.2.2.4.1 Inspection and testing at the place of manufacture and supply

The quality of materials, workmanship and performance of all items of equipment shall be thoroughly tested at the place of manufacture and supply, and test certificates, in triplicate and in the ruling language shall be submitted to the Engineer prior to the shipment, railing or transport to the equipment concerned.

The Contractor shall give reasonable notice in writing of the time and place of tests to enable the Engineer to inspect and witness tests of materials and equipment.

The acceptance by the Engineer of any plant item, following such inspection and tests at the place of manufacture and supply, shall not relieve the Contractor of any obligations under this Contract.

All cost of such tests and inspections and the necessary testing facilities shall be deemed to be included in the Contract Price.

3.2.2.4.2 Storage

Equipment and materials to be supplied under the Contract shall, on completion of fabrication, be stored at the Contractor's factory, store or yard until it is required for incorporation in the works. The Contractor shall ensure that the items are fully protected from the weather and damage of any kind. The cost of repair of any damage shall be to the Contractor's account.

3.2.2.4.3 Loading, transport and off-loading

The loading, transport to and off-loading at the Site of all equipment and materials supplied by him shall be the responsibility of the Contractor.

Items shall be handled with proper care at all times. Sufficient labour and equipment shall be on hand before loading and unloading is commenced. Under no circumstances shall items be dropped from vehicles and large or heavy items shall be carried out under proper supervision. Ropes, chains, sling, etc. shall be attached only at the correct lifting points and care shall be taken to ensure that they cause no damage.

During transport, all materials shall be properly placed in the vehicle to prevent undue movement and coverings; padded supports, packing or dunnage shall be provided as necessary to prevent damage from either the weather or the motion of the vehicle. All packing materials shall remain the property of the Contractor and shall be removed from the Site by him.

Breakage, damage or loss in transporting, handling, etc. shall be for the account of the Contractor.

An item shall be off-loaded at a locality and on a place and time arranged with the Engineer.

All costs in connection with loading transport and off-loading of the equipment shall be deemed to be included in the contract price.

3.2.3 *Erection, installation, site testing and commissioning*

3.2.3.1 Erection and installation

The Contractor shall supply everything required for erecting, installation and handling on Site of the mechanical equipment. The Contractor shall supply everything required for the protection of persons on the Site, the equipment and materials supplied and the civil works during the period of erection and installation.

All equipment shall be erected by or under the direction of experienced and competent fitters. It shall be accurately placed and shall be true to line and level.

Drift pins, jacking equipment and the like shall not be used to bring improperly fabricated pipe work and mechanical equipment items into place. A moderate degree of cutting and reaming may be employed to correct minor misfits only if, in the opinion of the Engineer, this will not be detrimental to the appearance or strength of the installation. Burning of holes will not be permitted without the written approval of the Engineer.

Pipe work shall, before installation, be checked to ensure that it is in good order and condition and each item shall be thoroughly cleaned inside and outside. Any pipes showing cracks, blowholes, broken flanges or other defects shall be set aside and the Engineer called upon to determine whether they are to be repaired or replaced, all at the Contractor's expense.

Skilled and experienced pipe layers shall carry out the fitting of the pipe work. Pipes shall be fixed accurately to line and level, and vertical pipes shall be truly plumb. Rubber joint rings shall be placed without distortion and pipes drawn together without straining. No flange bolts shall be omitted and all shall be fully tightened.

On completion of erection, the Contractor shall paint of repaint all parts of the equipment, steelwork, pipe work, etc. on the Site. The colours used shall be as specified by the Engineer. The work shall be executed in accordance with this Specification.

All paintwork shall be neatly finished off, free from defects and to the satisfaction of the Engineer, or it shall be made good or removed and repainted, as required. Care shall be taken to protect other parts of the plant and structure from spillage, drips, etc., and on completion all paint marks, spots and the like on other surfaces shall be carefully removed.

On completion of erection and installation, the Site shall be cleaned of all surplus material and debris and left in a cleaned and tidy condition.

3.2.3.2 Testing on site

At completion of erection and installation of all mechanical equipment and before commissioning of the plant all components of mechanical installation, included in this Contract will be subjected to testing in the presence of the Engineer and to his satisfaction. All cost of such testing as outlined below and specified in the Project Specification shall be deemed to be included into the Contract Price.

The Contractor shall give reasonable notice in writing of the time of testing to enable the Engineer to inspect and witness tests of materials and equipment.

The Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials including power, water and chemicals, as the Engineer may require to check the setting out, to measure, inspect and test any portions of the Works at any stage during construction, erection, installation or painting. During such operations, the Contractor shall, if required by the Engineer, suspend any or all of the Works without having a claim for loss or damage as a result thereof.

At the commencement of and during the whole of the testing, the Contractor shall have available on Site all essential spares and tools considered necessary to enable repairs of defective parts to be carried out immediately in the event of a breakdown.

The Contractor shall be responsible for the proper operation and maintenance of the plant throughout the period of the testing.

Acceptance by the Engineer of any plant item, following such inspection or tests, shall not relieve the Contractor of any obligations under this Contract.

The test on Site after completion of the erection and installation of the equipment shall include the following:

a) All electrical and electronic equipment and installations shall be tested for correct connection, installation, insulation, losses, output, earthing and overheating, whichever may be applicable for the part or installation to be tested.
b) All electrical and electronic equipment and installations shall be subjected to a complete operational test to check the correct operation thereof in terms of the operational requirements..
c) All mechanical equipment and installations shall be tested for correct positioning, alignment, fixing and all such items, which may affect the satisfactory operation thereof.

d) All mechanical equipment and installations shall be subjected to a complete operational test to check the correct operational requirements.
e) Complete operational tests of hydraulic equipment shall include for effective, efficient and adequate performance of each component individually and in concert according to the operational requirements specified.

3.2.3.3 Commissioning

At the completion of all work on the plant and after the successful testing of all civil, electrical and mechanical work the complete plant shall be commissioned. The Contractor will be responsible for the commissioning of all equipment supplied, erected and installed by him at a time arranged by the Engineer to enable the plant as a whole to be put into operation.

It is unlikely that the scheduling for the commissioning of the plant will follow directly after the completion of the erection and installation phase. The Contractor shall therefore allow for the return of site for commissioning as well as the adequate protection for equipment in the interim period between erection and installation and commissioning shall be deemed to be included into the Contract Price.

The Contractor shall at his own cost render all assistance and supply all labour, appliances and any other materials excluding power, water and chemicals, as may be required during commissioning. The Employer will supply power, water and chemicals required during the commissioning period.

At the commencement of and during the commissioning period, the Contractor shall have available on Site all essential spares and tools considered necessary to enable repairs of defective parts to be carried out immediately in the event of a breakdown.

On completion of the commissioning of equipment the plant shall be put into normal operation and the final adjustments of the equipment shall be made. Thereafter the Tests on Completion shall be carried out in the presence of the Engineer to ensure that the plant will fulfil the functions for which it has been supplied.

Such Tests on Completion shall include the following:

a) Simulated tests for all alarm and safety cut-out equipment to prove the operation of the equipment.
b) Simulated tests on automatic controls to prove the ability of the controls to rectify conditions which are outside the required design conditions. The tests shall be carried out by manually changing the desired values to produce an incorrect condition and then resetting the controls to the design conditions and checking the operation of valves, etc. to restore the design conditions.
c) Operational tests on the plant to demonstrate that it is giving the rated output and efficiency.

The Contractor shall provide all necessary temporary measuring and recording equipment. The equipment shall be of a type generally used for this type of testing and shall be approved by the Engineer. All instruments shall be accurately calibrated before the tests commence.

On completion of the commissioning of all the mechanical equipment, and provided the Contractor is satisfied that the entire plant is operating satisfactorily and will fulfil the function for which it has been supplied, he shall submit to the Engineer duplicate copies on all the tests called for in the Specifications. The Engineer shall reserve the right to ask for any reasonable additional tests in order to prove that the operation of the plant is satisfactory and in accordance with the Specifications and Drawings.

During the commissioning, the Contractor shall train and instruct the personnel as appointed by the Employer as plant supervisors in the correct working and operation of the equipment supplied by him. The Contractor shall, however, be responsible for the proper operation and maintenance of the plant throughout the period of the testing.

The Engineer will only issue a Commissioning Certificate after all aspects of the commissioning procedures have been complied with to his satisfaction.

3.2.3.4 Operating and maintenance manuals

The Contractor shall provide complete and adequate Operating and Maintenance Manuals in duplicate. The manuals shall be made up in book form with loose pages and shall include drawings, diagrams and cross-sectional drawings specially prepared and coloured in and marked to indicate relevant details.

The Operating and Maintenance Manuals shall be complied in an orderly and logical manner following as far as possible the sequence below and containing at least the information indicated.

a) Index
b) Components and functions of equipment
c) Normal operation
d) Guidelines and rules for abnormal operation: low flows; high flows; emergencies; components out of operation, bypassing certain components, etc.
e) Maintenance; routine maintenance and lubrication instructions; major maintenance; detailed instructions; list of spare parts that should be held in stock; complete schedule of all spare parts for use when ordering; address and telex, fax and telephone numbers of all equipment suppliers; technical brochures of individual items.

The text of the instructions, notations and titling of drawings shall be in English.

Draft manuals shall be available at commencement of site testing of the equipment and two copies shall be submitted to the Engineer for approval. The Engineer shall return to the Contractor one copy of the draft manual on which amendments regarded as essential have been indicated, and which is marked “Approved in Principle”.

The Contractor shall update the manuals before commissioning, and deliver two copies of the final manual to the Engineer.

No separate item for payment for Operating and Maintenance Manuals is included in the Schedule of Quantities, but payment for these will be deemed to be included in the contract price.

3.2.4 *Maintenance(retention)period*

The maintenance period will commence with the issue of the Commissioning Certificate. The maintenance/retention period shall be 12 months after the completion of the acceptance period of 28 days and the Contractor shall be responsible for all preventative maintenance as well as the repair of any defects and/or malfunctioning of the mechanical equipment during this period of time.

Repairs to any mechanical equipment shall be carried out promptly and at least within one week after receiving written notification from the Engineer. The Employer at the expense of the Contractor will carry out repairs if the above-mentioned conditions are not fulfilled.

The maintenance period will be extended by a proportional period of time if the mechanical equipment was not a fully operational condition for at least 10 months of the maintenance period. The Contractor shall not have any claim for interest payment on retention money, surety, etc. during such an extended maintenance period.

3.3 GENERAL REQUIREMENTS FOR MANUFACTURING, SUPPLY, ERECTION AND INSTALLATION

3.3.1 *General*

3.3.1.1 *Units of measurements*

All dimensions, masses, etc. shall be in S.I. metric units.

3.3.1.2 *Applicable standards and regulations*

In general all material, equipment and work shall at least conform to the requirements of the below-mentioned standards, regulations and codes of practice etc.:-

The South African National Standards (SANS) standard specifications, codes of practice or methods as applicable, including CKS specifications prepared by the SANS on behalf of the Central Standardization Committee.

If applicable SANS specifications do not exist, the appropriate International Standards Organization (ISO), International Electro technical Commission (IEC), Deutsche Industry Norm (DIN), British Standards (BS) or equivalent standard, as approved by the Engineer, shall apply.

The South African Factories, machinery and Building Works Act of 1941 and the Regulations thereof as applicable, except where these contradict the above South African Ordinance and Regulations.

In the above Regulations of the S.A. Act and the South African Ordinance, the word “Contractor” shall be read in lieu of the word “user” appearing in the Regulations, whenever applicable.

The Model Regulations for the Wiring of Premises, published according to Section 160 of the South African Municipal Ordinance of 1949.

The Standard Regulations for Wiring of Premises, issued by the South African Institute of Electrical Engineers, except where these contradict the above Model regulations.

Wherever reference is made to Standards Regulations etc., the latest editions, supplements or amendments thereof, are implied.

3.3.1.3 Arrangements with supply authorities

The Contractor shall be responsible to arrange with the relevant supply authorities with regards to inspection of the installation and he shall supply all labour and equipment, at his cost, as required to conduct such inspections in accordance with the requirements of those authorities.

The Contractor shall supply and erect all notices and warning signs in accordance with the applicable laws and regulations of the relevant authorities and as specified in the Contract Document.

3.3.1.4 Payment of fees and duties

The Contractor shall be responsible for the payment of all fees and duties required by law or the regulations of relevant supplier authorities with regard to the supply and installation of the equipment and to protect the Employers against any losses, claims, penalties, costs or expenditure that may arise from the Contractor’s negligence to comply with these requirements.

3.3.2 *Quality requirements*

3.3.2.1 Quality of materials and general design

All materials used in manufacture and erection of the equipment to be supplied shall be new of the respective classes best suited for the intended duty, and of the best quality, to the approval of the Engineer. Moving parts shall operate reasonably silently and shall be so arranged as to be easily and readily accessible for removal, maintenance and repair. Adequate protection shall be provided, to the satisfaction of the Engineer, for the exclusion of vermin, birds and insects from all moving, enclosed or live parts and to prevent damage to insulation by vermin.

The equipment shall be of the most modern but proven design and shall conform to the applicable standards and regulations. Unless otherwise specified in this Document, or otherwise specifically agreed to by the Engineer in writing, the latest edition of the relevant South African or British Standard Specification or Code or Practice shall be applied by the Contractor for determining the minimum requirements in respect of quality of material, working stresses, safety factors and tests (such as physical-, electrical-, hydraulic- and chemical performance) as may be required to prove that the equipment or portions or parts thereof will function safely and reliably for the duties required thereof in terms of the Contract. The South African Standards, where these exist, shall take preference over the corresponding British Standards.

All fabricated components shall be stress-relieved. The Contractor shall ensure that the erected equipment shall be free from harmful vibration. The Contractor shall also ensure that all moving parts, links, rotating shafts, belt drives and similar items are adequately protected, to ensure the safety of the construction works as well as operating and maintenance personnel in compliance with the requirements of the relevant regulations. The Contractor shall provide with the equipment the necessary precautionary devices so that the equipment cannot be operated by unauthorised persons or incorrectly operated by the operating staff.

All switch units to which unauthorised persons may have access shall be provided with suitably hinged or completely removable covers with locks. All locks shall have duplicate keys and the keys shall be clearly labelled with the name of the equipment to be protected on by attaching suitable non-corrosive metal label plates. All locks or groups of locks shall be of a similar locking system and the Contractor shall also supply the appropriate master key(s) for the system(s).

Belts, bolts, nuts and of the devices for clamping and fixing of renewable parts and stainless steel parts shall be made of stainless steel 316. Corrosion-resisting steel shall be used for all bolts and nuts when either or both

are subject to contact with water and/or frequent adjustment or removal, and for bolts projecting from concrete with nuts subject to removal. Split pins or other approved locking devices shall be provided by the Contractor for nuts, which may become loose after erection and during operation of the equipment.

All grease nipples shall be of the hexagonal hook-on type and shall, where necessary, be fitted with adaptors or bushings. The Contractor shall provide a grease gun for each appropriate type of grease to be used.

3.3.2.2 Equipment and material to be complete

The equipment and materials to be supplied by the Contractor shall be complete in respect of all parts, fixing bolts, anchorages, controls and all other items so as to ensure a complete, adequate and satisfactory permanent installation at the site as well as the operation and maintenance thereof, even though some parts may not be listed specifically or separately in the Specifications.

3.3.2.3 Numbering and marking of materials, equipment and parts

All items of the equipment, parts and materials to be supplied under this Contract shall be clearly numbered and marked to ensure the correct assembling and erection thereof on Site.

3.3.3 *Spares and tools*

The Contractor shall submit with his Tender a complete list with process of all the essential spares to be kept ready at the site to ensure continuity of operation and satisfactory maintenance of the equipment. These spares shall be supplied as part of the Contract and the prices quoted shall include for packing, for permanent storage and for protecting the spares against corrosion and damage. Larger spares may be packed individually or by grouping in adequately strong boxes with labels indicating the contents thereof for bulk storage but smaller spares shall preferably be stored in suitable steel cabinets, provided by the Contractor, which are protected against corrosion and fitted with locks.

3.3.3.1 Interchange ability of parts

Manufacturing all parts, which may require renewal or replacement to template, gauge or jig, shall ensure the interchange ability of original and spare parts.

The Contractor shall retain all records and patterns of parts, which may require repair or replacement, for a period of at least five (5) years free of extra cost to the Employer.

3.3.3.2 Tools, lifting devices and similar equipment

The Contractor shall supply a complete set of hardened spanners and tools and other implements necessary for the maintenance and adjustment of the equipment supplied under the Contract and the Contractor shall submit with his tender a complete list thereof together with prices. The spanners and tools shall be mounted in suitable cabinets, which are protected against corrosion and fitted with locks and the position of the various spanners, and tools shall be clearly marked.

3.3.3.3 Supply on site of spare parts and special tools

Spare parts and special tools shall be supplied on the site after successful testing and before commissioning of the mechanical equipment on site, and the tools or spare-part cabinets shall be installed in positions indicated by the Engineer. The special tools are defined as tools required for normal maintenance but to do not form part of the contents of a normal toolbox.

The Contractor shall also be responsible for the training of operational and maintenance personnel in the use of special tools if such tools are provided by him.

The costs for the installation of tools and spare part cabinets as well as the training of operational and maintenance personnel shall be deemed to be included in the contract price.

3.3.3.4 Site work by the contractor

All site work necessary for the complete and satisfactory erection and operation of all mechanical and electrical equipment shall be executed by the Contractor and shall be deemed to be included in the Contract price. The Contractor shall be responsible for the delivery and storage of equipment on site and for handling and transporting thereof to positions of permanent erection or storage. The Contractor shall provide all the

necessary plant and appliances for the erection of the equipment and he shall be responsible for the safety and adequacy of such erection plant and appliances.

3.3.3.5 Holding down bolts

The Civil Engineering Contractor will leave pockets and recesses. The Contractor shall be responsible for the provision of, alignment, grouting in and tightening up of all holding down bolts.

3.3.3.6 Pipes and other equipment through walls of structure

The Civil Engineering Contractor will supply and install all cast in fittings in concrete walls, floors and concrete structures to accommodate items of equipment to be built in or pipes to be connected too. The Contractor must supply the design, sizes and materials to be used to the Civil Contractor for the placement of orders for the materials required.

The Contractor shall be responsible for the positioning, alignment, anchoring, levelling and fixing of equipment to be built in, where after grouting and making good will be carried out by the Civil Engineering Contractor.

3.3.3.7 Excavation and backfill

The Contractor shall carry out excavations, backfill and compaction work required in connection with the installation of mechanical and electrical equipment.

3.4 PROTECTIVE COATING SYSTEMS FOR MECHANICAL EQUIPMENT

3.4.1 *Scope*

This specification covers the coating systems for corrosion protection for mechanical equipment.

3.4.2 *General*

The corrosion protection system to be used on plant and equipment will usually be specified for the equipment by the supplier or manufacturer. If not, the Contractor shall recommend a suitable system for approval by the Engineer.

This specification covers standard coatings for equipment or elements of equipment operating below or above the water. As the main coating is an epoxy generic, chalking in areas of exposure to the sunlight is anticipated. For this reason an ultra-violet light resistant polyurethane enamel has been recommended as a finishing coat in these areas.

Product names quoted in this specification are Plascon products but approved equivalent products may be used.

3.4.3 *Standard coating systems*

3.4.3.1 Standard coating system for equipment operating below water

3.4.3.1.1 ***Surface preparation***

Abrasive blast clean to Grade SA2,5 Swedish Code of Practice SIS055900-1967.

3.4.3.1.2 ***Coating system***

Apply 4 coats of Copon EP2300 Pipe coating (Product Code JYA1/2/8) to a dry film thickness of 65 -85 micron per coat to achieve a total dry film thickness of 300 – 350 micron. Application shall be by brush, roller of preferably airless spray.

The first and third coats shall be pale oxide (JYA2) and the second and final coats red oxide (JYA1) in colour. The coating shall be applied in strict accordance with product data Sheet E-13-D with particular care being taken in respect of overcoating times.

3.4.3.2 *Standard coating system for equipment operating above water*

3.4.3.2.1 **Surface preparation**

Abrasive blast clean to Grade SA2,5 of the Swedish Code of Practice SIS055900-1967.

3.4.3.2.2 **Coating system**

Apply 3 coats of Copon EP2300 Pipe Coating (Product Code JYA1/2/8) to a dry film thickness of 65 – 80 micron per coat to achieve a total dry film thickness of 200 – 250 micron for these 3 coats. Application shall be by brush, roller of preferably airless spray.

The first and third coats shall be red oxide (JYA1) and the second coat pale oxide (JYA2) in colour. The coating shall be applied in strict accordance with Product data Sheet E-13-D with particular care being taken in respect of over coating times.

3.4.3.2.3 ***Finishing coat***

Apply 1 coat of Plascon Polyurethane Acrylic Enamel (Product Code CPS Series) to a dry film thickness of 35 micron. Application shall be by brush, roller or preferably airless spray.
Colour shall be to the Engineer's approval.

The coating shall be applied in strict accordance with Product Data Sheet U-8-A. This coat must be applied within 24 to 72 hours after the final coating of Copon EP2300 has been applied.

3.4.3.3 Standard coating system for motors and gearboxes

3.4.3.3.1 Preparation

Abrasive blast clean to Grade SA2,5 of the Swedish Code of Practice SIS055900-1967.

3.4.3.3.2 Primer coat

Apply 1 coat Plascon Epimide Red Oxide Zinc Chromate Primer (Product Code EPD41) to a dry film thickness of 35 micron.

3.4.3.3.3 mediate coat

Apply 1 coat Plascon Epilite Hifill Epoxy Primer (Product Code EPD325/326) to a dry film thickness of 40 micron.

3.4.3.3.4 Finishing coat

Apply 1 coat Plascon Polyurethane Acrylic Enamel (Product Code CPC Series) to a dry film thickness of 35 micron.

The total DFT for this system shall be a minimum of 100 micron.

NOTE: The coatings are to be applied in strict accordance with the Product Data Sheets, namely E-2-E, E-19-C and U-8-A respectively.

3.4.4 *Coatings system selection*

Mechanical equipment is normally designed to have a steel or concrete support structure above the water level connected to elements in the splash zone or elements under water level. The coating systems mentioned above are also applicable to the elements in the splash zone or elements extending from the support structure to under the water surface.

Where a differentiation in coating systems between submerged and non-submerged areas on the same element or item is required the non-submerged area shall receive the full 4-coat Copon 2300 system before the application of the Polyurethane finishing coat. This will obviate problems at the interface between the two different fourth coats.

The finishing coat shall be applied to all elements in the splash zone and on any area that will not be permanently submerged in water.

3.4.5 *Proprietary equipment*

The coating systems on proprietary equipment shall be to the Engineer's approval. Where the coating system is deemed inadequate a specially designed over coating system may be required.

3.4.6 *Touch-up repair procedure*

The following procedure shall be adopted for the repair of transport and handling damage and the coating of nuts, bolts, etc.

Degrease, using Plascon Aquasolv Degreaser Product Code GIC.

Clean thoroughly using mechanical or hand wire brushed and/or abrasive paper to remove corrosion products and any other deleterious material to achieve a bright metal surface.

In the case of damaged coating the adjacent sound coating shall be feathered back for a minimum distance of 25mm using abrasive paper.

Prior to application of coating, the feathered-back existing coating shall be solvent-wiped with epoxy thinners (Product Code EPT).

Apply coating system i.e. Coating type and dry film thickness per coat as per the original specification.

3.4.7 *Measurement and payment*

As all mechanical equipment will be painted, the coating forms parts of the plant and no additional payments will be made for the specified coating systems. Equipment with non-approved coating systems shall be regarded as not conforming to the specifications.

3.5 MOTORS

3.5.1 *Scope*

The specification covers AC induction motors intended for the mechanical equipment installations. The properties and limitations of the motors are given as follows:

a) Power ratings generally do not exceed 375 kW.
b) Supply voltages generally do not exceed 1000 V.
c) Operating environments can range from indoor to outdoor and other situations where a severe risk of corrosion and dust and water ingress is present.

3.5.2 *Standards*

All electric motors shall comply with the following relevant standard specifications:

SANS 1804 "Induction Motors" (Relevant Parts)

SANS 60034: "Rotating Electrical Machines" (Relevant Parts)

SANS 60947: "LV Switchgear and Control gear" (Relevant Parts)

SANS 60072: "Dimensions and output series for rotating electrical machines"

3.5.3 *General*

Motors with a high starting torque shall have specially arranged rotor winding to ensure a high starting torque and a moderate starting current.

Motors shall be suitable for direct on line, star-delta, soft starting or starting with variable frequency drives.

3.5.4 *Ratings*

The following factors shall be taken into consideration when determining the rated output of the motor:

All motors shall be suitable to deliver the full-load output continuously.

The continuous maximum rating of the motor shall be 20% greater than the requirement to allow for the tolerance of 105% - 120% of over current protection equipment tripping characteristics as specified in SANS 60947.

All starting times, independent of the load characteristics or method of starting shall be limited to 20 seconds.

All motors shall be suitable for a minimum of ten on-load starts per hour with the specified starting method without the temperature limits of the insulation being exceeded unless otherwise specified. Furthermore, the motor shall be suitable for the number of starts per hour specified for the normal load and operating conditions. The manufacturer shall stipulate the maximum number of starts per hour during the system-commissioning period and it must be noted that more starts per hour than specified above may be required for this period.

Motor ratings chosen unnecessarily in excess of the driven load requirements with a resultant low power factor and low efficiency will not be accepted.

The starting torque and the speed-torque characteristics of the motor shall be carefully matched to the load characteristics to obviate stalling and/or crawling. The maximum torque developed by the motor in the final operating condition (i.e. when the starting cycle has been completed and starters have been switched out of circuit) shall be at least 1,6 times the full-load torque to accommodate temporary voltage and load fluctuations.

The actual ambient temperature and the condition under which the motor will operate and not only the ruling outdoors air temperature shall be considered.

NOTE: The motor manufacturer shall liaise closely with the driven load equipment supplier to ensure that a suitably rated motor is provided. The motor manufacturer shall submit together with the tender a written guarantee that the motor performance is suitable for the specified load and operating conditions.

3.5.5 *Performance characteristics*

The Contractor shall submit calculations proving that the starting and run-up time shall be less than 20 seconds. The following formula shall be used for the purpose:

Te = (T1-T2)ln(T1/T2) and t=NI/(9.55 Te)
Te = equivalent acceleration torque in Nm
T1 = maximum acceleration torque in Nm
T2 = minimum acceleration torque in Nm
I = moment of inertia of all rotating parts of both the motor and driven load in kgm2
N = final rotational speed in rpm
T = run-up time in seconds
n = natural-logarithm

Torque-speed characteristics for both the motor and driven load shall be submitted together with the tender.

3.5.6 *Enclosures and degree of protection, methods of cooling and mounting arrangements*

The enclosures and degrees of protection shall conform to the requirement of the IP code as stipulated in SANS 1804 and SANS 60034.

The cooling arrangements shall be in accordance with the IC code as stipulated in SANS 1804 and SANS 60034.

Mounting arrangements shall be in accordance with the mounting designations as stipulated in SANS 1804 and SANS 60034. The specific designation for each motor shall be determined in liaison with the driven load equipment supplier.

The enclosure shields and mountings of totally enclosed surface cooled motors shall be manufactured of cast iron, which complies with BS EN 1561:1997. Allowance must be made for condensate to drain from the motor.

The motor design shall be suitable for the mounting arrangement. This is also applicable for the borehole pumps in the beach wells.

3.5.7 *Insulation*

All motor windings shall be insulated to Class B or better in accordance with the requirements of SANS1804 and BS 2613 for a maximum ambient temperature of 400C. For higher ambient temperatures and where heaters are installed in the motors, the above values shall be reduced as described in the SABS and BS specifications.

All windings shall be varnish-impregnated and baked. The insulation shall be protected against dust, oil and high humidity.

End windings shall be thoroughly braced and supported to obviate movement and damage due to vibration.

3.5.8 *Bearings*

Wherever possible pre-lubricated and sealed ball or roller bearings shall be provided. In the event of unsealed bearings they shall be so designed to minimise lubrication to not more than once per year.

Bearings shall be protected against eddy current which may occur.

Bearings shall be suitable to withstand vibration due to reciprocating or unbalanced loads.

3.5.9 *Terminals*

Winding terminals shall be clearly marked U, V and W or U1, V1 and W1 or U2, V2 and W2.

All six winding terminals shall be brought out to be terminal box.

Vulcanised rubber insulation of the conductors connecting the windings with the terminals shall not be acceptable.

An earth terminal shall be provided on the motor frame in a suitable location.

Terminals shall be totally enclosed in a watertight terminal box. Terminal boxes shall be complete with packings, bolts, nuts, locknuts, washers, etc. The degree of protection shall not be less than IP 55.

Terminal boxes shall be adequately sized to accommodate all cables to be terminated in the boxes and to ensure that the cable cores can be terminated with suitable lugs without exceeding the bending radii of the cables.

Cable outlets shall be so designed to be positioned to point in any of four directions at 90 degree intervals.

Terminal boxes shall be positioned on the right hand side when viewed from the drive end of the motor unless otherwise specified.

Separate secondary terminal boxes must be provided for heaters and temperature detectors where applicable.

3.5.10 *Rotation*

The direction of rotation shall be clockwise looking on shaft end and with the supply phases R-W-B connected to terminal U-V-W.

For un-directional motors the correct rotation direction shall be permanently indicated on the motor frame.

3.5.11 *Temperature protection*

All motors with a rating of 25 kW and more as well as all motors with a rating of 15 kW and more subjected to run-up times in excess of 15 s, shall be provided with temperature protection by means of thermistors installed in the stator windings.

Six thermistors, two per phase, shall be installed. The thermistor tails shall be brought out to a terminal box and shall be clearly marked. Three thermistors, one per phase, shall be connected in series for normal operation and the other three shall be spare.

The thermistors shall be located at the winding "hot spot" and for this application the "Curie Point" shall be 150C above the specified temperature values.

Only thermistors of the Positive Temperature Coefficient (PTC) type shall be used.

Thermistors shall withstand a test pulse voltage of 2 kV for all motor supply voltages up to 600V. Additional insulation shall be provided for motors with a higher supply voltage.

Those portions of the thermistor leads, which are bedded in the windings, shall be protected against mechanical damage with a varnished "terylene" of fibreglass sleeve. Care shall be taken to ensure that this sleeving does not cover the thermistor itself.

The thermistors shall be so bedded in the winding to ensure the most efficient heat transfer.

All leads from the thermistor to the control unit shall consist of twisted pairs to minimise the influence of voltage interference. Shielded cables shall be used where the control unit is located more than 10 m away from the motor.

Isolating transformers shall be used to protect the control panels against high voltage resulting from a short circuit between the thermistors and windings.

For motors with a rating above 150 KW, temperature protection on the bearings must be included.

All submersible pump motors shall be provided with water ingress protection.

All non-active motor detector products shall be fitted in the oil housing between pump and motor. All leads from the detector shall be suitable for the intended application.

3.5.12 *Heaters*

Anti-condensation heaters shall be fitted with motor windings for all motors under the following conditions:

a) Direct coupled motors and pumps for cooling water systems.
b) Standby motors in cooling installation where the ambient temperature may reach dew point.
c) Motors serving pumps in humid atmospheres where motors do not work continuously.
d) In atmosphere with a relative humidity in excess of 95%.
e) All indoor motors in excess of 20 kW and outdoor motors in excess of 7.5 kW.

Heaters shall be so arranged to avoid moisture reaching terminals and exposed conductors.

3.5.13 *Environmental conditions*

Where the environmental conditions are in excess of the maximum conditions defined by SANS 1804 or SANS 60034 the motor ratings and insulation shall be derated. The Contractor shall supply full details of the derating factors applied to determine the available output at the given ambient temperatures and altitudes in excess of 400C and 1000 m respectively. Details shall also be provided of the increased impregnation and bake applied to the windings for relative humidity in excess of 95%.

3.5.14 *Duty*

The duty of the motor shall be classified in terms of IEC, duty cycle ratings S1 to S6.

3.5.15 *Starting class*

The starting class shall be defined, as the maximum permissible number of starts per hour and distinction shall be made between complete starts, jogs and electrical braking.

It is assumed that one jog is thermally equal to 25% of a complete start and one reverse current braking operation to one third of the rated speed is thermally equal to 80% of a complete start. The applicable starting classes shall be as shown in table 2.

TABLE 2: STARTING CLASSES

Starting Class	Starting					Cyclic Operation
	Equivalent Starting Duties					Per cent duty factors to be combined with the starting class (%)
	No of Starts per hour		No of Jogs per hour		No of breakings to one third of rated speed per hour	
150	150	+	0	+	0	25, 40, 60
	100	+	200	+	0	
	65	+	130	+	65	
300	300	+	0	+	0	40, 60
	200	+	400	+	0	
	130	+	260	+	130	
600	600	+	0	+	0	60
	400	+	800	+	0	
	260	+	520	+	260	

3.5.16 *Documentation*

Copies of routing and performance test certificates in accordance with SANS 1804, and SANS 60034 shall be submitted to the Engineer before delivery of the motors.

The manufacturer's guarantee that the motor shall meet the required load demand shall be submitted together with the tender.

Torque-speed curves for the motor and associated pump shall be submitted together with the tender.

Operating and maintenance manuals shall be provided to the Engineer before handing over of the installation.

3.5.17 *Testing*

Type testing in accordance with SANS 60034 shall be done for all motors of 55 kW and larger and other motors where type tests certificates is not available.

Additional routine testing shall be done on the continuity, operation and insulation of heaters and temperature sensors.

Before energising a motor for commissioning purposes, the insulation resistance between phases and the motor casing shall be more than 1,5megaohms using a 500V insulation tester.

The Engineer shall be notified at least 14 days prior to any tests in order that the Engineer or his authorised representative may witness these tests.

3.6 MOTOR STARTERS

3.6.1 *Scope*

This Specification covers starters for the AC induction motors described in Section 3, and is intended to operate in the same range of environmental conditions.

The starter includes the following types:

a) Direct-on-line starters
b) Star-delta starters
c) Soft starters
d) Variable Speed Drive (VSD) or Variable Frequency Drive (VFD)

3.6.2 *Standards*

Starters shall comply with the specified requirements, the requirements of the Local Supply Authority and the requirements, of the specific system.

Contactors and starters shall comply with the relevant parts of SANS 60947, SANS 60470, BS 5424 or VDE 0660 Section 14, or IEC 158 categories AC3 except in cases where a plugging duty is required in which case category AC4 shall apply. In cases where level switches or similar ON-OFF controls are required, inherent time lags or other protection methods shall be incorporated in the control circuitry to inhibit chatter or shuttle switching of the contractor at the change-over point.

3.6.3 *Isolation*

It shall be possible to isolate electrical driven mechanical equipment by means of either of the following:

An isolator on the motor.

A starter with a positive hand operated switching-off control, which complies with the requirement of an isolator mounted within 2 m of the equipment. The connection terminals where the submersible cable of the pump motor is connected, will be regarded as part of the equipment or motor.

Where the starter is located further than 2 m away from the motor a separately mounted load-break isolator shall be installed within a distance of 2 m from the motor. The isolator shall be capable of interrupting the current of the motor with a stalled rotor. Alternatively, a cut-out push-button control may be mounted within 2 m of the motor provided that the starter control switch is lockable in the “OFF” position and that this arrangement is acceptable to the supply authority.

In addition to the above, each circuit shall be provided with a load break isolator, circuit breaker or combination fuse switch on the control panel. These switches shall be capable of interrupting the current of a motor with a stalled rotor.

3.6.4 *Starting current limitations*

The starting method shall comply with the requirements of the Local Supply Authority.

The starting current of each individual motor shall not contribute to a larger peak system current than the largest peak current, which will result when the largest motor is started combined with the full-load currents of all the motors, which are consecutively started in the same system.

Starters, other than direct-on-line starters, shall be interlocked to prevent direct-on-line starting after a supply voltage failure.

3.6.5 *Direct-on-line (d.o.l) starters*

D.O.L. starters may be used for motors with ratings in excess of 3 kW provided that:

a) the starting current limitations are not exceeded; and
b) this method is admissible with regard to the driven load.

D.O.L. starters shall be suitable for at least 15 starting operations per hour except where a plugging duty is required in which case the starters shall be suitable for at least 40 operations per hour.

In cases where the motors are not required to start and stop frequently, i.e. S1 duty, electrically controlled circuit-breakers with over-current, anti-single phasing and under voltage protection may be used as D.O.L. starters.

3.6.6 *Star-delta starters*

Star-delta starters used to start motors with a capacity in excess of 50 kW shall have a code transition change-over in accordance with the “WAUCHOPE” resistor system. The resistors shall be sized to limit the change-over current to less than the maximum peak currents specified.

Star-delta starters including resistors, shall be capable of at least 15 operations per hour. For inching duties the starters shall be capable of 40 operations per hour.

Time relays controlling the star-delta starters with uninterrupted change-over shall be of the break-before-make type with a quick break action. These relays shall be of the 'SPRECHER AND SCHUH" RPZ 2-21 type.

Star-delta starters shall be electrically interlocked via normally closed contacts on the contractors.

The control circuits of star-delta starters with uninterrupted changeover shall be controlled with one relay only for the change-over control function. To protect the resistors an additional control relay, which will disconnect the supply current when the resistor currents persist for a longer period than the predetermined period, may be provided.

A "policeman timer" shall be provided on all-star-delta starters with uninterrupted change-over in addition to the change-over control relay to disconnect the load when the maximum allowable starting period is being exceeded. The operating mechanism of this relay shall differ from the star-delta control relay e.g. electronic versus electro-mechanical. In the case of two-wire control systems the "policeman timer" relay shall latch out with hand resetting to prevent repeated on-off switching of the starter.

Thermal overload protection shall be connected to the motor supply and not the main supply unless otherwise specified.

3.6.7 *Soft starters*

This specification covers the performance, functional specification, fabrication details and installation of digital solid state low voltage soft starter used for starting and stopping, motor control and motor protection of AC induction motors.

The minimum requirements for the acceleration control is:

- The initial output voltage shall be adjustable between 30-70%of nominal voltage.
- Current limit shall be adjustable between 100% and 500% of full load current.
- The ramp time shall be adjustable between 1 and 90 seconds.
- Kick start function shall be available with time adjustable between 0 and 1 second.

The minimum requirements for deceleration control is:

- End voltage shall be adjustable between 30-70%of nominal voltage.
- The ramp time shall be adjustable between 1 and 90 seconds.

Motor and load protection integrated into the starter shall include:

- Over load protection for Class 10, 20 and 30.
- Adjustable Current limitation to 700% of full load current.
- A system to prevent nuisance tripping during the starting cycle.
- Provision for manual or automatic resetting after a trip.
- A system for allowing the motor to cool down before restarting after a trip.
- Phase lost, imbalance or reverse phase protection.
- Over and under voltage protection.
- Under load protection adjustable between 40 and 100% of normal load and trip time adjustable up to 30 seconds.
- Built in Soft starter overload protection to protect the thyristors exceeding the loading as well as heating.

A stop and start input as well as two programmable inputs, and three programmable output relays must be available.

Operator interface shall be via a keypad and a LCD character display and English as the communication medium. Data should be actual values with standard unit of data (i.e. V, A or %).

Provision for serial communication shall be provided via a Field Bus Plug capable of least MUDBUS communication protocol.

At least the last 10 events, fault messages or fault history shall be saved in a non-volatile memory for access by field personnel.

The soft starter shall be designed and tested to withstand the under the following environmental conditions without derating:

- Temperature of 400C
- Altitude up to 1000m above sea level
- Humidity up to 95%RH non-condensating

3.6.8 *Variable speed drives (vsd)*

This specification covers the performance, functional specification, fabrication details and installation of Variable Speed or Variable Frequency drives used for starting and stopping, motor control and motor protection of AC induction motors.

The Contractor shall be responsible to ensure that the VDS, the motor and the power supply are fully compatible to operate as a system.

The VSD hardware should comply with the following:

- Each VSD must be suitable for separate cooling of the heatsink and forced air cooling
- Each VSD must include hardware necessary to produce the proper waveform while minimizing nuisance faults and the effects of harmonics.
- Output section shall consist of Insulated Gate Bipolar Transistors (IGBT's) throughout the entire range.
- VSD control must be microprocessor based and include surface-mount technology.
- Modbus RTU interface protocol.
- IP 54 enclosure protection

The VSD must operate within the following parameters:

- Ambient temperatures up to 400C
- Humidity up to 95%RH non-compensating.
- Input voltage: VSD must be designed for 400V three-phase input.
- Allowable voltage fluctuation: + 15%, - 15%.
- Input frequency: 50HZ.
- Allowable frequency fluctuation: +5%, -5%
- Carrier frequency: Field adjustable from 2.5-15KHZ to optimize the motor's operation and acoustical noise level.
- Output frequency: 0.1HZ-120HZ. Must be able to set output frequency limits to ensure safe operation.
- Output voltage: Must be able to set to ensure safe operation.
- Overload capability: 120% for one minute.
- 24 hour per day continuous operation.
- The total voltage harmonics must be less than 3%.
- The total current harmonics must be less than 5% of the rated current.
- Speed stability must be within 1% of the set value.

The VSD shall have the following control features:

- VSD shall have two analog inputs: one capable of accepting a 0-10V signal and the other a 0-10V or 4-20ma signal.
- VSD shall also have a power supply that can be used to power a 2-10Kohm potentiometer.
- Selection of the analog input can either be made through the keypad or from a remote contact closure.
- Bias and Gain functions must be available to adjust and fine-tune the drive speed based on the analog input signals.
- Digital inputs for speed reference shall include up to 4 selectable preset speeds and jog speed.
- At least two analogue outputs must be provided. They must be switchable from 0-10v and 4-20mA.
- RS485 Serial Communication must be standard.
- Current limit, adjustable from 10-200% of the VSD's rated current, to match the motor's operation capability.
- Speed Search selectable between "search from maximum freq."or "set freq." when starting into a rotating motor.
- Selectable PID control with adjustable parameters for maintaining a setpoint in a closed loop system.
- Three skip frequencies with an adjustable bandwidth of up to +-25.5HZ to avoid mechanical resonance.
- DC injection with selectable "time at start"," time at stop" and "injection current" to control motors rotation.

- Automatic torque boost to ensure 60riples operations and power savings during acceleration and at constant speed.

The following protective features must be included in the VSD:

- Stall Prevention during acceleration and during constant speed with each having an adjustable current limit from 30-200% of the drive's rated current. This will minimize nuisance overload to ensure continuous operation.
- Stall Prevention during deceleration to minimize nuisance overvoltage trips due to the motor's back-EMF.
- Frequency reference loss detection with the ability to run at 80% of last speed.
- Power loss ride-through with either a selectable time of 0-2-0 seconds or until control power is depleted.
- Automatic restart selectable from 0-10 attempts with the option of outputting a fault contact during the retry procedure.
- Electronic motor protection with a thermal memory.
- VSD and motor earth fault and short circuit protection.
- Reverse phase, loss of supply and loss of phase protection.

Operator interface must include the following:

- Keypad with a LCD character display.
- English as communication medium with actual values and standard units of data.
- Saving the last 10 events, fault messages or fault history in a non-volatile memory.
- Provide elapsed operating time and kWh readings.

3.6.9 *General*

All starters shall be housed in well-ventilated sections of the motor control centre or shall be housed in well-ventilated cubicles if separately mounted. Ventilation openings shall be backed with 1,5 mm copper or brass mesh. Forced cooling shall be provided where justified by the starter resetting or where the ambient temperature exceeds 400C.

Time relays shall be adjustable and the maximum time range shall exceed the starting time requirements.

All starters shall be provided with "ON" and "OFF" control mechanisms with resetting facilities as required by the system. Two-wire control systems shall be fitted with hand resets to prevent shuttle switching.

Magnetic over current trips or short-circuit protection relays shall not trip starting contractors but circuit-breakers.

Where isolators are provided in the motor supply circuit between the starter and the motor, electrical interlocking shall be provided via a secondary contact on the isolator to trip the starter when the isolator is opened.

One ammeter shall be provided on each motor circuit. The ammeter scales shall be suitable for the full-load current and shall provide for starting currents by means of condensed over current scales in accordance with the stipulations of BS 89. The ammeters shall also be capable of withstanding an over current of 40 times full load current for one second. During normal operation the ammeter pointer deflection shall be 50% - 70% of the full scale. Ammeters shall be of the "PCI" FA 21 x 72 mm or equal.

Starters shall have a suitable quantity of secondary contacts to accommodate circuits for interlocking, alarm, indicating, holding, etc. For control circuits with supply voltages of 220V or 110V standard contacts are acceptable but for control circuit voltages of 50V or less the secondary contacts shall have a sliding or forked action.

Where the starter contactor cannot accommodate the quantity of secondary contacts required an additional auxiliary relay shall be provided. The auxiliary relay shall be controlled by the secondary contacts of the main contactor. For three-wire control systems, the holding contact of the control circuit shall be supplied via contacts of the auxiliary relay to ensure that the circuit trips if either the main contactor or the auxiliary relay fails.
All starters shall be clearly labelled to show their functions and ratings.

3.7 MOTOR PROTECTION SYSTEMS

3.7.1 *Scope*

This specification covers the motor protection systems required for the Motors described in section 3 and for the Starters described in section 4.

3.7.2 *General*

Unless otherwise specified standard protection shall be as indicated in Table PMO-1:

TABLE PMO 1: STANDARD PROTECTION OF MOTORS

Type of Protection	Application
Thermal Overcurrent	All motors. For motors larger than 55kW thermal capacity memory must be included.
Magnetic Overcurrent	As short-circuit protection only when coupled to circuit-breakers
Anti-Single Phasing	All motors
Reverse Phasing	All circuits supplying centrifugal compressors or reciprocating compressors or circuits where reverse phasing can cause damage and all motors above 55kW
Unbalance Supply Voltage	All motors
Thermistor Temperature Protection	All motors with rating excess of 25 kW
Earth fault	Only when condensation can occur in motors e.g. standby or direct coupled cooling pump motors or outdoor motors
Thermal restart control	Motors larger than 55kW
Stall protection	Motors larger than 55kW
Underload/Undercurrent	All motors used for pump installations
Temperature protection mechanisms	All motors where temperature sensors are required as well as with the applicable starters

3.7.3 *Overcurrent protection*

Over current protection of motors shall be provided in accordance with the requirements of SANS 60947. Over current protection shall comprise thermal trip mechanisms or relays, which are coupled to contactors, hand operated starters or circuit breakers. HRC fuses shall not be regarded as over current protection.

In the cases where over current protection forms an integral part of the starter, the protection shall comprise a temperature compensated bi-metal thermal element which is directly heated by separate heating elements in each phase and which is coupled in series with the load. The over current protection shall be adjustable over a range of 75% to 120% of the full load current of the motor.

Motors subjected to frequent starting and stopping duties or to inching may be protected against over current with magnetic over current protection with a time delay provided the motor is suitable for the method of operation.

Magnetic over current tripping devices shall not trip starting contactors but shall be coupled to circuit-breakers with suitable breaking capacities.

Adequate protection shall be provided against extended overloads, but, unnecessary tripping during starting shall be prevented. For this condition short-circuiting of the over current protection, increased over current settings or connection of the over current protection to the delta circuit only in star-delta starters is not acceptable.

3.7.4 *Anti-single phasing protection*

Anti-single phasing shall form an inherent part of the over current protection unit in the case of integral motor starters.

Protection methods which rely on the over current only which may occur during single-phase conditions are not acceptable.

3.7.5 Short circuit protection

Tripping classes shall be selected as to ensure that tripping does not occur as result of starting cycles of motors.

3.7.6 Thermistor protection

Thermistor protection shall be provided as specified under the Quality Specification for motors.

Thermistor control units shall where possible be integrated with the motor starter.

Thermistor protection shall not be used in lieu of over current protection.

3.7.7 Reverse phasing protection

Reverse phasing protection shall be provided as stipulated under Clause PMO-2 and no all bi-directional motors where specified.

The sensing of reverse phasing shall be done at the outgoing terminals of the motor supply.

3.7.8 Combination and electronic motor protection units and relays

Motor protection units similar or equal to “GEC TYPE CTM & CTMF”, “P & B GOLDS TYPE M” or “NEWELEC TYPE MJE” may be used.

All units and relays shall be mounted in withdrawable panel-mounted enclosures.

Motor protection relays shall not be connected to current transformers used for metering purposes.

All protection relays shall be provided with test terminal blocks of the “CHAMBERLAIN & HOOKHAM” type or equal for the testing of relays, CT’s, etc.

3.8 PUMPS

3.8.1 Scope

This Specification covers the general requirements for the manufacture, supply, erection, installation, testing and commissioning of pumps.

3.8.2 Design specification

Pump sets shall consist of a pump, electrical motor, base frame, shaft and coupling. In and outlet flanges shall comply with SANS 1123. Associated pipework shall include flexible connections to prevent the transfer of external thrust which can influence the normal operation of equipment.

The required pump standby capacity or dry standby is prescribed in the Process specification portion of the Employers Requirement.

Shaft seals shall be done by means of mechanical seals. Seals shall be of the cartridge design and comply with industry standards for SWRO. All shafts used for pumping sea water and or concentrate shall be externally flushed. Flushing with pump fluid shall not be acceptable.

The Contractor shall offer the best solution considering the technical requirement, financial implication, electrical considerations and energy recovery for the highest operating efficiency, for each pump set proposed.

The Contractors design will be evaluated on the best technical and financial value offered, as well as other aspects provided in the technical data sheets provided.

The pump sets not enclosed must be capable of operating in an outdoor environment.

3.8.3 Manufacture of pumps

3.8.3.1 Centrifugal pumps

(i) Type of pumps

Only high-quality centrifugal pumps will be accepted. The pumps shall be of a well-known make, so that parts will be easily obtainable over a long period of time. The Employer prefers KSB, Grundfos or similar approved pumps.

In all applications, with the exception of clear water pumps, non-clogging impellers must be used. For pumping sludges the pump sleeve should be resistant to high wearing due to the possible presents of grit in the liquid phase.

(ii) Materials

The pump materials shall be suitable for use in the specific application and all materials utilised in the construction of the pump shall be resistant to the corrosivity of the operating environment and the matter transferred. All exposed wetted metal surfaces shall be stainless steel 904L, duplex stainless steel or similar approved. For flush pumps wetted metal surfaces shall be stainless steel 316 or similar approved.

(iii) Pump design

Pumps shall be statically balanced to prevent end thrust not only when the pump is new but after wear and tear has taken place.

Pumps shall be so designed that the impeller cover can be removed without moving the pump, engine or motor.

Each pump shall have a drip tray with a 20 mm diameter drainpipe to the nearest drainage point.

3.8.3.2 Rotor Pumps (Positive displacement pumps)

(i) Type and configuration

The rotor pump must be a positive displacement pump that can be used to pump water or liquid demands. Depending on the application as specified in the Project Specification, the pump installation can be either direct driven or belt driven pump, comprising a pump with flanged inlet and outlet couplings and a electrical motor or a pump with an extended shaft installed on rising main. The latter installation comprising a pump, a rising main and extended shaft, a discharge head and an electrical motor. The manufacturing requirements of the relevant components are specified below.

(ii) Wear resistant design

The inside of the pump shall be lined with a rubber rotor-stator, which enable the absorption of rotor's eccentric motion. The materials used for the rotor and rotor-stator must be able to withstand the corrosivity and wear and tear of the liquid to be pumped.

(iii) Rising Main and extended shaft

The rising main shall consist of pipe adequately protected against internal and external corrosion. No exposed threads shall be allowed at pipe unions. Galvanised pipes will not be allowed.

The extended shaft must have rolled threads, instead of weakening out threads. The shaft shall be centralized within the using main by means of bobber bearings of rubber and stainless steel bearing process.

In case of borehole pumps the pump and rising main will externally be equipped with stabilizers to hold the pump and main firmly in position.

(iv) Discharge head

The discharge head shall be equipped with a universal pulley to accommodate all available vee-bolts. The shaft bearing shall be a sealed pre-greased bearing. The gland and the shaft shall be adjustable to minimise leakages.

(v) Materials

Materials for the manufacture of the pump-installation are as follows:

The pump materials shall be suitable for use in the specific application and all materials utilised in the construction of the pump shall be resistant to the corrosivity of the operating environment and the matter transferred. All exposed wetted metal surfaces shall be stainless steel 904L, duplex stainless steel or similar approved.

3.8.3.3 Dosing Pumps

The Employer prefers Grundfos(Alldos) or similar approved pumps. Pumps should have displays of the dosing rates on the pumps. The pumps shall have a 4-20mA input and output of dosing rates to enable control of the pumps. The pumps shall also have digital error outputs to indicate that the pumps are not functioning properly or have detected an error in the pump system (internal diagnostics).

3.8.4 Erection and installation of pumps

3.8.4.1 Footplates for pumps

Each pump with its motor shall be mounted on a single sturdy footplate. The footplate shall have suitable openings for filling in with cement mortar and for affixing foundation bolts. Each unit shall be accurately placed according to the dimensions shown on the Drawings or prescribed by the Engineer. Footplates shall be painted with a zinc chromate primer and a glossy grey enamel topcoat to the Engineer's satisfaction.

3.8.4.2 Alignment of pump, motor and pipes

All pipe work shall be supported in such a way that the inlet and outlet of the pump shall not be subjected to pressures that might disturb the alignment. The pipes shall remain in their precise positions whether bolted to the pump or not. Vertical flanges shall be welded to pipes and adaptors to ensure accurate alignment of the piping.

Before filling with cement and before bolting the flanges to the pump, the Engineer will inspect the installation. The Contractor shall obtain his written approval of the alignment between pump and pipes before proceeding, but such approval does not absolve the Contractor of his responsibility for the correctness of the system.

Once the foundation bolts have been finally tightened and all suction and outlet pipes finally positioned and bolted, the axial and radial alignment of pump and motor shall be minutely checked and, if necessary, adjusted. The alignment shall be so accurate that no vibrations will occur and should be conducted by means of a laser. The alignment shall also be within the limits set by the manufacturer; and the deviation measured at the circumference of the movable coupling, shall in any case not exceed the following values:

Pump RPM Amplitude of Vibration (mm)

Pump RPM	Amplitude of Vibration (mm)
400	0.075
800	0.050
1 200	0.033
1 800	0.013

When the alignment has been tested and accepted by the Engineer, each pump and each motor shall be supplied with two permanent marks to indicate its correct position. The Contractor shall supply all equipment and measuring apparatus required for adjusting the alignment.

3.8.4.3 Installation of pump systems

All pumps, pipes and fittings shall be accessible. If the Contractor observes that any item will be inaccessible for maintenance or operation, he shall point this out to the Engineer before installing the item.

The installation shall comply either the requirements of the Factories Act, (Act No 6 of 1983). For example, all moving parts shall be screened off and high valve wheels shall be supplied with a step. No-one will be permitted to stand on pipes in order to reach valve wheels.

Pumps shall be installed in such a way that they can be removed with ease. A sufficient number of flanged joints shall therefore be provided; no long, unwieldy lengths of pipe shall be accepted. Even in the case of short lengths care shall be taken that pipes are not, for instance, so embedded in concrete that they cannot be completely removed.

All pipes shall be supported in such a way that they remain accurately in position against the pump whether flange bolts have been tightened or not. Before placing a firm order for the materials required under this section, the Contractor shall ensure that the items he orders will for the dimensions and layout shown on the Drawings.

3.8.4.4 Feed Connection

In the event where feed is required for the pump from its own high pressure side, as a source of lubrication, balancing or cooling of the pump, the operation of services must be incorporated in the pump control.

3.8.4.5 Maintenance

The contractor must supply lifting equipment where necessary and sufficient access too equipment for ease of removal without disturbing adjacent pipework or other fittings.

3.8.4.6 Coupling

There shall be a flexible coupling between the motor and the pump. The coupling shall have a cover and the coupling will allow independent removal of either the motor or the pump.

3.8.4.7 Corrosion protection

Corrosion protection on pumps are not specified but a detailed written report on the corrosion protection offered on the pumps shall be included in any submitted tender.

3.8.4.8 Pump accessories

Pumps shall be fitted with all necessary drainage and air valves, and approved calibrated pressure sensor or gauges shall be fitted to the inlet as well as the outlet sides of the pump.

3.8.4.9 Tests

Acceptance tests shall be carried out for all pumps supplied under this contract. The tests shall be done in accordance with BS5316, Acceptance tests for Centrifugal, mixed flow and axial pumps, Part 1. Class C tests.

These tests shall be carried out prior to delivery to site and the Engineer shall be given 14 days notice of the date, time and location of the tests. The cost of testing shall be included in the contract price.

The acceptance test will include but not be limited to the following test:

a) Alignment;
b) Pump performance: flow versus head, power efficiency, NPSH characteristics;
c) Motor performance;
d) Vibration;
e) Balancing and rotation.

3.9 BLOWERS AND FANS

3.9.1 Scope

This specification covers the selection, supply, delivery, storage and installation in complete working order of blowers and fans.

The contractor has the responsibility to provide blowers and fans which are within specification, able to perform to the required performance of the application and to the engineer's approval.

3.9.2 Design Specification

3.9.2.1 *General*

For this specification fans will mean blower and vice versa unless specifically indicated otherwise.

The blowers and fans selected are to be manufactured to the highest of quality with consideration to energy efficiency, environmental friendliness, low noise emission and a small foot print.

Fans and blowers shall be statically and dynamically balanced and shall be free of any objectionable vibrations.

Fans and blowers shall be selected to operate as close as possible to the point of maximum efficiency.

Lubrication points for fan bearings shall be readily accessible and shall, where necessary, be extended to the outside of the fan casing.

Fan and blower openings shall be provided with protective wire guards in accordance with the Manpower and Occupational Safety Act, 1983.

All belt drives shall be designed for a minimum of 25% overload with no less than two matched belts being used. Belts shall be selected and installed in accordance with BS 3790 – 1981.

Belt guards shall be provided and arranged to permit oiling, use of tachometers and other testing and maintenance operations with the guard in place. The guard shall have a front screen of expanded metal.

Fan and blower bearings shall be selected for a minimum of 200 000 hours average life.

Fan and blower shafts and bearings are to be properly protected from rust and corrosion by means of suitable wrapping and protective grease coatings prior to commissioning.

All fans and blowers shall be resiliently mounted to the building structure. Flexible canvas collars shall be fitted on both sides of the fans. Vibration isolators shall be installed to eliminate vibration from fans to the building.

Sound attenuation shall be below sound pressure levels specified elsewhere in the employers requirements.

All castings and machining are to be of proper and sound workmanship. The fabrication and assembly of the unit is to be of the highest quality.

3.9.2.1.1 (positive displacement) type Blowers

The Roots type blowers should be of three lobe configuration, be air-cooled and are to be selected for heavy duty operation. Pressure fluctuations shall not exceed 2% of the operating pressure. It shall be belt-driven incorporating variable speed drives for flow control.

Standard operation conditions are to be taken as site conditions for the design and selection of the blowers.

By design it should be impossible to damage the blowers in the event that it is started against closed valves or blocked pipes/ducts.

3.9.2.1.2 ifugal Blowers and Fans

Centrifugal air blowers and fans shall be selected taking the operating flow rate and pressure as well as the rest of the system into consideration to establish the correct type of impeller in order to complete an efficient solution.

The blowers or fans shall be direct driven through a gearbox to the required design speed incorporating variable speed drives for controlling air flow. The casing shall be horizontally split to permit access to the impeller and shaft.

The impellers shall be selected for close to maximum efficiency and shall be manufactured from an approved corrosion resistant material. In the case of multi-stage blowers, the impellers shall be designed to minimise axial thrust.

Shafts shall be steel, with sufficient mass that the critical speed of the wheel and shaft is well above the operating speed of the fan. The wheel shall be tightly fitted and keyed to the shaft. Bearings shall be self-aligning ball or roller type.

Fans and blowers with wheel diameters above 1000mm shall be provided with access doors fitted to the fan casing.

3.9.2.1.3 Blowers and Fans

Axial flow fans and blowers shall be in-line, direct driven type, with motor mounted inside the fan housing and shall be direct driven incorporating variable speed drive for flow control. The fan rotor assembly shall be attached directly to the motor shaft.

Fan housings and flanges shall be manufactured from mild steel material either spun construction or with end flanges continuously welded to casings.

Fan and blower rotor shall be of cast aluminium construction, blades shall have an aerofoil section, having a varying degree of twist and width from the hub of the tip of the blade to ensure equal air distribution along the length of the blade. Blade pitch shall be manually adjustable.

The fan and blower motor shall be totally enclosed and rated for continuous operation and shall be squirrel cage induction type suitable for vertical and horizontal operation with grease lubricated bearings.

Fans and blowers shall be of the long casing type, unless otherwise indicated.

Fans and blowers installed under free intake conditions shall be fitted with an inlet cone supplied by the fan manufacturer.

3.9.2.2 Operating conditions and duties

Refer to the employers requirements for the operating conditions and duties.

3.9.2.3 Filters

Filters are to be a standard product of a reputable manufacture regularly engaged in the fabrication of the particular type of air filter or, if imported, the product shall be well represented in South Africa.

Only filters which comply with the test results with regard to filter arrestance efficiency, dust holding capacity, air resistance, etc. all shown to the satisfaction of the Engineer. These results must have been obtained by the manufacturer from an independent institute or bureau, generally accepted as being well equipped for and reliable in the carrying out of such tests and making use of the ASHRAE Standard (Standard 52 – 76 “Method Testing Air Cleaning Devices”) whereby the efficiency curve can be determined. Prior approval of the filters to be used is to be obtained before purchasing.

Maximum airflow through filters is not to exceed the manufacturers rated capacity.

Each filter bank shall be equipped with a stationary inclined differential pressure gauge, complete with cocks, static pressure tips and necessary copper tubing shall be mounted where directed. The range of the instrument selected is to be suitable for the filter installation and is to be adjusted by the manufacturer ready for operation.

Provide access doors in ductwork or casing walls for convenient servicing and removal of filters.

Frames and filters shall be constructed so as to prevent the passage of unfiltered air with liners being provided between filter frames and unit casings, etc.

All metal parts of the filter shall be suitably protected against corrosion and shall be painted as specified elsewhere.

3.9.3 Noise and vibration control

3.9.3.1 General

The noise and vibration generated by equipment shall be isolated from the structure by means of anti-vibration mountings, spring hangers or flexible pipe connections.

All equipment, piping, etc. shall be mounted on or suspended from approved foundations and supports, all as specified herein.

Unless otherwise specified, all floor mounted equipment shall be erected on a reinforced concrete pad, cast into a channel frame. Where vibration isolation between machine and base is used, the base shall be extended to support the isolating system.

All vibration isolators shall be selected and supplied by the same manufacturer and shall be approved by the Engineer before installation.

Vibration isolators shall have a guaranteed static deflection as specified and the isolators shall be installed in accordance with the manufacturer's recommendations.

3.9.3.2 Vibration Isolation Mountings

3.9.3.2.1 ne Mountings

Neoprene mountings shall have a minimum rated static deflection of 10mm. All metal parts shall be moulded into the neoprene to prevent corrosion and to provide friction, so that the mounting need not be bolted to the floor.

3.9.3.2.2 strained Spring Mountings

This Specification covers three alternatives:

i) Open Spring Mountings

Spring mounting shall be open and free standing, and laterally stable without any housing. The springs must be isolated from the floor by neoprene friction pads or cups. Mountings shall have levelling bolts that can be rigidly bolted to the equipment. Spring diameters shall not be less than 80% of the compressed height of the springs at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. When the load per mounting exceeds single spring capacity, springs may be clustered in units of two or more.

ii) Housed Spring Mountings

The housing shall consist of cast iron top and bottom elements, separated by neoprene sponge inserts, to provide lateral support. The mounting shall incorporate a height adjusting bolt and a friction pad bonded to the bottom element, which must have provision for bolting down to the floor. Spring diameters shall not be less than 80% of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal of 50% of the rated deflection. When the load per mounting exceeds single spring capacity, springs may be clustered in units of two or more.

iii) Open Spring Mountings with Concrete Bases

When equipment is installed on a concrete base (without steel framework) the height of the base shall be at least 250mm and the base shall be cast on a plastic sheet to facilitate separation from the floor. Cast iron or fabricated steel housings shall be cast into the base, so that spring mountings as described in Specification i) can be neatly recessed into the base. The housing shall have an internal height equal to the height of the mounting and shall have a means of locating the adjusting bolt of the mounting in the centre of the housing, so that the mounting can be used to elevate the concrete base.

iv) Restrained Spring Mountings

Equipment which has an operating mass different from the installed mass, such as cooling towers, chillers and boilers and equipment exposed to the wind, shall be mounted on spring mountings as described for unrestrained spring mountings, but installed in a housing that includes restraining bolts to prevent extension when the mass is reduced. The housing shall also serve as blocking during erection so that the installed and operating heights shall be the same. A minimum clearance of 5mm shall be maintained around the restraining bolts and of 12mm between the housing and the spring, so as not to interfere with the spring performance. The housing shall be hot dipped galvanized.

3.9.3.3 Vibration Isolation Hangers

3.9.3.3.1 angers

This Specification covers three alternatives:

i) This is a basic spring hanger incorporating a low profile spring that ensures that the hanger rod does not touch the hanger cage. Vibration isolation hangers shall consist of a steel spring housed in a steel cage. The spring shall fit into a neoprene cup, which locates in the cage. To prevent contact between the cage and lower hanger rod, the cup shall contain a steel washer to evenly distribute the load on the neoprene. Spring diameters shall not be less than 80% of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50%of the rated deflection. The spring height and diameter, and the neoprene cup containing the spring, shall be so dimensioned as to allow the lower hanger rod to swing through a 30° arc before coming into contact with the cup. When the load exceeds single spring capacity, springs may be clustered in units of two or more.

ii) This adds a neoprene element to i) for better efficiency, particularly in eliminating high frequency noise, and is to be used when superior performance is required. Hangers shall be as specified in i) above but shall incorporate a neoprene element with a minimum rated static deflection of 8mm. The element shall locate in the top of the cage in order to prevent contact between the cage and the upper hanger rod.

iii) This adds a fixed elevation device to i) and ii), to facilitate installation. It also ensures that excessive load is not put onto equipment flanges, and is to be used for the three hangers nearest the inlet and outlet of each item of equipment. Hangers shall be as specified in i) or ii) above but shall have provision for the spring to be pre-compressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be provided with a method of releasing any residual pre-compression after the installation is complete and the hanger is subjected to its full load. Deflection shall be indicated by means of a scale. Pre-compressed hangers shall be used at the three support points nearest the inlet and outlet of each item of equipment.

3.9.3.4 Vibration Isolation Joints

3.9.3.4.1 Flexible Rubber Connections

Flexible rubber connectors shall be used in the positions indicated in the drawings, or where otherwise required, to reduce transmission of vibration or noise from equipment to pipework, accommodate pipe expansion and contraction, take up minor misalignment and facilitate connecting up. Where equipment is provided with a shut-off valve, the flexible connector shall be installed between the equipment and the valve.
Connectors shall be moulded in neoprene rubber with nylon reinforcing. Steel rings or wire reinforcement shall not be permitted. Only connectors of the spherical or arch type, allowing movement and misalignment in all planes, shall be used. Rubber hoses are not permitted.

The neoprene body shall be fitted with loose flanges, free to rotate, so as to facilitate lining up. Flange bolts must be fitted with the heads towards the rubber body. Where desirable for space saving or economy, elbow connectors can be used. For nominal diameters of up to 65mm flexible connectors with threaded ends, instead of flange, may be used.

Neoprene connectors may be used with single arch construction but where large movement or misalignment must be accommodated, or where maximum vibration and noise control is required, double arch connectors are preferred.

In cases where the piping is unanchored and the operating pressure (or test pressure or possible pressure surges) could over-extend the connector, rods or cables must be used to restrain thrust. Suitable neoprene washers must be used to isolate the rods or cables from the flanges, to prevent vibration short circuiting the connector.

Neoprene connectors offered must have a guaranteed burst pressure of at least three times the required working pressure. When allowance is made for temperature/pressure de-rating. Connectors must be rated for continuous operation at the required working pressure and temperature. If the pressure and/or temperature are excessive for neoprene connectors, flexible stainless steel connectors must be used.

3.9.3.5 Foundations

All rotating equipment shall be provided with concrete foundations with approved vibration isolators for rotating equipment. Refer to section “Noise and Vibration Control”.

The foundations shall be not less than 100mm high and extend not less than 150mm beyond the equipment on all sides. The Contractor shall provide galvanized steel channel forms the size and shape of each foundation. These forms shall be of suitable strength such that they will not distort when concrete is cast therein. Where necessary, the foundations are to be case on an isolating layer, which shall be provided by the Contractor. The forms and the isolating layers shall be provided to the Builder together with any holding down bolts required and drawings giving all necessary dimensions.

These foundations shall be painted by the Contractor once cast in position. A suitable etching primer shall be used on the exposed surfaces of the galvanized steel. Colour of paint to be used to be selected by the Engineer.

3.9.3.6 Blower and Fan accessories

3.9.3.6.1 ssure gauges

Pressure gauges are to be mounted on the suction and delivery sides of the blowers. They are to be glycerine filled and have a minimum diameter of 100mm. They are to be able to read twice the blower operating pressure. Stop cocks are to be provided to isolate the pressure gauges.

3.9.3.6.2 valves

A safety valve is to be provided to limit the operational difference pressure of the blower (pressure relieving valve).

For star-delta start up, an unloading valve is to be provided for start-up of the blower. A butterfly valve is to be installed in the delivery pipe line to isolate the blower.

3.9.3.7 Corrosion protection

Corrosion protection shall be carried out in accordance with the supplier recommendations or to the corrosion protection specification within the employers requirements.

3.10 AIR COMPRESSORS AND AIR RECEIVERS

3.10.1 Scope

This section of the specification covers the supply, delivery, transport, double handling (if required), storage and installation of air compressor and air receivers.

The design, material and construction, and operational conditions specifications are covered in the following specification. The contractor has the responsibility to provide compressors and air receivers which are within specification.

3.10.2 Design Specification

3.10.2.1 General

The air compressor shall be of the air cooled rotary type preferably be supplied by Ingersoll Rand or equal approved by the engineer package type complete with integrated refrigerant drier is preferred. The compressor shall be mounted in a soundproofed enclosure on anti-vibration mounts.

The volume of air delivered shall modulate to match the demand. Provision shall, however, be made for the compressor to shut down should there be no air demand for a predetermined period, and to restart when demand is re-established.

3.10.2.2 Integrated Refrigerated Type Air Dryer

Compressor Unit should have an integrated Air-cooled Refrigeration type Air Dryer with Moisture Trap (with automatic and manual drain), suitable for above mentioned applications. Hot gas by pass valve should be provided to maintain a stable pressure dew point (2°C to3°C) & avoid freezing during extended un-load run operation. Air dryer should be able to deliver compressed air to the machine according to ISO – 8573-1 having the following parameters of air:

- Solid particles / dust: Class – 1
- Humidity: Class – 4
- Oil content: Class – 1

3.10.2.3 Pre Filter

A suitable and efficient Pre Filter for Compressor Unit as per the requirement mentioned above for oil & other foreign particles removal from air.

3.10.2.4 Control Panel

Control panel for monitoring continuously & accurately (through microprocessor based Regulator and Electronic Controller) the data and for controlling the performance through feedback to the operator and interlocking arrangements. Built in protection systems, inclusive the following, should be provided for safe and fool proof operation of the complete compressor system.

a) Phase sequence protection relay,
b) Phase failure protection relay,
c) Motor overload Trip,
d) High Air / Oil Discharge Temperature Trip.
e) Protection against starting on load,
f) Suitable for controlling the compressor operation Locally, Remotely or via. Local Area Network.

3.10.2.5 Air receivers

Only South African manufactured construction materials shall be used for air receivers which shall be of heavy gauge steel with convex end-caps, shall be of welded construction and shall be manufactured to a code acceptable to the Engineer.

The vessels shall, in all respects, comply with the requirements of the applicable pressure vessel regulations and the Occupational Health and Safety Act, as amended, and each vessel shall include at least the following.

1. A pressure gauge of not less than 150mm in diameter, redlined at the maximum safe working pressure and calibrated in kPa.
2. Automatic drain valve cock. The draincock shall be piped to a drain.

The manufacturer shall supply a Test Certificate for the air receivers as required in terms of the Occupational Health and Safety Act, as amended. The installer shall also arrange for the receivers to be tested and inspected in accordance with the above Act after installation and before being put into use for the first time. This test shall be witnessed by the Engineer or a competent person delegated by him.

3.10.2.6 Corrosion protection

Corrosion protection shall be carried out in accordance with the supplier recommendations or to the corrosion protection specification elsewhere in the employer requirements.

RETURNABLE SCHEDULES

The following relevant returnable schedules, as listed below, will form part of this contract:

Contents

RETURNABLE SCHEDULE: SEA WATER DESALINATION

PLEASE NOTE THAT THE COMPLETION OF THE MAIN OFFER IS COMPULSORY BEFORE OFFERING ANY ALTERNATIVES.

PLEASE PROVIDE TECHNICAL DETAILS OF EACH MAIN MECHANICAL VESSEL, TANK AND OTHER STATIC EQUIPMENT (INCLUDING MEDIA FILTERS, CARTRIDGE FILTERS AND RO RACK) IN THE SCHEDULE PROVIDED BELOW:

(Copies may be made of this returnable schedule for each individual component and attached hereto or the relevant section of the Contractors proposal may be attached to this form as long as all the items mention below is described)

Tag number(s) as per Tenderer's PFD	
Equipment and/or vendor model description	
Total number installed and duty/standby approach	
Physical Dimensions	
Shape and orientation per unit	
Wall thicknesses (mm)	
3D dimensions per single unit (mm)	
2D Footprint per single unit (m^2)	
Other descriptions	
Materials of construction and protective coatings	
Wetted parts	
Non-wetted parts	
Attachments	
Other descriptions	
Included media and/or elements and/or cartridges	
Description and characteristics of item A	
Number, or mass of item A	
Description and characteristics of item B	
Number, or mass of item B	
Other descriptions	
Process information and performance	
Process medium (type and quality of liquid/gas/solid)	
Flow rate per unit, normal and maximum (m^3/h)	
Backwash/flush/scour flow rates (m^3/h and m/h linear)	
Operating and maximum design pressures (kPa)	
Minimum and maximum design temperatures (°C)	
Process efficiency (i.t.o. recovery, rejection, purity, etc.)	
Other descriptions	
Other evaluation data	
Delivery period	
Ease of operation and maintenance	
Availability of spares and after sale service	
Other descriptions	

PLEASE PROVIDE TECHNICAL DETAILS FOR PUMPS AND ANY OTHER ROTATING/MOVING MACHINERY IN THE SCHEDULE PROVIDED BELOW:

(Copies may be made of this returnable schedule for each individual component and attached hereto or the relevant section of the Contractors proposal may be attached to this form as long as all the items mention below is described)

Tag number(s) as per Tenderer's PFD	
Equipment and/or vendor model description	
Total number installed and duty/standby approach	
Physical Dimensions	
3D dimensions per single unit (mm)	
2D Footprint per single unit (m²)	
Other descriptions	
Materials of construction and corrosion resistance	
Wetted parts (e.g. internal casing, impellers, etc.)	
Non-wetted parts	
Attachments	
Other descriptions	
Mechanisms and power	
Mechanism (e.g. centrifugal, positive displacement, etc.)	
Seal mechanism	
Motor installed kW, voltage and phase	
Rotational speed	
Noise levels and related protection	
Other descriptions	
Process information and performance	
Process medium (type and quality of liquid/gas/solid)	
Flow rate per unit, normal and maximum (m³/h)	
Operating and maximum design pressures (kPa)	
Minimum and maximum design temperatures (°C)	
Energy efficiency (i.t.o. power consumption and transfer)	
Other descriptions	
Other evaluation data	
Delivery period	
Ease of operation and maintenance	
Availability of spares and after sale service	
Other descriptions	

GENERAL TECHNICAL DATA (Main offer / Alternative_____)

Item No	Description	Unit	Value
	Operating pressure	bar	
	Design feed water temperature	^oC	^oC to ^oC
	Operating hours per day	h	
	Feed flow	m^3/h	
	Sand filter: Effective media depth	m	
	Sand filter: Superficial down-flow rate	$m^3/(h \cdot m^2)$	
	Product flow @ 20h/d	m^3/h	
	Brine flow rate	m^3/h	
	Recovery	%	
	Membrane Flux	$l/(m^2.h)$	
	Membrane replacement interval	years	
	Membrane type		
	Pressure vessel diameter	inch	
	Max working pressure of pressure vessel	bar	
	Energy Recovery efficiency at design flow	%	
	High pressure replacement pump order time	months	
	Contract period	months	
	Max noise levels guaranteed (<85dB)	dB	
	Training hours provided	h	

Pre-treated Water quality guaranteed before RO. (Main offer / Alternative_____)

Component / Parameter	Specified Range	Guaranteed value
Turbidity, NTU	≤0.1 (95% confidence) 0.15 maximum	
SDI_{15}	≤3.0 (90% confidence) 3.5 maximum	
Biological Quality	C.Coli ……./100ml	

Permeate Water quality guaranteed. (Main offer / Alternative_____)

Component / Parameter	Units	Specified range/value	Stage		
			At commissioning	After 12 months of operations	After 36 months of operations
pH		5.0 to 8.5			
TDS	mg/ℓ	< 200			
Major Cations:					
Boron (B^{3+})	mg/ℓ	< 1.1			
Calcium (Ca^{2+})	mg/ℓ	< 40			
Magnesium (Mg^{2+})	mg/ℓ	< 10			
Potassium (K^{+})	mg/ℓ	< 6			
Sodium (Na^{+})	mg/ℓ	< 80			
Major Anions:					
Fluoride (F^{-})	mg/ℓ	< 0.5			
Chloride (Cl^{-})	mg/ℓ	< 120			
Sulphate (SO_4^{2-})	mg/ℓ	< 7			

Final Water quality guaranteed after stabilization. (Main offer / Alternative_____)

Component / Parameter	Units	Specified Range	Guaranteed value
$CaCO_3$ precipitation potential (CCPP)	mg/ℓ	2.5 and 5	
pH		8.0 and 9.0	
Calcium (Ca)	mg/ℓ	20 and 40	
Chloride (Cl)	mg/ℓ	< 200	
Sodium (Na)	mg/ℓ	< 200	

SECTION 4: ELECTRICAL AND ELECTRONIC SPECIFICATIONS

Contents

4. ELECTRICAL AND ELECTRONIC SCOPE OF SERVICES

4.1 GENERAL

The following scope of works shall be quantified and include the development and specifications for the concept design to ensure a basis for the services requirements in accordance with the project specifications developed:

- Material and IP rating specifications i.e. corrosive coastal environment.
- Instrumentation, control devices and instrumentation cabling, i.e. flow, pressure, TDS, Dissolved Oxygen, valve actuators etc.
- Automation and control systems i.e. PLC's, HMI's, distributed control, centralized control, SCADA computer terminal
- Low voltage electrical installation, i.e. Switchboards / MCC's, plant switchgear, OEM control panels, cabling to pumps and local control panels, field control stations, building and site electrical
- Telemetry and SCADA requirements i.e. I/O schedule, RTU, SCADA development
- Operation and Maintenance requirements

4.2 MATERIAL AND IP RATING SPECIFICATIONS:

All equipment and materials must be specified and selected to suit the local site and climatic conditions and therefore be adequately sealed and protected against corrosion i.e. full coastal specification, sea air conditions, etc.

Due to the corrosive environment of the coastal installation, we recommend the installation of stainless steel materials throughout, and that all electronic equipment be provided with suitable corrosion protection treatment or installed within high IP rating protected enclosures.

4.3 INSTRUMENTATION AND CONTROL

4.3.1 Instrumentation

Instrumentation is required for the efficient and effective control of the plant. All instrumentation shall be supplied from a dedicated 24V DC or UPS supply. The types of instrumentation selected must be suitable to operate in the specific ranges as required in the design of the plant. The default set-up of instrumentation should be retained as far as possible to reduce and limit the changes required.

Special attention must be given to ensure suitability of the selected instrumentation in accordance with the specific plant it is used in i.e. durability of internal and exposed wetted surfaces in seawater applications and chemical dosing applications.

All field instrumentation shall be connected to the PLC(s) in order to provide the monitoring specified for the control philosophy and architecture and indication on local HMI's and SCADA as applicable. The prime objective of the instrumentation is to enable automated and reliable monitoring of the pre-treatment system, to protect pumps and other electrical equipment and infrastructure and especially the downstream desalination system from operating under abnormal conditions.

Instrumentation shall typically include but may not be limited to the following of which the comprehensive technical specification shall be provided by the Contractor as part of the returnable schedules.

- Level sensors
- Turbidity (TDS) sensors
- Conductivity sensors
- pH sensors
- Residual Chlorine sensor
- ORP sensors
- Pressure sensors
- Differential pressure sensors (across media filter bed)
- General mechanical pressure, level and temperature gauges
- Temperature sensors

- Flow meters (electro-magnetic)
- Flow meters (mechanical)
- Switches as applicable for level, flow, temperature, pressure, vibration, proximity
- Load cells for weight measurement of dosing chemical product containers, etc.

The above instrumentation forms an integral part of the monitoring and control system for the desalination plant i.e. intake system, pre-treatment, desalination (RO) system, post-treatment, brine disposal system, CIP system, permeate delivery system. It is therefore a requirement that the specified instrumentation is locally supported as repair and maintenance of the instrumentation is critical.

Preference must be given to “smart” sensors in that internal diagnostic functions are provided to enable the identification of faulty instrumentation or incorrect readings.

4.3.2 Programmable Logic Controllers (PLC’s):

PLC’s shall be installed in the MCC’s or dedicated control panels as required and programmed to monitor and control the desalination plant as per the accepted and approved control philosophy and requirements.

The PLC’s shall typically provide the following functionality:

- Process and actuate all control, status, fault, instrumentation and alarm signals, totalizers and display on the HMI’s as applicable and also relay to the central SCADA.
- Implement the control requirements as provided for in the control philosophy i.e. Manual, Off, Auto; Local and Remote; Telemetry / SCADA
- Software routines / functions shall be provided for motor control, valve actuator control, alarms, totalizers, sequencing routines / functions, open and closed loop controllers (P&ID), interlocks
- Remote firmware and software download
- Data logging

4.3.3 Human Machine Interfaces (HMI’s):

A touch screen interface (colour) shall be provided at the positions of the PLC’s and shall be configured to provide the operator with control and status information, alarm notifications, trending and instrumentation measurements as applicable.

The HMI interface shall allow for control parameter changes to the PLC, which shall be password protected and logged. Operator actions, selections or settings described in the control philosophy shall be possible via the HMI interfaces as applicable.

The HMI’s shall typically provide the following functionality on the mimic screen:

- Graphical display of equipment and the respective status,
- Display of instrument readings
- Control mode selection on MCC’s and control of associated electrical devices i.e. actuators, pump motors
- Status shall be indicated by different state colours i.e. WHITE for available, GREEN for running, RED for tripped etc.
- Live and historical trend screens i.e. logged value vs. time
- Separate alarm page reflecting alarms

4.4 CONTROL PHILOSOPHY AND MONITORING SYSTEMS

The control philosophy and architecture forms the integral part of the complete desalination process in term of automation, control, monitoring and protection. The desalination plant i.e. feed water pumps and pre-treatment (chemical dosing), desalination (RO) plant, permeate transfer and stabilisation (chemical dosing) and ancillary processes is to be automated to ensure operational reliability.

The automation and control shall be facilitated via Programmable Logic Controllers (PLC’s) interfaced to Human Machine Interfaces (HMI’s) for local monitoring, diagnostics and control as well as a Supervisory Control and Data Acquisition (SCADA) system for control and to allow off-site remote control (if applicable), trending, logging, alarm notifications etc.

As part of the planning methodology, a general system integration and control narrative and functional description, considering the following shall be provided by the Contractor.

- The control and systems integration requirements in line with demand scenarios in order to select the optimum and most efficient scheme
- Factors i.e. ease of integration, control versatility and stability, scheme expandability, auto adjustment using measured parameters as per demand scenario requirements, fall-back modes and system redundancy
- Establish criteria and requirements for integration of the proposed control architecture into the existing client scheme as per client standardised preferences.
- Control flow diagrams shall be compiled (incl. P&ID) to evaluate control compatibility requirements.

It is expected that OEM package plants will form part of the installation and this will require the local control PLC's to be integrated with the main control PLC's for interfacing with the HMI's and SCADA network.

4.5 LOW-VOLTAGE ELECTRICAL INSTALLATION

4.5.1 General

The following shall be identified, quantified and specifications submitted with the tender for evaluation in order to ensure compliance with the client standardised preferences.

- Proposed Lighting, Small Power and DB single-line diagrams for the site and building as applicable and material selection specification.
- Cable specifications for power (SWA), control (SWA or Dekabon as applicable) and instrumentation cables, wireway specifications and schematic layouts
- MCC / Switchboard specifications and single-line diagrams, surge protection specifications.
- Protection philosophy and specifications for motor control switchgear (soft starters, variable frequency control) and associated control interface requirements
- Field control stations (E-stop and remote start) i.e. at each motor position in the field
- Ventilation requirements and specifications
- Visual and audible alarm notifications i.e. plant failure, power failure etc.
- Power factor correction of plant
- UPS installation (230Vac) or battery system (24Vdc) for the control and instrumentation voltages
- Lightning and surge protection classification and specifications to the plant as applicable
- Earthing design specification and schematic layout
- Testing and commissioning procedures and requirements
- Compliance with regulations and standards

4.5.2 Voltages

The voltages (24VDC, 220VAC, 400VAC) are the preferred voltages ranges. Any deviation on the use of these voltages must be agreed between the Contractor and the Employer.

The 24VDC range is normally used for controls systems and instrumentation. The 24VDC supply systems are normally equipped with backup supply systems to ensure monitoring of the systems during short power interruptions. The contractor will ensure a stable and reliable 24VDC supply.

The 220VAC range (single phase) range is normally use for equipment like small dosing pumps and other AC equipment with relative low power requirements.

The 400VAC (thee phase) range is normally used for equipment like pump sets, actuators and other AC equipment with medium power requirements (<375KW).

The 11000VAC (three phase) range is normally used for equipment like large pump sets with high power requirements (>375KW).

4.5.3 Standardisation of Equipment and Equipment Types

The Contractor shall pay special attention to ensure that the principle of standardization is applied on the use of equipment throughout the plant. The standardization process will be based on the standardized equipment as mentioned in this tender. The Contractor will discuss the selection of equipment if he does not agree with the proposed equipment or if required equipment was not specified. The selection of equipment will be done taking cognisance of local support in the Western Cape and the time required to repair or replace equipment. The selection of equipment will be based on the use and experience with proven technology in existing applications.

4.5.4 Surge & Lightning Protection

4.5.4.1 General

Surge and lightning protection is considered as a very important part of the total electrical and electronic system. The Contractor will ensure that adequate protection is installed and monitored by the monitoring and control systems to ensure that failures are detected. The PLC/SCADA system will display and log failures of such systems. Specific details of the specific system and actions to repair or replace systems will be provided on the alarm help files of the SCADA systems.

4.5.4.2 Low/Medium voltage systems (400V minimum spec)

Surge protection will be part of the design of all power supply systems to protect equipment against surges and lightning.

As a minimum all MCC for control of equipment in the 400VAC range will be equipment with lightning and surge protection units in the incomer section of the MCC and shall meet the SABS 0171 (1986) standards.

The design shall be based on the use of the DEHN surge protection equipment and design guidelines.

Visual fault indicator to indicate failure of the surge protection components in the protection systems is required. The failure of components will be wired to the control system to indicate a fault with the protection on the SCADA system.

4.5.4.3 Power measurement and monitoring

Reliable power measurement, instantaneous kWh consumption meters and totalizers, shall be installed for all the major pump sets.

A master power meter shall be provided so that the guaranteed electric power consumption on the treatment processes can be monitored at a single location. This meter will not include a record of external, non-process electrical usage, such as lighting, HVAC, etc.

4.5.4.4 Backup power and generator set

The Contractor will make provision in the design of the plant for a backup power supply system to provide power during power failures. The purpose of the backup power will be to provide power to critical parts of the plant to enable safe shutdown of the plant. The Contractor will provide the details of the critical functions that need to be performed during a power failure. The power requirements to enable the performance of this function will form the basis for the design of the backup systems.

The backup and power supply systems will also make provision for site power during items of possible load shedding by the power utility. The systems will be designed that power distribution system will only be supplied to certain pre-defined areas. The Contractor will provide and discuss the proposal of such system.

If the Contractor decide to use diesel generator sets provision must be made for bulk fuel tanks and special designs to limit ground contamination due to fuel leaks or spillages.

4.5.4.5 Lighting, site lighting, building services and power

The systems will be designed to be flexible to allow for energy saving. Lighting will be installed to provide for following situations:

- Normal operation – all areas for the effective monitoring and control of the plant and all its functions to ensure
- Emergency lighting – power is only provided to predefined areas during power failures or load shedding.
- Lighting when maintenance work be performed during night times on the plant.
- Energy saving mode / functions – minimum system required for operation to continue.
- Site lighting – adequate site lighting must be installed.

All design will be done taking into consideration the proposed backup power system for critical functions and areas during the loss of power. The power points connected to the backup systems will be clearly marked throughout the buildings.

4.5.4.6 MCC specifications (400VAC)

Motor Control Centre (400V)

The MCC(s) will consist of separate sections as a minimum for the following:

Incomer section with the following:

- Incoming power cables
- Surge protection
- Main circuit breaker with the required protection and lockable extended handle systems
- Current measurement and display of all phases
- Voltage measurement and display of all phases and phase to phase

Separate motor starter sections for each pump set with the following:

- Pump Circuit Breaker protection and lockable extended handle systems
- Motor Protection Unit (MPU)
- Current measurement and display of all phases where this is part of the functionality of the MPU
- Hour meter of running hours

Control section with the following:

- DC Power supply system
- Surge protection
- Devices for voltage protections
- Signal converters as required
- Ethernet equipment as required
- PLC hardware
- Additional relays for pump starters
- Controls for small pump applications like Chlorine and dosing/chemical feed pumps
- HMI such as touch panels

4.6 SCADA

A central computer based SCADA system must be provided at the desalination plant control room from where the complete plant processes can be monitored, controlled and reported via the mimic screen and shall be multi-user capable. The central SCADA provision shall consist of a computer, screen, printers and pointing device.

The client has an existing SCADA and telemetry system with the central SCADA terminal at the Robben Island Water Treatment Works consisting of Spectrum “Tele-ranger” RTU’s and “Adroit” SCADA software package. The availability of adequate spare tags for the desalination plant application and shall be discussed with the client with regards to upgrade requirements.

As part of the tender submission, the following information shall be identified, quantified and submitted for evaluation to ensure compliance with the client standardised preferences:

4.6.1 SCADA

PC hardware and software and system performance requirements: The minimum requirement for the computer is an Intel dual core processor 2,7GHz with 500Gb hard disk, 2G extendible RAM, minimum of three USP ports, DVD writer and 19" LCD flat screen with keyboard and mouse. The computer must be pre-loaded with Windows 7 and MS 2010 latest version complete with all certification and licensing.

- SCADA software package and features: The SCADA package prosed must be the latest version of ADROIT, with scan point capacity for complete installation as specified and 20% spare capacity.
- SCADA modes of operation
- Mimic screen graphics overview (P&ID diagram) and dynamic graphic symbol display for running or switchable equipment (The use of the IEC standards for Process and Instrumentation diagrams)
- Historical and real-time trending and reporting
- SCADA security i.e. Administrator, Supervisor and Operator log-in, each group with different operational rights
- Process flow mimics
- Equipment displays i.e. motors, actuators, measured values and controllers
- Alarms and event reporting providing sorting and filtering functionality
- Calculations and Analysis
- General reporting and report structuring
- Notifications i.e. paging, GSM, radio alerts
- Database management
- Client standardised preferences

4.6.2 Telemetry

The telemetry installation and interfacing to the SCADA shall be facilitated by others. Contractor to allow for the co-ordination with the telemetry contractor during the set-up, installation and commissioning stages.

4.7 GENERAL

When evaluating the above infrastructure and taking into account the specific application requirements, the following general principles and functional requirements should be adhered to ensure reliability of the system:

- Minimum component requirement
- Minimum wiring and cabling requirement
- Standardized design and system architectures
- Equipment and electrical infrastructure specification taking into account environmental conditions
- Good voltage supply and protection of pumps, control systems and associated electrical and electronic infrastructure
- Easy fault finding for corrective and preventative maintenance procedures
- Ergonomic solution that offers low and easy maintenance, long life utility, robustness and maintaining quality by control.
- Local agent support and service level agreements to ensure acceptable response times during possible plant, process or equipment failure

The information and technical schedules shall be submitted by the Contractor for the following as requested but not necessarily limited to:

- Control system functional description and specification with corresponding flow diagrams
- Process and instrumentation diagrams
- PLC control logic (logic diagrams, flow charts and software printouts)
- Low voltage electrical installation specifications
- General layout of the installation i.e. instrumentation, MCC / Switchboard positions, cabling routes etc.
- Technical data sheets for the MCC's and switchboards, metering and indication equipment, building electrical equipment, cables. VFD's and soft starters, instrumentation, PLC's, HMI's, UPS unit(s), SCADA computer etc.
- Testing and Commissioning procedures
- Compliance with the regulations and standards as applicable

- Functional testing of all the control system components and integration prior to installation
- Performance monitoring and optimization

4.8 GENERAL NON-TECHNICAL REQUIREMENTS

4.8.1 Definitions

The following words and expressions shall have the meanings assigned to them hereunder, except where the context otherwise requires:

Local Authority	:	Robben Island Museum
Local Supply Authority	:	Eskom
MV	:	Medium Voltage, i.e. 11 000V
LV	:	Low Voltage, i.e. 400/231V
Project/Site	:	Reverse Osmosis Desalination Plant, Robben Island
Specification	:	This document in which the general requirements for the Contract Works are specified and which forms part of the Contract Documents.

4.8.2 Contradictory Requirements

Should any requirements of the Specification and/or the Drawings be found to be contradictory, the Contractor shall bring such contradictions to the attention of the Engineer prior to the ordering of Materials and Goods and prior to the execution by the Contractor of any work which may be affected by such contradictions.

4.8.3 Laws, Bye-Laws, Regulations, Standards and Codes

4.8.3.1 Compliance

All material, plant equipment, accessories and fittings installed in the execution of the Contract shall, except where otherwise specified or specifically exempted by the Engineer in writing, be new and shall comply with:

a) The Specification
b) The Occupational Health and Safety Act, Act 85 of 1993
c) The Construction Regulations (2003).
d) Code of Practice for the Wiring of Premises, SANS 10142:1 (2008)
e) The Regulations of the Local Supply Authority
f) The Regulations of the Local Fire Brigade
g) The Regulations of Telkom SA
h) The Standard Regulations of any Government Department or Public Service Company where applicable.
i) Specifications and codes by the South African Bureau for Standards where applicable
j) The technical guidelines and/or technical specifications as issued by the relevant Local Supply Authority and applicable to electrical installations within the Local Supply Authority's area of jurisdiction.

4.8.3.2 Contradictions

It is assumed that the Contractor is conversant with the above-mentioned laws, regulations, standards and codes. Should any law or regulation contradicting the requirements of this Specification apply or become applicable during construction of the Contract Works, such law or regulation shall overrule the requirements of this Specification. The Contractor shall immediately inform the Engineer of such a contradiction, if possible prior to the ordering of any materials affected and prior to the execution of any work affected. Under no circumstances

shall the Contractor carry out any variations to the Contract Works in terms of such contradictions without first obtaining the written permission to do so from the Engineer.

4.8.3.3 Exemption

The Contractor shall exempt the Employer from all liabilities, losses, costs or expenditure which may arise as a result of the Contractor's negligence to comply with the requirements of the laws, bye-laws, regulations, standards and codes specified above.

4.8.4 Operation and Maintenance Documentation

4.8.4.1 Operation and Maintenance Manuals

The Contractor shall submit to the Engineer three (3) complete sets of operation and maintenance, manuals, drawings, pamphlets, test certificates and other technical literature which may be required for the maintenance and/or operation of the Contract Works.

4.8.4.2 Record Drawings

During the construction of the Contract Works, the Contractor shall record the as built conditions on a set of record drawings to be supplied by the Engineer for that purpose. On completion of the Contract Works, the Contractor shall submit a complete set of record drawings to the Engineer.

4.8.5 Standard and Samples

Samples of all items of equipment used and the relevant SABS test report or certificates shall be submitted to the Engineer on his request before installation is commenced.

All such samples may be retained until completion of the Contract. All such samples shall have securely attached thereto labels designating the Contract by name and number (if any), the name of the Contractor and any further relevant information.

4.8.6 Uniformity

All items of the same type of equipment shall, where at all possible, be of the same make and type of each item throughout the installation, to ensure interchange ability and ease of maintenance.

4.8.7 Radio, Television, Computer and Computer System Interface

The Contractor shall allow for interference suppression components, where required, to ensure that the electrical installation shall not cause interference to radio, television, staff location, computer and computer systems.

All necessary steps are to be taken to comply with the regulations concerning interface.

4.8.8 Delivery

The Contractor must co-ordinate the delivery dates for all items of equipment supplied by him to allow adequate time for installation, commissioning and testing prior to contract completion.

To this end, the Contractor must ensure that shop drawings are presented to the Engineer for approval timeously, and a programme of submission of such drawings must be approved by the Engineer within three months of the acceptance of the tender.

Documentary proof is to be supplied of the placing of all orders for equipment having a protracted delivery period. No substitution of specified items will be allowed due to the late placing of orders, and no delay claims in this regard will be entertained.

4.8.9 Methods of Fixing

The size of bolts or screws shall be the largest permitted by diameter of the hole in the apparatus concerned and are to be of adequate length. When fixing any item of equipment, all bolt or screw holes provided therein shall be used and the fixing in each hole is to be secure.

In all cases, bolts shall be secured by means of a washer on either side of the items being bolted followed by a lock washer and nut.

4.8.10 Electrical Work Associated with Mechanical Services

The electrical work associated with mechanical services will be the responsibility of the Mechanical Contractor.

The relevant requirements of this specification shall apply.

4.8.11 Schedules of Equipment

A complete list of fittings and other equipment intended for use on this Contract is to be submitted with the tender. This list shall contain manufacturers' names, catalogue numbers, etc. Where any item offered is not to specification, prior approval in writing shall be obtained before this can be offered.

Should any item supplied not comply with the specification, an alternative which meets the specification is to be provided at no additional cost to the contract.

4.8.12 Voltage Ratings

The voltage ratings of appliances, etc. installed by the Contractor, shall comply with the nominal declared voltage of the respective Supply Authority.

4.9 GENERAL TECHNICAL REQUIREMENTS

4.9.1 Quality of Materials and Equipment

All material to be supplied in terms of this Project shall be new and unused. Where specific manufacturers' materials or equipment were not prescribed in the Specification, Materials and Goods supplied shall be of the best quality available. Preference shall be given to materials of South African manufacture and in particular to materials bearing the SABS mark of quality.

The Engineer reserves the right to call for the replacement of any materials found on Site which do not conform with the above requirements, provided that alternative materials which do conform to the above requirements, are available. Any such replacements shall be effected by the Contractor at his own cost and the cost shall not be recoverable from the Employer or the Engineer.

If a detailed specification for material or equipment is not provided, the Contractor shall select material or equipment that complies with best practice for the specific application based on national and international standards.

4.9.2 Delivery of Materials and Equipment

The Contractor shall ensure that all materials required for the completion of the Works, shall be timeously ordered and delivered. Delivery dates and possible delays shall be established at an early stage. No claims for extension of the Contract period as a result of delays in delivery of materials shall be considered by the Engineer, unless such delivery periods are in excess of the time for completion of the Contract works.

4.9.3 Finishes on Materials and Goods

4.9.3.1 General

All Materials and Goods to be supplied for the Works, shall have durable finishes to withstand the weather and local site conditions. The Contractor shall exercise care regarding Materials and Goods to be utilised in corrosive areas. The types of finishes required on various Materials and Goods and the final colour are specified in the relevant sections of the Technical Specification.

In the event of painting, baked enamel and electrostatically applied powder coating, the metal surface shall be prepared as follows prior to painting. All sharp edges shall be smoothed and rounded to ensure that the finishing layer(s) will adhere properly to the entire metal surfaces. Surface preparation shall comply with the requirements of SANS10064. All metal parts shall be thoroughly cleaned of corrosion, mill scale, grease and foreign matter to a continuous metal finish. Sand or shot blasting or acid pickling and washing shall be employed for this purpose.

4.9.3.2 Finishes

The following terms will be used to specify the required finishes and are defined as follows:

a) Painting:

In the event of **ungalvanized metal work**, one layer of approved zinc chromate undercoat conforming to the requirements of the SANS 10679, Type 1, shall be applied immediately after cleaning is competed and the metal properly dried. The undercoat dry film thickness shall measure at least 25 microns. Once the undercoat layer has dried for a period of minimum 24 hours, the fist of two final coats of high gloss paint shall be applied. The paint shall conform to the requirements of SANS 10630, Grade 1. The dry film thickness for each coat shall be minimum 25 microns, resulting in an overall paint dry film thickness of at least 75 microns. In highly corrosive areas or in areas within 50km from the coast, the paint thickness shall be increased so that the total dry film thickness shall be at least 120 microns.

In the event that painting of **Galvanised metal work** is required, the galvanised metal shall be treated with a passivate coating and then washed with water and dried. Thereafter one coat of calcium plumate undercoating complying with the requirements of SANS10912 shall be applied, followed by one coat of approved undercoat conforming to the requirements of SANS 10681, Type 2. Once the undercoat has dried for a period of minim 24 hours, the first of two final coats shall be applied. The paint shall conform to the requirements of SANS 630, Grade 1. The dry film thickness for each coat shall be minimum 25 microns, resulting in an overall paint dry film thickness of at least 75 microns.

In the event that painting of **aluminium** is required, one coat of self-etching primer, conforming to the requirements of SANS 10723 (Plascon Hi-Sheen or similar and equal) shall be applied immediately after the cleaning is completed and the metal properly dried. Once the primer has dried for a period of minimum 24 hours, the first of two final coats shall be applied. The paint shall conform to the requirements of SANS 10630, Grade 1. The dry film thickness for each coat shall be minimum 25 microns, resulting in an overall paint dry film thickness of at least 75 microns.

Paint thickness shall be determined in accordance with the SANS 10140 methods.

b) Baked Enamel:

Immediately after cleaning, all surfaces shall be covered by a tough, corrosion inhibiting, unbroken, metal phosphate film and then properly dried. Within forty eight (48) hours after phosphatising, a passivating layer, consisting of a high quality zinc chromate primer shall be applied, followed by two coats of high quality alkyd based baked enamel paint. The enamel finish shall comply with the requirements of SANS 10783, Type IV. The minimum dry film thickness shall be 75 micron and in coastal areas the dry film thickness shall be increased to at least 120 micron. The paint finish shall further have an impact resistance of 5.65 J on cold rolled steel plate and a scratch resistance of 2.0kg.

c) Powder Coating:

Immediately after cleaning, the metal shall be pre-heated and then covered by a micro structured paint powder applied electrostatically. Particular care shall be taken to cover all sharp edges properly. The paint shall then be baked and shall harden within 10 minutes at a temperature of 190 EC. The minimum dry film thickness after baking shall be 50 micron and in coastal areas the dry film thickness shall be increased to 100 micron. The paint finish shall further have an impact resistance of 5.65 J on cold rolled steel plated and a scratch resistance of 2.0kg.

d) Galvanising:

All galvanising shall be of the hot dip process and shall conform to the requirements of SANS 10121 (SABS ISO 1461). All completed galvanised structures shall either bear the SABS mark of approval or shall be accompanied by a certificate by the galvanising company to confirm that the galvanising conforms to the requirements of the SANS 10121 (SABS ISO 1461). It will be the Contractor's responsibility to obtain and submit such certificates to the Engineer and pay all costs in such regard. Should the Engineer at his own discretion prefer to have the galvanising evaluated by the SABS and the SABS should find that such galvanising does not conform to the requirements of the SANS 10121 (SABS ISO 1461)specification, the Contractor will be instructed to have all suspect structures re-galvanised at his own costs. In addition, the Contractor will be liable for all costs incurred by the Employer and the Engineer during the process of evaluation by the SABS and the re-galvanising process.

Prior to galvanising, the metal work shall be designed and prepared to ensure thorough liquid zinc coverage of all metal surfaces, both inside and outside, and to prevent undue distortion of the metal structure due to the heat of the hot dip process. The metal structure shall be prepared with all drilling, welding, punching, cutting, bending and other forming processes completed prior to galvanising. Furthermore, all welded seams shall be inspected for suitability and properly prepared prior to galvanising.

In the event that the galvanising finish should get damaged after galvanising and prior to the first handover of the Contract, the Contractor will be liable to repair such damage at his own cost and to the satisfaction of the Engineer. Repairs shall be in the form of either re-galvanising or on site repairing. On site repairing shall be by means of soldering or preferably hot zinc spaying in accordance with SANS 121 (SABS ISO 1461), as called for by the Engineer at his own discretion.

4.9.4 Colours

The colour of HV switchboards and HV switchgear enclosures shall be “DARK ADMIRAL GREY”, colour G12 of SANS 1091.

The colour of LV switchboards and equipment enclosures in buildings shall be “ELECTRIC ORANGE”, colour B26 of SANS 11091 as recommended in SANS 10140-2 unless specified to the contrary.

The standby power section of LV switchboards in buildings shall be coloured “SIGNAL RED”, colour AII of SANS 1091.

Switchboards for no-break power supplies or sections of switchboards containing no-break power supplies, shall be coloured “DARK VIOLET”, colour FO6.

In the case of switchboards and larger equipment enclosures, a tin of matching touch-up paint shall be provided.

4.9.5 Operating Conditions

All material and equipment supplied by the Contractor and all installation methods applied by the Contractor shall be suitable for the following operating conditions.

4.9.5.1 Environmental Conditions

Altitude above sea level	:	Less than 50m
Distance from sea	:	Less than 1000m
Ambient temperature	:	-4°C to 40°C
Wind speed	:	In excess of 120 km/h
Rain	:	Light drizzle to heavy driving rain in stormy conditions

4.9.5.2 Electrical Conditions

Supply voltage	:	medium voltage	:	11 000V ±6%
		low voltage	:	400V ±10% line voltage
231V±10%phase voltage frequency:		50 Hz		
Vector Group	:	Dyn 11		
Fault level	:	50MVA		
Phase rotation	:	To be confirmed with Local Supply Authority		
Earth system	:	Solidly earthed neutral at distribution transformers		

4.9.6 Fixing of Material and Equipment

All material and equipment shall be installed in accordance with the manufacturer's instructions and recommendations.

Appropriate fastening methods shall be used using suitable washers under screws and nuts.

No gun-bolting may be used unless written permission is obtained from the Engineer.

The Contractor will be held responsible for damage to the building work due inappropriate fastening methods being used.

4.9.7 Existing Services

The Contractor shall negotiate with other Contractors on Site, the Local Authority, the Local Supply Authority (if not the Local Authority), Telkom and other relevant parties in order to determine the presence of existing services on Site which will influence the Works and shall advise the Contractor accordingly.

The Contractor shall exercise care to avoid any damage to existing services. The Contractor will be liable for the costs involved to repair any damage inflicted upon existing services by the Contractor or his personnel. Such repairs may not be undertaken by the Contractor unless approved by the Engineer, since such existing services may still be under guarantee and any interference by the Contractor with such services may nullify such guarantees. All damage shall therefore be reported to the Engineer who will arrange for the repairs of such damage. The Contractor is however strongly advised to insist on written quotations in respect of repairs to damage prior to the undertaking of such repairs. The Engineer reserves the right to issue variation orders on this Contract to omit any costs due to repairs made by others.

4.10 LOW VOLTAGE (LV) AND CONTROL CABLES

4.10.1 General

The Contractor shall supply and install all the low voltage, instrumentation and control cables as stated required. Where applicable, the manufacturer specific power supply cables for the instrumentation, meters and sensors must be included.

The Contractor shall supply and install the low voltage cables that shall conform to the following requirements:

Manufacturer: Aberdare or similar and equal approved

Type:	PVC/PVC/SWA/PVC
Conductor material:	Copper
Insulation	600V/1000V grade
Conductor size:	As required
Cores:	As required
Applicable specification:	SANS 1507-1 (General)
	SANS 1507-3 (PVC Distribution cables)
Markings:	Cables shall bear the SABS mark of approval

4.10.2 Through Joints

Through joints shall typically be of the Scotchcast or Durocast resin type, chosen and installed in accordance with the cable manufacturer's recommendations. The number of joints shall be kept to an absolute minimum and joints will only be allowed where cable runs exceed full drum lengths, unless otherwise authorised in writing by the Engineer. Raychem heat shrink tubing (Type: UNF) with heat activated glue on the inside walls, shall be installed over each crimped conductor joined. Heated air shall be applied from the centre of each tube to the outside direction to allow excess glue to flow outwards.

Cable joints shall be marked on the kerb stones opposite the joints. If no kerb stones are available, suitable cable markers will be used to indicate the joints. In addition, the exact location of each joint shall be indicated on the record drawings, complete with dimensions from fixed reference points such as erf boundaries (in two directions).

4.10.3 Terminations

Cable terminations throughout the system shall follow the same conductor run.

Suitable pin lugs, terminals, and other fittings shall be used to match the different sizes and construction of cables. The correct type of crimping tools shall be used to crimp the lugs, terminals and other fittings onto the cores. The lugs shall be installed directly onto the busbars, terminals or other fittings. Lugs shall be of the correct size to suit both the conductors and the bolts they have to be connected with. Oversize lugs will not be accepted. Suitably sized washers shall be installed on top of the lugs and split washers shall be used underneath nuts for all bolted terminations.

Conductor tails shall be of sufficient length to terminate the cable in a neat and workmanlike manner inside the termination boxes. Excess length of tails shall be removed. The tails shall be neatly bound together with PVC straps and secured where possible.

SANS approved type cable glands, complete with neoprene shrouds, shall be used wherever suitable gland plates are available for the securing of cables at termination points. Where suitable unistruts are available, suitable K-clamps shall be used to secure the cables. In the event that cable ends are exposed to the weather, such ends shall be sealed against the ingress of water. For cable glands suitable inner seals will be acceptable. For non-cable gland terminations, suitable heat shrink cable end seals shall be provided.

All armouring at cable ends shall be suitably bonded to earth. In the event of cable glands, suitably sized earth tags shall be provided as an integral part of the glands. The earth tags shall be connected to the earth bar by means of a 10mm² bare stranded copper earth conductor. The conductor shall be crimped into suitable lugs, which shall be bolted onto the earth tag and the earth bar.

4.10.4 Labels

At each cable termination the cable shall be provided with a label. The labels shall be of the non-metallic type and shall be secured to the cables at approximately 200mm below the cable glands or K-clamps by means of PVC strapping. The labels shall nevertheless always be visible and should the positions below the glands or K-clamps not be visible, the labels can be secured to the cable tails just above the glands or K-clamps. The labels shall indicate the following information:

a) size of the cable
b) cores of the cable
c) identity of the equipment at the other end of the cable

A typical label shall read: "1,5mm², 4, To Pump station 2"

4.10.5 Installation

Cables shall be handled and stored in accordance with the manufacturer's specifications and shall be installed in a workmanlike fashion and in accordance with generally accepted standards. Cables shall never be installed over any sharp edges without suitable protection for the cable against damage. Two or more cables installed next to each other shall be installed parallel and shall not cross each other unnecessarily. The cable installation shall further be planned in advance in order to minimize the number of times that cables installed parallel shall have to cross at turn off points. The distance between adjacent cables shall not be less than 2 x the diameter of the larger cable. No cable shall be bent to a radius of less than 10 x the overall diameter of such a cable in accordance with the requirements of the Wiring Code (SANS 10142-1 Annexure F).

Cables installed into trenches shall be installed with the aid of suitable cable rollers to avoid damage to the cable due to the installation process. Particular care must be exercised where it is necessary to draw cables through pipes and ducts, to avoid abrasion, elongation or distortion of any kind.

The end of such pipes and ducts shall be sealed to approval of the Engineer after the drawing in of the cables.

4.11 DISTRIBUTION BOARDS AND ANCILLARY EQUIPMENT

4.11.1 General

The Contractor shall supply and install the electrical distribution boards, complete with switchgear as specified. Details of the distribution boards are indicated on the relevant drawings.

The onus rests with the Contractor to ensure that the distribution board offered, comply in all respects with the requirements of this Specification and the SABS regulations.

4.11.2 Manufacturers

The distribution board shall be manufactured by an approved and accredited distribution board manufacturer, such as Switchboard Manufacturers, EDS, Nuco or MCB Switchboards.

The fact that a distribution board manufacturer is considered to be "approved" merely implies that the standard of workmanship as experienced before, is acceptable. However, such "approval" does not in any way alleviate the responsibility of the Contractor to ensure that the requirements of the Specification are met in all respects by such a manufacturer.

4.11.3 Construction and Finish

4.11.3.1 General

The distribution board shall be constructed in accordance with the requirements of the SANS 1973-3 specification.

The distribution board shall be manufactured from 3CR12 steel, minimum thickness 1,6mm or 2,0mm, depending on overall dimensions. The epoxy paint finish is specified on the drawing.

Sealing strips and gaskets shall be made of durable non hardening rubber, neoprene and other synthetic materials. Care must be taken to ensure that even pressure is exerted along the entire length of the gasket and that neither deflection nor buckling of panels occurs when the gaskets are compressed. Door latching and unlatching operation shall be smooth.

Bolts, nuts and washers used shall be Stainless steel, with the exception of busbar bolts, which shall be of high tensile stainless steel.

Flash barriers shall be interposed between items of equipment which by virtue of their operation in the board could cause breakdown of the dielectric insulation to adjacent items of equipment.

All parts of the distribution board shall be electrically continuous and a suitable stud shall be provided for the earthing of the enclosure. Particular attention shall be paid to the earth continuity of supervisory equipment. Flexible copper straps may be used for the purpose of ensuring earth continuity between the board and panels.

Free standing boards shall be protected against vermin, especially from below. Where cables have to pass through the gland plate, rubber grommets shall be provided and enough non-hardening compound shall be delivered with the board so that these holes can be sealed properly after installation of the cables.

4.11.3.2 Accommodation

The mounting of equipment shall comply with the SANS 1973-3, where applicable.

The distribution equipment shall be mounted in parallel horizontal rows. The arrangements shall be such that a minimum 100mm space exists between adjacent rows of equipment for the installation of incoming and outgoing conductors and expansion of ionised gas generated during circuit interruption. Minimum 75mm space shall be provided between the top and the bottom rows of equipment and the top and bottom edges respectively. Similarly minimum 50mm space is required between side edges of the switchboard and equipment. The spaces specified shall be free space, accessible for the full dimensions specified. The minimum clearance between live and live parts, live and neutral parts and live and earthed parts shall be 20mm for systems up to 500V.

The board shall be of sufficient dimensions to allow for all equipment specified, plus for 20% spare capacity for future circuits or equipment.

Particular attention shall be paid to the accommodation and bending of the incoming and outgoing conductors within the enclosure and the working space required for making off the cables, crimping the lugs and connecting into the equipment. Adequate provision shall be made for earthing of the LV cable armouring.

Circuit breakers for socket outlet circuits shall be preceded by the earth leakage unit controlling those circuits. Immediately after such circuit breakers, a minimum of two spaces shall be provided for future circuit breakers to be connected to the same earth leakage unit. The interconnecting busbar shall extend to the positions for such future circuit breakers.

In a similar fashion, all spaces for future circuit breakers shall be provided with busbars to facilitate easy installation of future circuit breakers. Provision shall also be made in the capacity of neutral and earth bars to accept future conductors for the equipment to be installed in the spare spaces.

Dummy circuit breakers or blank covers shall be provided for all spaces for future equipment.

4.11.3.3 Wiring and Busbars

The phase identification colours shall be red, white and blue from the top of the distribution board to the bottom and from the left to the right. All other conductors in the board, supplying control circuits, etc. shall be coded in colours other than those specified above. A colour code shall be devised for each board and the colour code shall be shown on the wiring diagrams. Wiring sizes shall be selected in accordance with SANS 10142 according to the rated current of the circuit breaker or fuse controlling the current to such wiring, suitably derated to allow for the bunching of wiring inside the board.

All wiring shall be 600/1000V grade PVC insulated, multi-stranded copper conductors conforming to the requirements of SANS 1507. Insulation shall be stripped without damage to the conductors, utilising a purpose designed tool. Insulation shall be stripped to the proper length for the terminal or lug so that exposed bare conductor is limited to maximum 1mm. Crimped on lugs and ferrules shall be used throughout, except where

box or compression type terminals exist.

Cables connected to incoming or outgoing circuits shall be terminated on the gland plate supplied for this purpose. Power cables up to and including 70mm² may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. Connection to the equipment can then be made with cables that are similarly connected to the clamp terminal. All power cables larger than 70mm² terminate on busbars that are connected to the associated equipment. Parallel incoming or outgoing cables shall be connected to a collector busbar without crossing the conductors.

The cutting of strands in order that conductors may fit into terminals, lugs or ferrules will not be accepted. Suitable extended terminals shall be used to accommodate conductors which are too big for standard terminals. A maximum of two conductors shall be installed onto the same terminal. Wiring shall not impede access to any of the equipment inside the board. The wiring shall be neatly grouped together in horizontal and vertical rows and tied with PVC cable ties.

Conductors to hinged panels and doors shall be secured on both the door and the frame and shall be looped between the two points. The loop shall be arranged to produce a twisting motion when the door is opened or closed. A flexible protection sleeve shall be installed over the conductors.

Where wiring channels are used, they shall be installed horizontally and vertically. Under no circumstances may power and control circuit wiring be installed in the same wiring channels. Channel shall not be more than 40% full.
All wiring between different panels within the same switchboard shall be installed in wiring channels.

Grommets shall be installed in each hole in the metalwork through which conductors pass.

All wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges.

Wiring should as far as possible be confined to the front portions of switchboards for ease of access. This requirement is important for wiring between smaller circuit breakers and the associated main circuit breaker as well as the wiring from circuit breakers to lighting and socket outlet circuits.

A maximum of two conductors will be allowed per equipment terminal. Where more conductors must be connected to the same equipment terminal (e.g. a main circuit breaker feeding other circuit breakers), stub busbars shall be provided for the various conductors.

Equipment with a rating exceeding the current rating of 70mm² conductors shall be connected by means of busbars to the main busbars. Looped connections may only be installed for a maximum of two outgoing circuits. Where there are more than two outgoing circuits, busbars shall be used and equipment connected individually to the busbars. Where miniature circuit breakers are mounted in continuous rows and supplied by busbars connected to each MDB, each busbar shall be supplied by a separate conductor. This conductor shall be connected to the busbar by means of a separate lug and not via an MCB terminal.

Connections to circuit breakers, isolators or contactors shall be made by one of the following methods:

a) A ferrule of the correct size;
b) soldering the end of the conductor, or
c) winding a conductor strand tightly around the end to totally cover the end.

All conductors terminating on meters, fuse holders and other equipment with screwed terminals shall be fitted with lugs. The lugs shall be crimped to the end of the conductor. The correct amount of insulation shall be stripped from the end to fit into the terminal. Strands may not be cut from the end of the conductor.

Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SANS 60439, SANS 11195, BS 159 and BS EN 13601, where applicable.

Busbars shall be supplied for the following applications:

1. Distribution of supply voltage
2. Connection of equipment with ratings exceeding the current rating of 70mm² conductors
3. Connection of outgoing circuits with current ratings in excess of that allowed for 70mm² conductors
4. Collector bars for parallel cables
5. Connection bars for neutral conductors
6. Earth busbars
7. Connections to miniature circuit breakers

Busbars shall be rated for minimum 120% of the current rating of the circuit breaker or fuse controlling the current to such busbar, subject thereto that the fault current can be accommodated. The maximum acceptable current density for copper busbars is 1,5 A/mm² and 0,8 A/mm² for aluminium busbars. Busbars shall be installed on colour coded insulators of sufficient size and strength to withstand the fault current specified for that board without any damage.

4.11.3.4 Motor Control

Each motor shall be manually and individually controlled. Run and stop indication for each motor shall also be displayed, as well as trip.

Each motor shall also be protected by thermal over-current protection, as well as phase failure relays. Provision shall be made for telemetry monitoring of the motor status (i.e. run/stop, trip/healthy). Provision for telemetry shall be made by potential free relay contacts for the mentioned status of the motor and wired through a terminal block inside the kiosk. Also refer to the Telemetry requirements else ware in the document.

The normal operation of the four beach well pump motors will be 3 + 1 standby or in 22/24 hour cycles. Provision must be made for alternating the duty cycles and to adopt different duty cycles. The level of the raw water reservoir will determine stop and start signals for the pump motors. Staggered starting for the pumps must be provided as to limit the effect of the starting on the supply transformer.

Static Power Factor Correction must be provided for each pump motor.

All drawings of DB's/MCC's for motor control and distribution shall be submitted to the Engineer, prior to manufacturing, for approval.

4.11.3.5 Earthing

The external earth conductors shall be terminated onto the earth bar. Apart from the bolts required in the earth bar for earth conductors to be installed by the manufacturer, the earth bar shall therefore have at least two additional bolts to accommodate maximum 2 x 70mm² external earth conductors. One cable only will be allowed per bolt.

An earth stud with a diameter of 10mm shall be fixed onto one side of the steel frame on the rear side of the panel. The earth stud shall be connected to the earth bar by means of 1 x 35mm², green PVC insulated copper conductor.

The neutral busbar shall be connected to the earth bar by means of 1 x 35mm² green PVC insulated copper conductor.

All non-current carrying metal parts and equipment shall be suitably bonded to the earth bar.

4.11.3.6 Cable Clamping Facilities

Galvanised unistruts shall be provided at the bottom of the frame minimum 100mm above the top of the plinth to facilitate the clamping of cables. Separate unistruts shall be provided for supply cables at the back and for consumer cables at the front of the kiosk. Cables shall be secured to the unistruts by means of suitably sized K-clamps.

The unistruts shall have sufficient capacity to accommodate the following cables:

Supply cables	:	3 x 240mm², 4 core, PVC/SWA/PVC cables
Consumer cables	:	No of ways + 2 x 25mm², 2 core, PVC/SWA/PVC or Airdac cables

4.11.3.7 Identification Labels

All labels shall be engraved Traffolite labels and shall be fixed to the equipment panel with small brass wooden screws.

4.11.3.8 Danger Signs

Indelible danger signs for electrical apparatus shall be provided on each door of the DB's/MCC's. The danger sign (lightning arrow) shall be in accordance with the requirements of the Occupational Health and Safety Act, Act 85 of 1993 (as amended).

After curing, the inside of the components shall be finished to a smooth surface and coated with white coloured resin to seal off all the glass fibres.

The finished components shall be resistant to abrasion and accelerated weathering.

4.11.3.9 Padlocks

DB's/MCC's shall be locked with padlocks. The padlocks shall be purchased by the Contractor from the Local Supply Authority and installed as soon as the kiosks are installed on Site.

4.11.4 Workshop Drawings

The manufacturing of the electrical distribution boards shall only commence once the Engineer approved in writing the workshop drawings for such distribution boards.

Three paper prints of each workshop drawing shall be submitted to the Engineer. These workshop drawings shall indicate on a scale not smaller than 1:10 the following:

1. A complete wiring diagram of the equipment on the distribution boards.
2. Front view of distribution boards showing face panel layout, types and current ratings of switchgear and circuit numbers. External dimensions shall also be shown.
3. A typical section through the distribution board showing the relative positions of switchgear, busbars, gland plate, etc.
4. A complete list of the switchgear indicating the make, catalogue number, frame size and fault current rating for each.
5. All labelling information on a separate sheet.
6. Details regarding type and thickness of metal, paint finish, etc.

All workshop drawings for distribution boards will be approved by the Engineer subject thereto that such distribution boards shall comply with all the requirements of the Specification. The onus rests therefore with the Contractor to ensure that the distribution boards comply in all respects with such requirements of the Specification.

4.11.5 Site Conditions

The Contractor will be responsible to ensure that the distribution boards are suited to the actual Site conditions, such as:

i) Access route(s) for distribution boards (especially door heights)
ii) Final positions of distribution boards
iii) Maximum dimensions for distribution boards
iv) Number and sizes of sleeves and conduit
v) Termination and/or connection of sleeves, conduit and other wiring channels

vi) Permissible mass

4.11.6 Inspections

The Contractor shall notify the Engineer timeously of the completion of distribution boards by the manufacturer. A minimum of two (2) days' notice is required in respect of a proposed inspection date. Switchboards may be inspected by the Engineer at the manufacturer's factory prior to the despatching thereof to the Site.

The Contractor shall undertake the inspection of all distribution boards himself and shall ensure that the distribution boards comply with all the requirements of the Specification and with all the requirements with regard to the installation of the distribution boards on the Site. The Contractor shall be fully responsible for accepting the distribution boards from the manufacturer. Should any defects be found once the distribution boards have left the manufacturer's premises, the Contractor shall be fully liable for the cost to rectify such defects to the satisfaction of the Engineer.

The Engineer's inspection (if any) shall be regarded as a supporting effort to identify possible defects at an early stage so same can be rectified timeously. Under no circumstances will the Engineer approve distribution boards prior to the final inspection on Site and the official works completion hand-over of the completed Contract Works.

All distribution boards will therefore remain the full responsibility of the Contractor until the final handover of the completed Contract Works.

4.11.7 Labels

All switchgear protruding through the face plates of distribution boards shall be provided with permanent engraved labels. Wherever possible all switchgear and instruments shall be provided with labels describing the exact function of such switchgear and/or instruments.

Each distribution board shall be identified by means of an engraved label bearing a legend similar to the following:

"DB-A or DB-G"

In addition to the above all switchgear and equipment behind faceplates of distribution boards shall also be provided with engraved labels denoting the functions of such equipment. Labels at fuses shall denote inter alia fuse ratings.

All labels shall consist of engraved Ivorene or Trafolite material of suitable sizes. White lettering on a black background shall be used for all "normal" power labels. White lettering on a red background shall be used all "emergency" power labels.

All labels shall fit tightly into proper label holders welded or alternatively rivetted to the metal work. Alternatively labels may be secured directly onto the metal work. In the event of numbered labels, a suitable legend card frame or holder shall be provided to accommodate a detailed legend card. The frame shall accommodate the legend card and a transparent cover and shall allow the legend card to be removed easily. All legend cards shall be typed and shall identify the nature of the equipment connected to a circuit, as well as the circuit number.

4.11.8 Wire Numbers

All instrumentation, control and electrical wiring shall be installed in suitable wiring channels and each conductor shall be identified by means of its unique circuit number at both ends where such a conductor is connected. In the case of terminal strips, the terminals shall be labelled with corresponding numbers or alternatively their own unique numbers. Wiring channels shall be of adequate size to ensure that the collective cross-sectional area of all conductors shall not exceed 50% of the measured internal cross-sectional area of such wiring channels as per SABS requirement.

4.11.9 Equipment

The switchgear, instruments and other equipment to be provided on the distribution board shall be of the prescribed types. Wherever possible, equipment manufactured in South Africa and bearing the SABS mark of approval, shall be utilised.

Contractors shall base their tenders on the specific prescribed types of equipment specified. Should any of the prescribed equipment not be obtainable, the Contractor shall state so in his Tender and shall qualify the Tender with regard to the alternative equipment offered. Similar equipment used on all distribution boards shall be of the same manufacture.

All equipment to be utilised shall have a minimum fault current rating capacity of 5 kA unless specified otherwise.

Equipment shall be arranged and grouped in logical fashion as follows:

a) Main switch to be installed either at the top or bottom of the board
b) Short circuit protection equipment - fuse gear of fuse switches
c) Change-over contactors or other contactors controlling the supply
d) Motor supplies
e) Fuse switches for outgoing circuits
f) Other circuits and equipment

Where a portion of the equipment on the switchboard is supplied from a standby power source, the change-over contactor and the associated equipment shall be grouped in a separate compartment.

Where earth leakage units are required, the associated circuit breakers shall be installed adjacent to the unit.

All moulded case circuit breakers shall be flush mounted with only the toggles protruding. Miniature circuit breakers may be installed in clip-in trays mounted on the frame. All other circuit breakers shall be bolted to the chassis. Special provision shall be made for large main switches when designing the framework. Care shall be exercised that the rear studs of circuit breakers are properly insulated from the steel chassis. Where necessary, insulating material shall be installed between the rear studs and the chassis. Circuit breakers shall be installed so that the toggles are in the up position when “ON” and down when “OFF”.

All metering instruments shall be flush mounted in the front panel or door. The rear terminals of instruments mounted on doors shall be covered with an insulating material to prevent accidental contact. Current transformers for metering shall be mounted so that the rating plate is clearly visible. Fuses for instrumentation shall be mounted in an easily accessible position and clearly marked.

Fuse holders shall be mounted semi-recessed in the front panel so that fuses can readily be changed without removing the front panel. Busbar mounted fuses for instrumentation shall be used as far as possible.

Where equipment requiring fuses is specified on a board (fuse switches, etc.), a ruling shall be obtained from the Engineer on the quantity of spare fuses to be provided.

If the main switch is a moulded case circuit breaker or isolator it shall be flush mounted.

Contactors controlling the supply shall be installed behind separate front panels.

All metering, protection and indicating equipment shall be clearly visible from the front of the board. Current transformer ratios and multiplication factors shall be clearly marked. Where doors are specified the equipment shall be installed flush in the doors and covered.

All circuit breakers and fuses (with the exception of fuse switches) may be grouped together behind one or more panels.

Fuses or fuse switches providing back-up protection for circuit breakers, shall be grouped with the associated circuit breakers. Exposed surfaces of fuse switches shall be of the same finish and colour as the rest of the board where practical.

Where standby power from a diesel generator set or UPS is available and has to be connected to some of the equipment on a switchboard, the switchboard shall be divided into separate sections with sheet metal divisions to isolate standby power and mains power sections.

Standby, UPS normal supply shall each have its own incoming isolator or circuit breaker.

The equipment on the respective distribution boards is identified in the Specification and on the relevant drawings by means of abbreviations. The explanation of these abbreviations and further details regarding the distribution boards are specified in the Technical Schedules.

Switchboards shall be properly ventilated, especially when containing contactors, transformers, motor starters, lighting dimmers and other heat producing equipment. Louvres shall be fitted to provide adequate upward or cross ventilation. All louvres shall be vermin proofed with 1,5mm brass mesh or perforated steel plate internally spot welded over the louvres. The internal ambient temperature shall not exceed 40°C.

4.11.10 Wiring Terminals

Terminal bodies and screws shall be of non-corrosive metal, enclosed in fire resistant, moulded plastic insulating bodies. Terminal bodies or screws shall not project beyond the insulating material and shall afford suitable protection against accidental contact by personnel and against short circuits and tracking.

The construction of the terminal block and mounting rail shall be such as to ensure a firm and positive location of the terminal blocks. It shall be possible to add additional terminal blocks within the terminal sequence without having to disconnect or dismantle the terminal strip. The terminal blocks shall be held in position by means of standard end clamps.

It shall be possible to intermix terminals of various sizes, ie. for different sizes of conductors, whilst utilizing the same mounting rail. Where smaller terminal blocks occur adjacent to larger terminal blocks, suitable shielding barriers shall be inserted to cover the terminals that might otherwise be exposed.

The terminal bodies and clamping screws shall be so constructed as to ensure that conductors are not nicked or severed when the clamping screws are tightened. Screws shall not come in direct contact with the conductors.

Terminals shall be sized and rated to match the conductors that are connected to them.

Each terminal block shall have provision for clip-in numbering or labelling strips to be installed, together with protective, clear caps over the sheets.

4.11.11 Installation

The distribution board shall be installed with the top of the board 1,8m above the finished floor level.

A metal cable channel with removable metal cover plate shall be installed by the Contractor and shall extend from the line shop distribution board to the floor or into the ceiling void as required. The channel shall coincide with the position of sleeves, where installed.

The cable channel shall be large enough to permit the installation of cable glands and future cables.

The colour of the channel cover shall match that of the associated switchboard.

Where cables in floor trenches are connected to wall mounted switchboards, approved sleeves or conduits shall be installed from the side of the trench to the bottom of the switchboard. These sleeves shall be positioned and

fixed.

Where conduits from a distribution board run into a false ceiling space above the board, a minimum of two 25mm and two 20mm spare conduits shall be installed into the ceiling space immediately above the board.

Where underground cables are to be connected to distribution boards, it shall be the responsibility of the Contractor to ensure that sleeves are built in correctly to enable installation can connection of the cable to the switchboard.

4.11.12 Additional Equipment Specifications

4.11.12.1 Kilowatt-Hour Meters

Unless specified to the contrary, kilowatt-hour meters are to be suitable for operation on 250/400V, 50Hz systems and to have no creepage reading under voltage fluctuation or no load.

The meter is to be of the digital type with recording memory capacity of up to 3 months.

The integrating period on maximum demand meters is to be 30 minutes, unless specified to the contrary.

Kilowatt-hour meters are to be graded and calibrated for the specific application to avoid the application of multiplication factors where possible. Where multiplication factors are unavoidable, this is to be clearly indicated in unit form and not a combination of several factors. Current transformer ratios must be incorporated in the factor.

Facilities for a security seal are to be provided on the fixing screws of the cover.

4.11.12.2 Instantaneous and Maximum Demand Ammeters

Ammeters are to be manufactured to the international standard and to be totally enclosed in robust insulated dust proof housings, suitable for flush mounting in a vertical position.

The ammeter is to have 100mm² dial with a clear scale showing the instantaneous current value and maximum demand mean current value on the basis of a 15 minute period, and is to be fitted with a residual pointer to indicate the maximum mean current value during any period between manual resetting.

Ammeters are not to impose a burden exceeding three V.A. at the current corresponding to full-scale deflection. Current transformers are to be manufactured to the international standard and be rated at 5VA and have a Class “C” accuracy. The current transformers are to have a short circuit time rating equal to that of the switchgear in which they are installed.

4.11.12.3 Voltmeters

Voltmeters are to be manufactured to the international standard. They are to be of the moving iron, spring controlled pattern totally enclosed in robust insulation dustproof housings, suitable for flush mounting in a vertical position.

The voltmeters are to have 100mm² dial scaled to suit the system voltage and having a suppressed zero. The nominal voltage must be marked with a red line.

The voltmeters are to be protected by HRC cartridge fuses and housed in suitable insulated fuse carriers with a panel-mounting base.

A rotary selector switch is to be provided to select the voltage between lines or between any line and neutral. The switch must be clearly marked to indicate which reading has been selected.

4.11.12.4 Moulded Case Circuit Breakers

- The circuit breakers shall comply with SANS 156.
- The continuous current rating, trip rating and rupturing capacity shall be as specified.
- The contacts shall be silver alloy and shall close with a high pressure wiping action.
- Where specified, the circuit breaker shall be capable of accommodating factory fitted shunt trip
- or auxiliary contact units or similar equipment.
- The operating handle shall provide clear indication of “ON”, “OFF” and “TRIP” positions.
- The mechanism shall be of the TRIP-FREE type preventing the unit from being held in the ON position under overload conditions.
- All moulded case circuit breakers in a particular installation shall as far as is practical be supplied by a single manufacturer.
- The incoming terminals of single pole miniature circuit breakers shall be suitable for connection to a common busbar.
- The circuit breaker shall have a rating plate indicating the current rating, voltage rating and breaking capacity.
- Extension type operating handles shall be provided for units of 600A rating and above.

4.11.12.5 Isolators

This section covers switches suitable for panel mounting for use in power distribution systems of 50Hz, 600V. Switches for motor isolation are included.

The switches are to be of the single- & triple-pole, on load, hand operated type. The switches are to have a high-speed closing and opening feature.

The switches are to be suitable rated for the continuous carrying, making and breaking of the rated current specified, as well as the through-fault current capacity as specified.

To distinguish the switches from circuit breakers the operating handles are to have a distinctive colour and/or the switch is to be clearly and indelibly labelled “ISOLATOR”.

All Isolators shall comply with the relevant parts of SANS 60947 (LV Switchgear and Control gear)

4.11.12.6 Earth Leakage Relays

- Earth leakage relays shall be single or three-phase units with a sensitivity of 30mA, with associated circuit breaker or on-load switch for use on 220/250V single phase or 380/433V three phase, 50Hz, supplies.
- The units shall be suitable for installation in switchboards in clip-in trays or bolted to the chassis.
- The earth leakage relay shall function on the current balance principle and shall comply with SANS 767 as amended, and shall bear the SABS mark. Integral test facilities shall be incorporated in the unit.
- Circuit breakers with trip coils used integrally with earth leakage units (two pole for single phase units and three pole for three phase units) shall comply with SANS 156.
- On-load switches used integrally with earth leakage units (two pole for single phase units and three pole for three phase units) shall comply with SANS 60947.
- The fault current rating of the unit shall be 5kA as required, when tested in accordance with SANS 156.

4.11.12.7 Contactors

Contactors are to be of the open or totally enclosed, triple or double pole, electromechanical operated, on load, air-break type suitable for 400V or 250V supplies.

Contactors are to have the following characteristics:

1. Enclosed coil, easily replaceable
2. A permanent air gap in the magnetic circuit to prevent sticky operation
3. Provision for quick and simple inspection of contacts; and
4. Clearly marked main and auxiliary terminals.

All parts must be accessible from the front.

Contactors that are not located in switchboards are to be housed in enclosures that comply with IP 54 of SANS 60529 (IP Code)

The current rating of the contactors is to be as specified for the circuit with a switching duty in accordance with the manufacturer's data plate, utilisation category ACI for lighting and power circuits and utilisation category AC3 for motor starting.

In addition to the required current carrying capacity and switching duty of a contactor, the contactor chosen for particular application is to be rated for the maximum through fault current allowed by the back-up protection devices at the point where the contactor is installed. Careful co-ordination of short circuit devices must take place.

All laminations of the magnetic system of the contactor are to be tightly clamped. Noisy contactors will not be accepted.

Non-current-carrying metallic parts are to be solidly interconnected and a common screwed earth terminal is to be provided. The contactor is to be earthed to the switchboard earth bar.

Latched contactors are to be provided with a trip coil and a closing coil. The contactor is to remain closed after de-energising the closing coil and shall only trip on energising the trip coil.

4.11.12.8 Cartridge Fuses and Fuse Holders

The following fuse and fuse holder types are acceptable for use in distribution and power systems:

a) A cartridge type fuse link which fits into a fuse carrier together with a fuse base with fixed terminals. The fuse can be removed by taking out the fuse carrier and then removing the fuse from the carrier.

b) A cartridge type fuse link which fits into a fuse base with fixed terminals. In this case a fuse puller is required to disengage the fuse from the base. These fuses are only acceptable on equipment imported with these fuses as a standard item. One puller shall be supplied for each board or box in which these fuses are used.

Re-wirable fuses are not acceptable and shall not be used.

Fuses shall normally be installed in moulded plastic fuse holders or rigid isolating barriers shall be installed between the fuses. Sufficient spacing to prevent accidental contact when inserting or withdrawing fuses shall be maintained. The covers or barriers shall be manufactured for the specific fuses to be used.

All fuses and holders used for distribution systems shall comply with the following standards:

SANS 60269 or BS 88
SANS 60946 (Relevant Parts)

Fuse ratings shall be accurate to within 5% of the published value for unused fuses and shall not vary significantly after long periods of service.

Fuses shall be derated for ambient temperatures above 25°C in accordance with the manufacturer=s recommendation. If no such recommendation exists, a derating factor of 1% per °C above 25°C shall be applied.

Time/current characteristics shall be chosen to suit the application:

Cable protection:	The fusing factor shall not exceed 1,5.
Motor circuits:	Time lag characteristic so that the starting currents will not cause deterioration of the fuse.

Capacitor circuits: Fuses shall be chosen to withstand a higher than normal full load current (1,5 times rates capacitor current) to allow for harmonics and shall not deteriorate due to the high transients at switch on.

Distribution systems: The total operating I5t let through by secondary (minor) fuses shall be less than that of primary (major) fuses in any specific branch.

It shall be ensured that the rupturing capacity of a fuse chosen for a specific application shall be adequate, both as far as short circuit current and applied voltage are concerned.

4.11.12.9 Indoor Surge Arrestors

Surge arrestors shall comply with the requirements of SANS 61643

Surge arrestors shall be suitable for installation at altitudes of up to 1800m above sea level.

The unit shall be contained within a thermoplastic or cast resin housing and all internal components shall be fully sealed in.

The unit shall be supplied complete with a galvanized steel mounting bracket for convenient mounting onto the metalwork or tray of a switchboard.

Alternatively, the unit shall be of the type which can be mounted into the clip-tray of a switchboard.

4.11.12.10 Current Transformers

Current transformers shall comply with the requirements of SANS 60044-1 with the exception of the required impulse test level.

Current transformers are to be of the ring-type and shall be suitable for the primary currents listed hereunder and their decimal multiples:

10, 12.5, 15, 20, 25, 30, 40, 50, 60 and 75

The preferred values are:

10, 15, 20, 30, 50 and 75

Current transformers shall have secondary ratings of 1, 2 and 5A, with 5A being preferred.

Current transformers shall have standard outputs of 2, 5, 10, 15 or 30VA as applicable in terms of the burden of the instruments and interconnecting wiring. The current transformer output shall match the actual instrument burden as closely as possible in order not to introduce unnecessary errors.

For metering applications, accuracy classes of 0.1, 0.2, 0.5, 1, 3 or are applicable. Where no accuracy class has been specified, the following table may be used as a guide:

Application	Primary Current	Suggested Class
Indicating Instruments	All	5
Metering Applications	Up to 200A	1
Metering Applications	200A to 600A	0.5
Metering Applications	600A and above	0.2

Where ring type current transformers are specified, the aperture shall not be unnecessarily large as accuracy is thereby reduced.

The classes for protection are 5P, 10P, 15P, 20P or 30P with 5P and 10P being standard.

Manufacturers shall supply the magnetisation curve details and saturation factors of each different transformer ratio.

All current transformers shall come complete with a label on which the following information is indelibly stamped:

- Manufacturer
- Serial number or type
- Rated primary and secondary current
- Rated frequency
- Rated output and accuracy class
- Highest system voltage
- Rated insulation level

Current transformers shall be capable of withstanding the dynamic forces resulting from the maximum through-fault current which may be encountered at the point where they are installed. The short time current rating of current transformers shall be at least equal to that of the associated circuit breaker.

Current transformers used in system voltages in excess of 660V shall withstand an impulse test level of 95kV. Impulse levels for current transformers used in system voltages up to 660V shall comply with BS 3938.

One protection current transformer of each type used in a contract shall be tested to confirm the estimated characteristics. The following results shall be submitted:

a) Magnetisation curve
b) Secondary resistance
c) Secondary leakage reactance, if not negligible or if required by the Department.

The power frequency, secondary to earth and over voltage inter-turn tests in accordance with BS 3938 shall be conducted on all current transformers. Impulse tests shall be conducted on all current transformers intended for use in system voltages in excess of 660V.

All current transformers are to be earthed through a removable link.

4.11.12.11Time Switches

Time switches shall be of single pole type, suitable for 220/250V systems, with contacts rated for the duty to be performed with a minimum rating of 15A. Contacts shall be of high quality material, e.g. silver plated or solid silver.

The clock is to be an electronic quartz clock with a rechargeable battery for a minimum of 24 hours reserve in case of mains failure. The time switch is to have, in addition to a weekend program, a 24 hour setting, with day and night indication that can be set to switch in 15 minutes steps.

An external manual bypass switch shall be provided to permit the circuit to be switched “ON” or “OFF” manually without affecting the operation of the time switch.

The time switch shall be housed in a dust-tight moulded plastic or metal case, consisting of a plastic clip-on front cover and a moulded plastic or metal base. Time switches to be used for surface mounting on walls shall be provided with a suitably positioned 20mm conduit knock-out.

4.11.12.12Photocells

The switches shall be used for the control of general and parking area lighting and shall be provided with switch contacts able to carry at least 15A. The current during no-load conditions may not exceed 50mA.

The units shall be suitable for 240V + 6%, 50Hz, single phase alternating current.

A time delay of no less than 60 seconds must be provided to prevent the unit from functioning due to short period changes in illumination. The unit must be effectively safeguarded against voltage surges by means of a suitable surge protector, which must preferably form an integral part of the unit.

The unit is to be of the wall mounting or panel type and be fitted into an approved polycarbonate bulkhead fitting, complete with a suitable bracket.

The cover of the unit is to be manufactured from a tough, durable material providing protection against tampering. The cover is to have good weathering properties. It is to be ultraviolet-resistant and not to deteriorate when exposed to sunlight for prolonged periods.

The units shall switch on when the light intensity drops to 54 lux + 20% and shall switch off when the light intensity again reaches 108 lux + 20%.

The positions of the switches as indicated on the drawings are provisional and the exact positions are to be confirmed with the Architect on site.

A by-pass switch enabling the lights to be turned on at any time must be provided.

4.11.12.13 Motor Control

Each motor shall be manually and individually controlled. Run and stop indication for each motor shall also be displayed, as well as trip.

Each motor shall also be protected by thermal over-current protection, as well as phase failure relays. Provision shall be made for telemetry monitoring of the motor status (i.e. run/stop, trip/healthy). Provision for telemetry shall be made by potential free relay contacts for the mentioned status of the motor and wired through to terminal blocks inside the MCC's.

Static Power Factor Correction must be provided for each pump motor.

All drawings of DB's/MCC's for motor control and distribution shall be submitted to the Engineer, prior to manufacturing, for approval.

4.11.12.14 Cable Clamping Facilities

Galvanised unistruts shall be provided at the bottom of the frame minimum 100mm above the top of the plinth to facilitate the clamping of cables. Separate unistruts shall be provided for supply cables at the back and for consumer cables at the front of the kiosk. Cables shall be secured to the unistruts by means of suitably sized K-clamps.

The unistruts shall have sufficient capacity to accommodate the following cables:

Supply cables:	3 x 240mm², 4 core, PVC/SWA/PVC cables
Consumer cables:	No of ways + 2 x 25mm², 2 core, PVC/SWA/PVC or Airdac cables

4.11.12.15 Control Push Buttons

Push buttons complying with the specifications and codes of practice shall be provided by a single reputable local supplier.

Standardized physical dimensions shall be used to enable interchangeability and illuminated push buttons shall also comply with the requirements of the signal lights.

Standardized colour coding shall be used in addition to button labelling:

- Start Button: Green
- Open Button: Green (O)

- Stop Button: Red
- Close Button: Red (I)
- Trip test button: Black
- Emergency Stop Button: Red with Yellow background
- Lamp Test Button: White
- Other Functions : Pale Blue

4.11.12.16 Indicator Lights

Indicator lights complying with the specifications and codes of practice shall be provided by a single reputable local supplier.

Standardized physical dimensions shall be used to enable interchangeability. Lamp replacement shall be from the front with a removable screw cap.

Standardized colour coding lenses shall be used in addition to button labelling: (Painted lenses shall not be acceptable)

Drive stopped with power available:	White
Drive running:	Green
Drive tripped:	Red
Emergency Stop Activated:	Yellow
Moisture:	Blue

Breaker, Isolator closed or abnormal state:	Red
Breaker tripped:	Yellow
Breaker, Isolator Open or ready state:	Green
Interlocking:	White
Other functions:	White

Indicator lamps shall have a lamp test facility from a single panel with a timer adjustable 0-5 minutes.

4.12 CONDUIT, WIRING CHANNELS, UNDERFLOOR DUCTING, POWER SKIRTING, CABLE TRAY AND OTHER WIREWAYS

4.12.1 General

Only one manufacture of conduit and conduit accessories will be permitted throughout the installation.

Bushes or grommets shall be provided at wiring entrances, exits and transitions in order to prevent damage to wiring insulation.

Where the capacity of a wireway is not covered in the regulations and standards, the combined overall cross sectional area of the conductors installed into such a wireway shall not exceed 40% of the interior cross sectional area of the wireway.

4.12.2 Elements to be Installed in Concrete Structures

Any element of the Contract Works to be installed within a concrete structure will be subject to the approval of the structural engineer. This requirement applies especially to conduit and/or sleeves to be installed in concrete columns, beams or slabs. The Contractor is advised to clarify the intended routes for conduit and/or sleeves with the structural engineer prior to the installation of such material. No claims for additional cost resulting from variations requested by the structural engineer, will be considered by the Engineer, unless the Contractor can prove that the variation was requested subsequent to approval being obtained for the original installation.

All conduits to dry wall partitions are to be run down from ceiling in preference to being cast into floor slabs.

4.12.3 Conduit and Accessories

4.12.3.1 General

The Contractor shall supply and install all conduit and accessories which may be required for this Contract Works. The respective drawings indicate mostly collective conduit, conduit for supply wiring to switchboards and few other conduits. The routes for such conduit are indicated schematically only and do not therefore specify the actual physical routes to be followed on Site. Conduits for individual circuits are mostly not shown at all on the drawings.

Contractors must ensure that general approval of the proposed conduit system to be used is obtained from the Engineer prior to the submission of their tender. Under no circumstances will consideration be given by the Engineer to any claim submitted by the Contractor, which may result from a lack of knowledge in regard to the requirements of this specification.

4.12.3.2 Types of Conduit

All conduits to be used in this Contract Works shall bear the SABS mark of quality.

Non-Metallic Conduit and Accessories

Non-metallic conduit and fittings shall conform with the requirements of SANS 10950.

White PVC conduit will be acceptable in general, except in the case of surface mounted conduit or exposed conduit which shall be galvanised in all cases. Conduit laid below the floor slab, shall be installed in a sand bedding with 50mm cover and only PVC conduit shall then be used.

Screwed Metallic Conduit and Accessories

All metallic conduits shall be manufactured of mild steel with a minimum thickness of 1,2mm for plain-end conduit and 1,6mm in respect of screwed conduit.

Conduits shall comply with SANS 11065 and shall bear the SABS mark.

All conduit shall be heavy gauge, welded or solid drawn, hot-dip galvanized or black enamelled, screwed tube.

Galvanized conduit shall be hot-dipped inside and outside in accordance with SANS 10763.

All conduit ends shall be reamed and threaded on both sides and delivered with a coupling at one end and a plastic cap on the other end.

All metal conduit accessories shall be of malleable cast iron or pressed steel with brass bushes in accordance with SANS 11065. Alloy or pressure cast metal accessories or zinc base alloy fittings are not acceptable. All fittings, whether galvanized or black enamelled, shall be fitted with brass screws.

The boxes shall be of the long spout pattern, manufactured of malleable cast iron or pressed steel and stove enamelled jet black or galvanized as required. The two cover fixing holes shall be diametrically opposite each other, drilled and tapped at 50mm centers.

Junction, draw-in and inspection boxes shall be of adequate size and shall be supplied with heavy gauge metal cover plates.

Boxes shall comply with SANS 11065.

All switch boxes and socket outlet boxes shall be manufactured of pressed galvanized steel of at least 1mm thickness. All boxes shall be fitted with the necessary lugs to suit standard flush mounted switches and socket outlets manufactured in accordance with SANS 10518 and SANS 11085.

Light switch boxes shall be 100 x 50 x 50mm with two 20mm knockouts on the sides, one 20mm knockout on the top, bottom, side and back.

Socket outlet boxes shall be 100 x 100 x 50mm with two 20mm knockouts each on the top, bottom, sides and back.

Switch and socket outlet cover plates shall comply with SANS 11084.

Earth clamps shall consist of copper strips at least 1,2mm thick and not less than 12mm wide secured with a brass bolt, nut and washers and shall be so constructed that the clamp will fit firmly to the conduit without any additional packing.

4.12.3.3 Installation of Conduit

The positions of switchboards, drawboxes, outlet boxes and circuits are indicated on the drawings. The Contractor shall design the actual conduit installation with the aid of the information given on the relevant drawings.

All accessories such as boxes for socket outlets, switches, lights, etc. shall be accurately positioned. It is the responsibility of the Contractor to ensure that all outlets are installed level and square, at the correct height from the floor, ceiling or roof level and in the correct position relative to building lines and equipment positions as specified. It shall be the responsibility of the Contractor to determine the correct final floor, ceiling and roof levels in conjunction with the Main Contractor. Draw boxes shall not be installed in positions where they will be inaccessible after completion of the installation. Draw boxes shall only be installed in inconspicuous positions when approved by the Engineer. This shall then be indicated on the “as-built” drawings.

Draw boxes shall be installed at maximum intervals of 15m in straight runs. All bends shall be made without heating the conduit or without reducing the diameter of the conduit. The inside radius of a bend shall not be less than five times the outside diameter of the conduit (refer to SANS 10142).

A maximum of two 90° bends or the equivalent displacement will be allowed between outlets and/or boxes.

The edges of flush mounted outlet boxes shall not be deeper than 10mm from the final surface. Spacer springs shall be used under screws where necessary.

All excess holes in draw boxes or other conduit accessories shall be securely blanked off by means of brass plugs to render the installation vermin proof.

Care shall be taken to prevent debris or moisture from entering conduits during and after installation. Conduit ends shall be sealed by means of a solid plug which shall be screwed to the conduit end. Conduits shall be cleaned and swabbed to remove oil, moisture or other debris that may be present before conductors are installed. Swabs shall not be attached to the conductors.

Each length of conduit shall be inspected for defects and all burrs shall be removed. All conduits that are split, dented or otherwise damaged or any conduits with sharp internal edges, shall be removed from site. The Contractor shall ensure that conduits are not blocked.

To ensure that all electrical conductors are easily withdrawable from conduits and to ensure that there are no joints in the conductors, the Engineer will have the right to have the conductors of any circuit removed at his discretion. If the conductors are found to have been damaged during the installation or removal or if joints are found, they shall be replaced and the cost shall be borne by the Contractor.

Conduit runs shall be kept as straight and as short as possible. In order not to delay building operations, the Contractor shall ensure that all conduits and accessories which are to be cast in concrete are placed in position in good time. The Contractor or his representative shall be in attendance when the concrete is cast.

Draw boxes, expansion joints and round ceiling boxes shall be installed where required and shall be neatly finished to match the finished slab and wall surfaces. Ceiling draw boxes shall be of the deep type. In hollow block slabs, rear-entry draw boxes shall be used. In columns where flush mounted draw boxes are installed, the conduits shall be offset from the surface of the column immediately after leaving the draw box.

Elbows for conduits of 32mm dia and smaller and sharp bends will not be allowed in concrete slabs.

Draw boxes and/or inspection boxes shall, where possible, be grouped together under a common approved cover plate, and must preferably be installed in passages or male toilets. The cover plate shall be secured by means of screws.

All conduits shall be installed as close as possible to the neutral axis of concrete beams, slabs and columns. The conduits shall be rigidly secured to the reinforcing to prevent movement towards the surface of the concrete.

All conduits, draw boxes, etc. shall be securely fixed to the shuttering to prevent displacement when concrete is cast. Draw boxes and outlet boxes shall preferably be secured by means of a bolt and nut installed from the back of the box through the shuttering. Fixing lugs may also be used to screw the boxes to the shuttering. Wire will not be accepted for securing boxes to the shuttering where off-shutter finishes are required. Where fibreglass shuttering is used by the Builder, the equipment shall be fixed to the steel only and no holes shall be drilled or made in shuttering. All draw boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.

Before any concrete slabs are cast, all conduit droppers to switchboards shall be neatly spaced and rigidly fixed.

Conduits will not be allowed in concrete floor slabs of boiler rooms (or boiler houses), laundries or other damp areas. All socket outlets and three phase outlets in damp areas shall be supplied from above with galvanized conduit and accessories.

As far as possible, conduits shall not be installed across expansion joints. Where this is unavoidable, a conduit expansion joint shall be provided.

In the event of conduit installed into slots cut into walls, the slots shall be deep enough to install the conduit flush with the surface of the bricks. The conduit shall be secured to the bricks prior to the plastering of the wall. In the event of conduit in ceiling spaces, such conduit shall be secured to the rafters or beams at regular distances not exceeding 2m.

Under no circumstances will conduit having a wall thickness of less than 1,6mm be allowed in screeding laid on top of concrete slabs.

The installation of conduits in floor screeds shall be kept to a minimum. Where conduits are installed in screeds, the top of the conduit shall be at least 20mm below the surface of the screed. Where the screed is laid directly on the ground, galvanized conduits shall be used. This ruling will always be applicable to the lowest floor of a building. A minimum distance of twice the outside diameter of the conduit shall be left free between adjoining conduits. Conduits shall be secured to the concrete slab at intervals not exceeding 2m. The Contractor shall ensure that conduits are not visible above the screed where the conduits leave the screed.

All draw boxes, conduits, etc. which are installed in concrete shall be cleaned with compressed air and provided with draw wires two days after the removal of the shuttering. Errors that occurred during the installation of the conduits, or any lost draw boxes, or blocked conduits shall be immediately reported to the Engineer by telephone and confirmed in writing in order that an alternative route can be planned and approved by the Engineer before the additional concrete is cast. Any additional cost shall be for the Contractor’s account.

Uncovered threading in steel conduit shall be avoided. Should open threading be unavoidable, such open threading shall be treated with lead oxide paint to prevent corrosion.

The open ends of conduit shall be protected at all times. The use of paper plugs will not be accepted. For steel conduit metal plugs or short sealed lengths of conduit shall be installed onto conduit ends. For PVC conduit the conduit ends shall be heated and then bent over and sealed.

Bending and setting of conduit must be done with special bending apparatus manufacture for the purpose and which are obtainable from the manufacturers of the conduit systems. Damage to conduit resulting from the used of incorrect bending apparatus or methods applied must on indication by the Engineer inspectorate staff, be completely removed and rectified and any wiring already drawn into such damaged conduits must be completely renewed at the Contractor's expense.

Conduits may not be installed closer than 150mm to pipes containing gas, steam, hot water or other materials, which may damage the conduits or conductors. Conduits may not touch pipes of other service installations in order to prevent electrolytic corrosion. Where this is unavoidable, cathodic protection shall be provided.

Conduit and conduit accessories used for flame-proof or explosion proof installations and for the suspension of luminaires as well as all load bearing conduit shall in all instances be of the metallic screwed type.

When any part of a non-metallic conduit system has to be connected to metal equipment or components (eg. switchboard, surface socket outlet or switch box, existing metallic conduit system, etc.), fittings and joints manufactured specifically for this purpose must be used. Non-metallic conduit must not be threaded to fit metallic connectors.

4.12.3.4 Surface Mounted Conduit

Wherever possible, the conduit installation is to be concealed in the building work; however, where unavoidable or otherwise specified, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

Conduits shall be firmly secured by means of saddles and screws and in accordance with SANS 10142. Where saddles are used to secure vertical lengths of conduit connected to surface mounted switch boxes or socket outlet boxes, the saddles shall be spaced so that the intervals between the box and the first saddle, between any two successive saddles and between the last saddle and the ceiling or roof are equidistant. Conduits shall be secured within 150mm before and after each 90° bend and within 100mm of each outlet box.

Conduit routes shall be carefully planned to avoid crossovers. Where a crossover is inevitable, one conduit only shall be offset to cross the other. Crossovers shall be as short as possible and shall be uniform. Alternatively, crossovers shall be installed in purpose-made boxes. This method shall be employed on facebrick walls and in other circumstances where required by the Engineer.

Parallel conduit runs shall be equidistant and saddles shall be installed in line. Alternatively, a special clamp may be used to secure all conduits in unison. In the case of conduits of different diameters, the latter method shall only be used if a purpose-made clamp designed to accommodate the various conduit sizes, is provided.

All surface mounted conduits and accessories shall be painted with two coats of a high quality enamel paint or as otherwise specified. The colour shall comply with the colour code specified for the installation or where no code has been specified, shall match the colour of the surrounding finishes.

In open roof spaces (no ceiling) conduits shall run along the wall plates and the rafters. The installation of conduits suspended between the rafters is not acceptable.

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1,5m by means of saddles screwed to the roof timbers for metallic conduit and 1m for non-metallic conduit.

Nails or crampets will not be allowed.

Under flat roofs in false ceilings or where there is less than 900mm clearance, or in instances where the ceilings are insulated with glass-wool or other insulating material impeding access, the conduit shall be installed in a manner which allows for wiring from below the ceilings.

Conduit runs from switchboards shall terminate in fabricated sheet steel draw boxes installed directly above or in close proximity to the boards. Refer to the specification for “CONNECTIONS TO SWITCHBOARDS”.

Spare conduits covering the total number of spare ways on switchboards, shall be provided between the boards and the roof draw box.

Where non-metallic conduit has been specified for a particular service, the conduit shall be supported and fixed with saddles with a maximum spacing of 450mm throughout the installation. The Contractor shall supply and install all additional supporting timbers in the roof space as required.

Only approved plugging materials such as aluminium inserts, fibre plugs or plastic plugs, etc. and round-head screws shall be used when fixing saddles, switches, plugs, etc. to walls. Wood plugs are not acceptable nor should plugs be installed in joints in brick walls.

Surface mounted conduit will only be accepted when specified or when written permission thereto was obtained beforehand from the Engineer. In the event that any conduit is omitted during the construction when such conduit was specified to be installed flush, the Contractor shall be liable for the cost involved to install such conduit flush at a later stage.

Conduits concealed above suspended ceilings are to be priced as a surface installation.

4.12.3.5 Chases and Builder's Work

Except where otherwise specified the Contractor shall be responsible for the builder's work concerned with conduits, outlet boxes, switchboard trays, bonding trays and the wall outlet boxes as well as the necessary chasing and cutting of walls and the provision of openings in ceilings and floors for light fittings and other electrical outlets. The Contractor shall notify the Contractor of his requirements and the responsibility lies with the Contractor to ensure that these requirements are met.

Electrical materials to be built in must be supplied, placed and fixed in position by the Contractor when required by the Contractor. The Contractor shall also ensure that these materials are installed in the correct positions.

Chases shall be made by means of an approved vacuum-type double blade cutting machine.

Under no circumstances shall face brick walls or finished surfaces be chased or cut without the written permission of the Engineer. Where it is necessary to cut or drill holes in the concrete structure, the prior permission of the Structural Engineer shall be obtained to ensure that the structure is not weakened.

4.12.3.6 Drawboxes

All drawboxes installed on the surface shall be of the galvanised type, except in the case of drawboxes which will be exposed to the external atmosphere in which case such drawboxes shall be of the weatherproof type. In all other cases the type of drawboxes shall match the type of conduit used.

The requirements of the SABS wiring code with regard to drawboxes in conduit runs shall be strictly adhered to. The positions of drawboxes provided by the Contractor as a result of long runs of conduit or excessive bends in conduit runs, shall be marked on the drawings to be used for the installation of conduit. The positions for such additional drawboxes will be subject to the Engineer's approval.

The Contractor's attention is drawn to the fact that special collective expansion joint drawboxes shall be used where conduit runs cross an expansion joint in the structure of a building. The draw boxes shall be installed adjacent to the expansion joint of the structure and a conduit sleeve, one size larger than that specified for the circuit, shall be provided on the side of the draw box nearest the joint. The one end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw box by means of locknuts. Such expansion joint drawboxes can be collective drawboxes for various circuits, but separate drawboxes shall be provided for the electrical, telephone and other services.

All drawboxes and outlet boxes to be installed in concrete ceilings shall be of the deep type. Where such drawboxes or outlet boxes are to be installed in coffer type concrete slabs, the boxes shall be installed in the centre of the upper surface of such concrete coffers. Wherever possible the associated conduit shall be installed along the ribs of the coffer structure.

All drawboxes installed in concrete shall be secured to the reinforcing steel with the open ends of such drawboxes flush onto the surface of the shuttering. The drawboxes shall be filled with wet paper to prevent concrete from entering the drawboxes.

Drawboxes installed in brick walls will not be accepted if the front edges of such drawboxes are more than 15mm below the final surface of the walls. Once installed, these drawboxes shall be filled with paper and tied with binding wire to prevent the inside of the drawboxes and conduit from being filled with dagha.

Drawboxes installed in ceiling spaces shall be secured to supporting wooden battens so that the open ends of such drawboxes shall be flat onto the upper surface of the ceiling boards where applicable. Drawboxes which are not flat onto the ceiling surface will not be accepted. The supporting wooden battens shall be installed by the Contractor to prevent the drawboxes from being moved away from the ceiling surface and to provide a supporting structure for the drawboxes where luminaires are installed onto such drawboxes.

Due to scale it is not always possible to indicate exact locations for drawboxes on drawings. The Contractor is required to use good judgement in the location of drawboxes. E.g. if a drawbox is required in the wall underneath a window, the drawbox shall be located in the centre of the window. In the event of a light switch above a socket outlet, the boxes shall be installed in a vertical line. Drawboxes installed adjacent to each other, shall be located next to each other at the same height. It is preferable that two bushes shall be installed as separators between adjacent drawboxes. Refer in this regard to the standard drawings.

4.12.3.7 Draw Wires

The Contractor shall supply and install corrosion resistant draw wires into all conduit and sleeves into which the Contractor will not install wiring himself. Such conduit and sleeves include inter alia the conduit and sleeves for the following services:

a) Telephone cable wireways
b) Intercom cable wireways
c) Fire detection and security equipment wireways
d) Conduit for future equipment
e) Spare conduit and cable sleeves

4.12.3.8 Spare Conduit for Future Extensions

The Contractor shall supply and install minimum 2 x 20mm diameter and 2 x 25mm diameter spare conduits from each switchboard to the ceiling space directly above it for future use. No wiring shall be installed by the Contractor into these spare conduits.

Conduits intended for future switches and socket outlets, shall terminate 40mm above the tie beams in roof spaces with more than 900mm free space. The conduit ends shall be threaded and fitted with a coupling and brass plug.

Conduit ends shall protrude 150mm from the concrete to facilitate the installation of future extensions above, below or to the side of the concrete slabs. All these conduits shall be connected to a draw box, which is cast into the concrete within 2m of the end of the concrete. Conduit ends shall be threaded and fitted with a coupling and brass plug. In cases where holes cannot be drilled through the shuttering to accommodate the conduit end, a deep draw box with rear entry may be placed over the conduit end.

Unused boxes for switches and socket outlets shall be covered with metal cover plates. Unused boxes for luminaires shall be covered with round galvanized metal cover plates, which fit tightly against the finished surface. The cover plate shall overlap the outlet box and recess.

4.12.3.9 Connection to Floor Standing Surface Mounted Switchboards

All conduit required to bring about connections into floor standing surface mounted switchboards, shall be connected to suitable lengths of 127mm x 76,2mm galvanised steel channels (OL 9 000 or equivalent) installed on the wall above the switchboard. The position of the channel on the wall shall be clarified with the manufacturer of the switchboard beforehand in order that a slot may be provided on the top of the switchboard in order that the wiring from the channel may be routed directly into the switchboard.

4.12.3.10 Inspections

The Engineer may at his discretion prefer to inspect conduit installations prior to the casting of concrete. Such inspections shall however be regarded as a preventative measure in an effort to locate problems in the conduit installations prior to the casting of concrete. Under no circumstances will the Engineer be liable for any shortcomings in the conduit installation which may possible have been overlooked during such inspections. The responsibility to ensure that all conduit installations are complete will be entirely the Contractor's. The Contractor shall notify the Engineer at least forty eight (48) hours prior to the time that an inspection by the Engineer may be required.

4.12.3.11 Abbreviations

A number of abbreviations are used in the Technical Schedule and on the Drawings to identify the various types of drawboxes and outlet boxes. The explanation of such abbreviations is specified in the Technical Schedules.

4.12.4 Wiring Channels

Wiring channels shall be manufactured of rolled sheet steel. The minimum thickness of the sheet steel shall be:

a) 1,6mm for ribbed channels with a maximum width of 42mm
b) 2,5mm for unribbed channels with a maximum width of 42mm
c) 1,2mm for channels with a width in excess of 42mm

The channels shall be finished as follows:

a) In coastal areas (under all installation conditions) -Hot-dip galvanized to SANS 10763 or epoxy powder coated
b) Cast in concrete - Pre-galvanized
c) False ceiling voids -Pre-galvanized
d) Vertical building ducts - Hot-dip galvanized to SANS 10763 or epoxy powder coated
e) Surface mounted in plant rooms, substations, service tunnels and basements - Epoxy powder coated or electro-galvanized
f) Damp areas, exposed to weather, underground runs in contact with earth - Hot-dip galvanized to SANS 10763 or epoxy powder coated
g) Undercover industrial applications - Hot-dip galvanized to SANS 10763 or epoxy powder coated

The abovementioned finishes shall apply unless specified to the contrary or approved by the Engineer. Hot-dip galvanized ducts shall be cold galvanized at all joints, sections that have been cut and at places where the galvanizing has been damaged. Powder coated ducts shall likewise be touched up at joints, cuts and damaged portions using methods recommended by the manufacturer of the channels.

All channels shall be supplied with cover plates.

Channels up to 127mm wide shall have snap-in cover plates of metal or PVC.

For channels wider than 127mm only metal cover plates shall be used.

The finish of steel cover plates shall be the same as the finish of the channels.

All accessories ie. hangers, brackets, etc. shall be purpose made and in general have the same finish as the channels.

Wiring supports shall be provided in order to prevent the wires falling out when cover plates are removed.

The ducting shall be manufactured of 2mm thick rolled sheet steel or rectangular tubing. Galvanized steel shall be used or shall be epoxy coated after manufacture.

Outlets shall be provided on a modular basis in the ducting to accommodate pedestal or recessed socket units. Tapped holes shall be provided to fix the pedestal units to the ducting.

Draw boxes at junctions of perpendicular ducts shall have removable barriers for wiring and shall be provided with a heavy gauge cover plate. Pedestals shall be manufactured of die-cast aluminium or pressed steel.

The finish of pedestals shall be epoxy powder coating of an approved colour.

The channel and cover shall be manufactured of 1mm thick rolled sheet steel, unless specified to the contrary.

The channel and cover shall be epoxy coated after manufacture.

Outlets pre-punched on a modular basis shall be provided to accommodate socket outlets or future socket outlets.

In addition to standard lengths, covers of 250mm length shall be provided for installation on building module lines.

The Contractor shall supply and install all wiring channels, underfloor ducting and power skirting as specified or as required for the cable, socket outlet and wiring installation including the necessary supports, hangers, fixing materials, bends, angles, junctions, T-pieces, etc. He shall further liaise with the Main Contractor to verify the position of holes and access routes through the structure and finishes.

The Contractor shall supply and install all hangers, supports or fixings for the channels. Channels up to and including 76 x 76mm shall be supported at maximum intervals of 600mm and larger channels at maximum intervals of 1m. Channel runs shall be carefully planned to avoid clashes with other services and to ensure that all covers can be removed after completion of the entire installation. Purpose made clamps, hangers, etc. shall be used as required. Where it is not possible to support the channels at the specified intervals, they shall be supported in a sound manner to the satisfaction of the Engineer.

All channels up to and including 127mm width shall have snap-in cover plates of metal or PVC. Cover plates for wider channels shall be of metal and shall be fixed by means of screws at suitable intervals to prevent warping. Cover plates shall be installed over the full length of the channels. Flush mounted wiring channels shall be fitted with overlapping metal cover plates with plastic edge trim to cover irregularities in the wall recess.

Adjoining lengths shall be aligned and securely joined by means of fishplates fixed by mushroom bolts, washers and nuts or connection pieces that are pop-riveted to both adjoining sections. All adjoining sections shall be rectangular and shall butt tightly. Covers shall fit tightly across the joints. Where channels cross expansion joints in the structure, suitable expansion joints shall be provided in the channels by means of fishplates pop-riveted or screwed to the channels on one side of the expansion joint and floating freely in the channel on the other side of the expansion joint.

All conductors in inverted cable channels shall be retained by means of metal clips or metal spacer bars at not more than 1m centres. Where vertical duct lengths exceed 5m, conductors installed in the channels shall be secured at intervals not exceeding 5m to support the weight of the conductors. Clamps shall be provided in suitable draw boxes for this purpose.

Conduit connections shall be terminated by means of two locknuts and a brass female bush. Where the channel is wide enough, conduit connections may be made by means of a conduit box and hole through the back or side of the channel. All holes through which conductors pass shall be fitted with bushes or grommets or shall be sleeved.

Bends and T-joints shall be constructed to ensure compliance with the allowable bending radii specified in SABS 0142, Appendix D in the case of PVC-insulated cables and conductors and shall comply with the relevant specification in the case of other cables. Burrs and sharp edges shall be removed and the inside edges of the joints shall be lined with rubber cement or other suitable rubberised or plastic compound to prevent laceration of the conductor insulation.

All cable channels shall be vermin proofed after installation. Holes shall be covered by means of screwed metal plugs or by means of metal strips, which are bolted, or pop-riveted to the channel. Wooden or other plugs which are driven into holes or other temporary plugs or covers are not acceptable.

Power skirting

Two or three compartment power skirting as specified shall be supplied and installed in the positions and according to the layouts indicated on the drawings.

The top compartment shall be used for power wiring and switched socket outlets, whilst the bottom compartments shall be for telephone and other light current services.

The power skirting shall be manufactured from 1mm (minimum) thick sheet steel or aluminium (as specified) in approximately 2,5m lengths.

The covers shall be manufactured in modular lengths, as specified in the Detail Technical Specification or otherwise 1m lengths and shall be secured to the wall channel by means of toggle or swivel nuts. Snap-in covers are also acceptable.

At the building module lines, covers of specified length or otherwise in 250mm lengths shall be installed, against which partition walls may be installed, thereby trapping these covers. The removable modular covers shall be installed between these “fixed” covers.

Each modular cover associated with the power compartment shall be punched and prepared for the installation of either a 13A or a 16A, 3-pin standard flush switched socket outlet, whether any is specified or indicated for that module or not. Where socket outlets are not installed, the punched holes shall be blanked off with a metal blanking plate, painted the same colour as the power skirting and installed at the back of the covers. These blanking plates shall be easily removable to permit future installation of socket outlets.

Unless otherwise specified, no provision shall be made on the covers of the telephone or light current services compartments for the installation of sockets.

Factory-made end covers shall be installed at the ends of all runs of power skirting. All internal and external blends or offsets shall be factory-made and shall be installed to provide a neat and workmanlike appearance.

Standard 13A or 16A, 3-pin flush mounted switched socket outlets (100 x 50mm nominal size) shall be supplied and installed in the positions indicated on the drawings and as specified in the Detail Technical Specification.

The switched socket outlets shall be secured to the channel by means of suitable brackets.

After installation of the modular front covers, they shall be screwed to the socket outlets to ensure proper alignment between the two components. Separate standard covers need not be provided for the socket outlets.

Conduits for the circuit wiring to the power skirting shall be installed in the floor slab and shall terminate in flush conduit or boxes, behind the power skirting and installed to match the height of the power, telephone and light current services compartments of the skirting.

The wiring/cables shall pass through large diameter holes cut in the rear of the power skirting. The holes shall be suitably bushes or trimmed to prevent damage to the wiring or cables.

Alternatively conduits feeding to the telephone compartment may be terminated in boxes facing upwards in the floor slab immediately below the power skirting, with suitable bushes or trimmed openings being provided through the bottom of the power skirting duct for the cables to pass through. (Applicable only where the power skirting occurs at floor level.)

Where a section of power skirting is interrupted by a doorway, bridging conduits shall be installed to interconnect the power skirting sections. Where conduits are not specifically indicated, a minimum of 1 x 32mm bridging conduit shall be installed for each of the power, light current and telephone compartments.

Prior to fitting front covers, the power skirting shall be thoroughly cleaned to remove all dust and rubble and damage to paintwork where this has occurred, shall be repaired.

4.12.5 Cable Trays

The Contractor shall supply and install all cable trays and/or ladders as specified or as required by the cable routes including the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces, etc. He shall further liaise with the Main Contractor for the provision of holes and access through the structure and finishes. The Contractor shall co-ordinate with other services to reduce delays and possible disputes.

Metal cable trays shall be manufactured from perforated rolled steel. Metal trays manufactured to the following standards shall be used:

a) Less than 150mm wide - 1,2mm minimum thickness with 12mm minimum return
b) 150mm to 457mm - 1,2mm minimum thickness with 19mm minimum return
c) 460mm to 610mm (heavy duty) -2,5mm minimum thickness with 76mm return

Metal cable trays and ladders shall be finished as follows:

a) In coastal areas - Hot-dip galvanized to SANS 10763 or epoxy powder coated
b) False ceiling voids -Electro-galvanized baked enamel powder coated
c) Vertical building ducts - Hot-dip galvanized to SANS 10763 or baked enamel epoxy powder coated
d) Plant rooms, substations, service tunnels, basements - Electro-galvanized baked enamel or epoxy powder coated
e) Damp areas, exposed to weather - Hot-dip galvanized to SANS 10763 baked enamel or epoxy powder coated
f) Undercover industrial application - Hot-dip galvanized to SANS 10763 or baked enamel epoxy powder coated

The abovementioned finishes shall apply unless specified to the contrary in the Detail Technical Specification. Hot-dip galvanized trays shall be cold galvanized at all joints, sections that have been cut and at places where the galvanizing has been damaged. Powder coated or enamel painted trays and ladders shall likewise be touched up at joints, cuts and damaged portions using spray canisters recommended by the manufacturer of the trays and ladders.

Horizontal and vertical bends, T-junctions and cross connections shall be supplied by the Contractor. The dimensions of these connections shall correspond to the dimensions of the linear sections to which they are connected. The radius of all bends shall be 1m minimum. The inside dimensions of horizontal angles or connections shall be large enough that the allowable bending radius of the cables is not exceeded. Sharp angles shall be 45° degrees if the cable route will allow the use thereof and if the cut edges have been filed and treated with cold galvanizing.

Cable tray supports shall consist of two steel hangar rods, at least 8mm in diameter, on both sides of the tray with a substantial steel cross-member on the underside of the tray and bolted to the rods. Alternatively, cable trays may be cantilevered from wall on suitable brackets.

Horizontal trays shall be supported at the following maximum intervals:

a) 1,2mm to 1,6mm thick metal with 12mm to 19mm return trays - 1m maximum spacing
b) 2,5mm thick metal trays with 76mm return - 1,5m spacing

In addition to the above spacing on the longitudinal run, trays shall be supported at each bend, offset and T-junction.

Joints shall be smooth and without projections or rough edges that may damage the cables. The Contractor will be required to cover joints with rubber cement or other non-hardening rubberised or plastic compounds if in the opinion of the Engineer joints may damage cables.

Joints shall as far as possible be arranged to fall on supports. Where joints do not coincide with supports, joints shall be made by means of wrap-around splices of the same material as the tray and at least 450mm long. The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray.

Splices as described above shall be provided at joints, which do coincide with supports if the loaded tray sags adjacent to the joint due to the interruption of the bending moment in the tray.

Trays shall be bolted to supports by at least two round head bolts per support. Bolts shall be securely tightened against the tray surface to avoid projections which might damage cables during installation.

Where installed on concrete or brick, the supports for cable trays shall be securely fixed by means of at least 2 heavy duty, expansion type anchor bolts. Cantilevered trays shall be supported by a minimum of two 6mm diameter expansion bolts per support.

It is the responsibility of the Contractor to ensure that adequate fixing is provided since cable trays that work loose shall be rectified at his expense. The fixing shall take into account site conditions that prevail during installation.

Where installed on vertical steelwork, cable trays shall be fixed by means of 6mm diameter bolts and nuts.

On horizontal steelwork, use may alternatively be made of “CADDY” type fasteners.

Horizontal trays shall in general be installed 450mm below slabs, ceilings, etc. to facilitate access during installation of cables.

Multiple runs shall be spaced at least 300mm apart unless a different spacing is specified in the Detail Technical Specification.

Metal trays and ladders are to be bonded to the earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape must be bolted to the tray or ladder where the electrical continuity cannot be guaranteed. These additional conductors or tapes must, in any event, always be installed in outdoor applications and in coastal regions.

Cables shall be installed adjacent and parallel to each other on the trays with spacings as specified in the Engineer's standard specification for "INSTALLATION OF CABLES" and snaked slightly to allow for expansion. Cables shall present a neat appearance and shall under no circumstances be bunched. Cables shall be clamped at maximum intervals of 3m when installed on horizontal trays and at maximum intervals of 600mm when installed on vertical trays.

4.13 POWER FACTOR CORRECTION EQUIPMENT

4.13.1 Enclosure

The power factor control panel must be part the MDB, which consist of a floor standing modular panel. Provision must be made for protected penetrations from one panel to the other for the mains cabling, as specified elsewhere. Enclosures must conform to IEC (international standard) specifications and be of multi modular cubicle design.

The cubicle must be suitably louvered to ensure adequate free air circulation and, for systems exceeding 200kVA, each section must be fitted with fans to assist air movement.

4.13.2 Main Isolator

The PFC panel must be fitted with a door interlocking triple pole on load isolator, suitably rated for the system fault level and to a capacity equal to 1,8 times the size of the sum of the full capacitor bank current rating. Preference must be given to a suitable fast acting high rupturing capacity circuit breaker instead of a fused unit. An auxiliary early break contact is to be fitted to the isolator to open circuit to all contactors in system.

4.13.3 Busbars

Busbars are to be copper, rated at 2,5 times the full load of the total current of capacitors, or at that of the circuit breaker feeding the PFC panel.

Also refer to requirements in the section for the Distribution Boards and Ancillary Equipment.

4.13.4 Contactors

Contactors are to be rated for AC3 category at 1,8 times of capacitor current. Two-pole switching is not acceptable and only a maximum of 60kV switching at any one time will be allowed. If contactors with inrush limiting resistors or inductances are installed, then the fuse rating may be reduced to 1,35 times the rated step current. These inrush limiting resistors must be moved automatically from circuit once the main contactor poles have closed.

Also refer to requirements in the section for the Distribution Boards and Ancillary Equipment.

4.13.5 Fuses and Fuse Holders

Only 3-pole din type or NS type fuse base and carriers, suitably rated, may be used. Each capacitor step is to be supplied only by one triple pole HRC fuse base, for short circuit protection. Busbar mounted fuse bases are preferred. A rating between 1,43 and 1,8 times the rated step current must be adopted. The fuses must be of slow blowing type owing to high momentary current at make.

Connecting cables must be designed for 1,5 times the rated current values, with bolt and nuts for wiring termination and to have barriers between phases.

Also refer to requirements in the section for the Distribution Boards and Ancillary Equipment.

4.13.6 Capacitors

Capacitors are to have a nominal voltage rating of 440V with the kVA outputs indicated also for 400 and 415V respectively. Only 3-phase capacitors, which are biodegradable, non-toxic and free of PCB and lead, are acceptable. Capacitors must have a high resilience to withstand harmonic interference. Not more than one capacitor in a single container is acceptable and it must be fitted on top with stud type terminals for wiring.
A minimum of 30mm must be allowed between capacitors when mounted. The capacitor's film must have a minimum thickness of 9 microns, with technical characteristics as detailed below.

Discharge resistors must be fitted to the capacitor terminals to reduce the voltage to 50V within 20 seconds.

Dielectric:	Metalised polypropylene
Frequency:	50Hz
Temperature range:	-40 to +45 degrees
Capacitance tolerance:	-5 to +10%
Losses:	<0.5 W/KVAr
Voltage overload:	1.1 Un
Current overload:	1.5 In
Test voltage between terminals:	4.3 Un DC
Test voltage between earth and terminals:	3kV Ac 1 minute
Specification:	IEC 70-70A, IEC 110, BS 1650, VDE 0560

Also refer to requirements in the section for the Distribution Boards and Ancillary Equipment.

4.13.7 Control Circuit Protection

This is to be a single pole rail mounted miniature circuit breaker.

4.13.8 Wiring

Inductance coils between the contactor and the capacitor of 5 turns of 40mm diameter must be installed.

All control wiring must be a minimum of 1,5mm panel wire, numbered on both ends of each wire. Capacities of the main cables shall be to the following minimum ratings.

1. 6mm wire - up to 30kVA capacitors;
2. 25mm wire - between 35 and 50kVA capacitors; and
3. 35mm wire - for 60kVA capacitors.

4.14 WIRING

4.14.1 Conductors for Wiring

The Contractor shall supply and install all conductors for wiring of the Contract Works. All conductors shall consist of 600/1000 V, PVC insulated, stranded copper conductors. All circuit wiring in conduit and trunking shall be PVC insulated stranded copper conductors to SANS 1507, 1000 V grade. A separate green PVC insulated or bare stranded copper earth conductor shall be run with every circuit to form the earth continuity system. The colours of PVC insulation material shall comply with requirements of the SANS 10142-1. The colours of PVC insulation material for conductors to be used for circuits with voltages below 231V shall be different in colour to those used for circuits with voltages of 231V up to 1000V.

The colours of conductors for wiring to two-way and intermediate switches shall preferably differ from the colour of phase conductors.

The following is an extract from the SANS 10142-1 specification giving the minimum sizes of conductors that shall be used throughout for the wiring of circuits, unless specified to the contrary on the Drawings. In general the Contractor shall ensure that the current carrying capacities of the conductors exceed the current carrying capacities of the circuit breakers protecting such circuits. In the event of the bunching together of wiring, the Contractor shall derate the current carrying capacities in accordance with the SANS 10142-1 specification and if necessary, select larger sizes.

Circuit type (Single phase)	Circuit breaker Rating (A)	Current Carrying Conductor Size (mm²)	Earth Conductor	
			Size (mm²)	Max length (m)
Lighting	15	1,5	1,5	50
		2,5	1,5	50
Socket outlets	20	2,5	1,5	60
		4	2,5	101

The Contractor's attention is drawn to the fact that only one circuit per final conduit run will be allowed. Conductors that are connected to different switchboards shall not be installed in the same wireway. This requirement is however not applicable on any of the specified collective conduit or collective trunking.

4.14.2 Installation

All unarmoured conductors shall be installed in conduits, cable channels (trunking) or power skirting and shall under no circumstances be exposed.

Common wireways will only be permitted for relatively light current carrying conductors such as lighting and socket outlet circuits. Heavy current carrying conductors such as feeders to distribution boards and large power points, must be installed in separate conduits or wireways.
All wireways shall be thoroughly cleaned and freed of all builders' sand, cement or other debris (if necessary by means of a high power vacuum cleaner) prior to the installation of wiring. Wiring shall not be installed in any wireway until the entire wireway has been completed, is dry and clean and until the building is in an advanced stage of completion.

When conductors are drawn through conduit, care shall be taken that they are not kinked or twisted. Care shall also be taken that the conductors do not come into contact with materials or surfaces that may damage or otherwise adversely affect the durability of the conductor.

All wiring in conduit and other wireways shall be of the loop-in system. No joints will be accepted in wiring, except when made at terminal points where the wiring is connected to equipment. The free ends of the wiring shall be sufficiently long to facilitate connections and alterations and shall not be less than 150mm in length.

The insulation of conductors shall only be removed over the portion of the conductors that enter the terminals of switches, socket outlets or other equipment. When more than one conductor enters a terminal, the strands shall be securely twisted together. Under no circumstances shall strands be cut off.

For wiring which may be subject to mechanical strain, the length of the earth conductor shall be such that it will not be subject to strain until after the failure of the strain relieving device and straining of the active conductor. Any strain relieving device shall not be live.

When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and then soldered or ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

One circuit only will be allowed in any final conduit, ie excluding collective conduit such as at expansion joint drawboxes. More than one circuit may be installed in trunking, underfloor trunking or power skirting if necessary, provided that all conductors belonging to the same circuit, including the neutral and earth conductors are secured together by means of ties or similar means apt to identify the conductors of one circuit from those of another at intervals of 1m. The conductors of separate circuits shall however remain separate to ensure that any given circuit can be withdrawn.

With the exception of three-phase outlets, circuits connected to different phases shall not normally be present at lighting, switch or socket outlet boxes. Where this is unavoidable, barriers shall be provided between terminals or connections of the various phases and the box shall be suitably labelled internally to indicate the presence of three-phase voltage on voltages exceeding 250V.

All wiring in the DB/MCC shall conform to the Wiring Code (SANS 10142-1). Wiring shall be neatly bound together and secured onto the equipment panel where required.

All connections shall be done with lugs of the correct sizes, bolted onto the equipment. Hydraulic crimping tools of the correct sizes shall be used. No connections will be allowed on the busbar insulator mounting bolts.

Internal wiring shall be of sizes with current carrying capacities in excess of the current rating of the circuit breaker connected thereto. All wiring shall be in the red, white and blue phase and black neutral colours.

A separate dedicated connection terminal strip must be provided for connecting the control and monitoring signals to the SCADA / telemetry equipment.

4.15 LUMINAIRE OUTLETS, SWITCHES, SOCKET OUTLETS AND OTHER EQUIPMENT

4.15.1 Luminaire Outlets

4.15.1.1 General

The conduit to all wall and ceiling surface mounted luminaires shall be terminated in a flush mounted standard 50mm round draw-in conduit outlet box. This conduit outlet box shall be adequately supported in an approved manner such that a mass of 1 kilogram could be permanently attached to the outlet box fixing cover screws, without appreciable deflection. Additional adequate timber beams may have to be provided to meet this requirement.

Every luminaire shall be adequately secured by not less than two suitable fixing screws and washers, screwed into the outlet box. Rustproofed steel screws shall be used.

All fluorescent luminaires shall be fixed at each end through the stand-off points with an additional fixing at the central outlet box. This additional fixing point shall be utilised for the purpose of providing a standby anchorage, but shall not be tightened up such as to distort the luminaire.

All outdoor mounted luminaires are to be connected via a bushed conduit end rather than mounted over a conduit box, to ensure the integrity of the waterproofing.

4.15.1.2 Installation

The mounting positions and heights of luminaires are as indicated on the drawings and shall be verified on site. All luminaires shall be placed symmetrically with respect to ceiling panels, battens, beams, columns or other architectural features of the space unless otherwise indicated. The layout, as shown on the drawings, shall generally be adhered to but any discrepancies or clashes with structural or other features must be referred to the Engineer before commencing of the installation.

Where provision has not been made for the fixing of luminaires, the Contractor shall supply the necessary supports, hangers, conduit extensions, angle brackets or any other fixing method approved by the Engineer.

The necessary hangers shall be provided where luminaires, which are of the non-suspension type, have to be fixed below false ceilings or roof slabs. The use of 20mm conduits fixed to the roof slab or ceiling is preferred. Provision shall be made for adjustments to enable the levelling of luminaires. Suspended conduits shall be fixed to the ceiling by means of screwed dome lids, bolts and nuts. Ball-and-spigot type dome lids shall be used where conduit lengths exceed 600mm. Wiring shall be installed in the conduit hangers.

In the case of tiled ceilings with exposed or concealed T-section supports, surface mounted luminaires shall be fixed only to the tiles by means of butterfly screws or bolts with nuts and washers. The tiles shall be suitably reinforced. Luminaires may alternatively be fixed to metal cross pieces resting in the ceiling tees. Drilling of holes in ceiling tees to support luminaires will not be allowed. Luminaires shall be fixed in neat relation to the ceiling layout.

In cases where fluorescent luminaires are installed in tandem, only one connection outlet shall be supplied per circuit. All luminaires shall be coupled to one another by means of nipples or brass bushes and locknuts to ensure that wiring is not exposed and that earth continuity is maintained. Luminaires on the same circuit may be wired through the channel formed by the luminaire bodies. In this case silicon rubber insulated conductors shall be used and internal connections shall be made at porcelain terminal blocks. “SCREW-IT” or similar connectors may only be used if prior permission is obtained from the Engineer. The wiring for any other circuits or outlets, even though these maybe in the same row, may not be installed through the luminaire bodies. The Contractor shall ensure that continuous rows are straight and parallel to the relevant building lines.

Where recessed luminaires are specified, the Contractor shall maintain close liaison with the ceiling Contractor. In the case of tiled ceilings, the luminaires shall preferably be installed while the metal supports are being installed and before the tiles are placed in position. The Contractor shall be responsible for the co-ordination of the cutting of ceiling tiles with the other Contractors concerned.

Surface mounted bulkhead luminaires shall not be screwed directly to conduit ends. The conduit shall terminate in a round draw-box at the top or rear of the luminaire. The PVC insulated conductors shall terminate in a porcelain terminal strip in the draw-box. Silicon rubber insulated conductors shall be installed from the terminal strip to the luminaire lamp holder. “SCREW-IT” or similar connectors may only be used if prior permission is obtained from the Engineer.

The central terminal of Edison Screw (E.S.-type) lamp holders shall be connected to the phase conductor and the screwed housing to the neutral conductor.

Luminaires may be suspended from metal roof trusses with the aid of “CADDY” or similar fasteners.

4.15.2 Flush- and Surface Mounted Switches

4.15.2.1 General

Switching of the lighting installation in general will be done using light switches as indicated on the drawings. These light switches shall be installed in 100x50x50mm conduit draw boxes which shall comply with the SANS 10163 shall bear the SABS mark. Where multiple switches are indicated in adjacent position, these switches shall be installed in the same conduit box provided they are fed from the same circuit.

Light switches where indicated shall in general be of the 16A 220/250V flush-mounted Crabtree or Clipsal type or similar and equally approved.

4.15.2.2 Installation

Light switches shall be installed 1,4m above finished floor level unless specified to the contrary. Mounting heights given shall be measured from the finished floor level to the centre of the switch.

Unless specified to the contrary, switches adjacent to doors shall be installed on the side containing the lock. If the position of the lock is not shown on the drawings, the position shall be verified before the switch box is installed. Switch boxes in brick or concrete walls shall be installed 150mm from the door frame.

Where several switches are required in one position, multi-lever switches in a common switch box are to be provided wherever possible. All circuits wired into this box must be on the same phase, in order that voltages in excess of 250V are not present in the box. Where it is not possible or practical to do this, barriers must be installed and a label prominently displayed within the box, stating that different circuits are present, and that voltages in excess of 250V are possible.

4.15.3 Flush- and Surface Mounted Switched Socket Outlets

4.15.3.1 Normal Switched Socket Outlets

All switched socket outlets shall be suitable for mounting in 100 x100x50mm or 100x50x50mm boxes, shall comply with SABS 164. These shall be of the standard round 2 pole and earthed pin type. They shall be rated at 16 Amp, 250 Volts, 50Hz, shall be shuttered and shall be switch socket outlets with the switch and the socket power outlet manufactured and assembled as one combined unit. The cover plates shall be fixed with chromium plate counter-sunk screws.

4.15.3.2 Dedicated Socket Outlets

These shall be of the standard round 2 pole and shaved earth pin type. They shall be rated at 16 Amp, 220/250V, 50Hz and shall be shuttered.

4.15.3.3 Unswitched Socket Outlets

These shall be 5A, 220/250V, 3-pin socket outlets intended for the connection of recessed light fittings installed in false ceilings. The socket outlet shall have shuttered live and neutral openings. The 5A socket outlets shall be suitable for installation in pre-punched wiring channels, deep round conduit boxes, 100x50x50mm or 100x100x50mm boxes.

4.15.3.4 Three-Phase Switched Socket Outlets

These shall be of the 380V, 5-pin type. The correct rating shall be as specified. The unit shall also be interlocked to prevent switching on if the plug top is not installed. The live terminals shall be shrouded and shall be completely safe with the plug top removed.

4.15.3.5 Watertight Switched Sockets

The housing of watertight switched sockets is to be of galvanized cast iron or die cast aluminium with watertight machined joints.

The switch is to have a porcelain base and a quick-acting spring mechanism and be rated at 16A.

The ON/OFF positions are to be clearly marked on the switch or housing.

The socket openings are to be rendered watertight by means of gasketed cover plates, which are screwed onto the body of the unit. The cover plates are to be secured to the body of the unit by means of a chain.

4.15.3.6 Installation

Switches and socket outlets shall be accurately positioned in accordance with the drawings. It is the Contractor's responsibility to ensure that all outlets are installed level and square, at the correct height from the floor and at the correct position relative to building lines and equipment positions as specified. It is the Contractor's responsibility to determine the correct final floor level and ceiling level in conjunction with the Main Contractor.

Where flush mounted switches or switched socket outlets are installed in special wall finishes e.g. wood or board panels, acoustic tiles or other cladding, etc. and where the wall finishes must be cut to accommodate the switch, it may be necessary to fix an escutcheon plate to the wall to cover the cut-outs. The escutcheon plate shall fit closely around the outlet boxes and shall be fixed independently of the boxes and cover plates. Bevelled cover plates shall be fixed to the outlet boxes and shall fit firmly against the escutcheon plate.

The sides of adjacent switches, plugs, push-buttons, etc. shall be parallel or perpendicular to each other and uniformly spaced.

Where switch or socket outlet boxes have been set deep, spiral type steel wire spacers shall be used to fix the yoke of the switch or socket. Outlet boxes are not to be recessed more than 20mm from the finished wall surface.

The cradles of switch socket outlets shall be labelled with nominally 20 mm diameter adhesive labels marked to identify the circuit number supplying the outlet.

4.16 LUMINAIRES

4.16.1 General

Provide luminaires, lighting equipment components and lamps for all lighting outlets.

Type of luminaires shall be as indicated by numbers on drawings and as herein specified.

Locations of luminaires on Electrical Drawings are diagrammatic. Verify location and spacing with Architectural Reflected Ceiling Plans and other reference data before installation. Co-ordinate space conditions with other trades before installation of fittings. Pendant mount, as approved, surface type fittings where required to meet space conditions. Examine existing conditions for variance from drawings and specifications.

Refer to Architectural Finish Schedules and Details for ceiling construction and furnish accessories to suit. Luminaire catalogue numbers do not necessarily denote specific mounting accessories for type of ceilings in which fittings may be installed.

Where plaster ceilings occur, supply plaster frames for setting under work of other Contract. Direct setting and be responsible for correct location; make sure the bottom of frame is flush with finished ceiling, forming screed edge for finished plaster. Luminaires shall be supported by plaster frames utilizing yokes or levelling lugs. Luminaires and supports shall have channel cross-section of approved gauge, and shall support fixture of means of not less than two bolts each. Submit sample if directed.

Lighting in Machine rooms, Duct Voids, Roof Voids, Mechanical Equipment Room and Fan Rooms is diagrammatic, indicating type, quantity and general circuiting of luminaires. Modify locations, mounting, and where necessary, type to suit conditions as approved or directed.

Install rows of luminaires accurately on straight lines unless otherwise indicated on drawings.

Luminaires shall be designed to provide sufficient ventilation of the lamps and ballasts. Outdoor luminaires with vent holes shall have wire mesh screens in the vent holes and preferably filter breathers to prevent ingress of dust and dirt.

Provide approved support for each luminaire outlet.

Pendant-mounted luminaires shall be supported by framework of ceiling or from inserts in slab.

For each wall bracket type luminaire provide flanged metal stem attached to outlet box, with threaded end suitable for holding luminaires. Flanged part of luminaire stud shall be of broad base type and secured to outlet box at not less than three points.

Wiring channels and lamp holder mountings shall be rigid and accurately made.

Lamp holders shall hold lamps securely against normal vibration and maintenance handling. Provide silver plated contacts in lamp holders for the following type of lamps:

- Edison base incandescent lamps
- Lamps in all outdoor luminaires
- Quartz iodine lamps

Reflector cones, baffles, aperture plates, diffusers and decorative elements of luminaires shall not be installed until completion of plastering, ceiling tile work, painting and the area has been cleaned.

Blemished, damaged or unsatisfactory luminaires shall be replaced in a manner satisfactory to the Architect and Engineer.

Provide labour and materials if necessary for final aiming of all adjustable luminaires under the Architect's supervision. Aiming shall take place immediately before building is turned over to the Employer, after regular working hours where required.

In adjustable luminaires, indicate aiming and locking devices.

In luminaires using lamps with asymmetrical beams, indicate lamp adjustment devices to assure permanent orientation of light beam unaffected by re-lamping.

All luminaires and lamps supplied under this Contract will be new and unused when delivered to Site.

When luminaires require circuits more involved than simple wiring, the supplier shall submit wiring diagrams to the Engineer for approval at least 4 weeks prior to installation.

Luminaires exposed to the weather shall be anodised or die cast aluminium, stainless steel, or equivalent. All screws or fixings to be stainless steel. Indoor luminaires shall be baked enamel, epoxy coated or anodized except as otherwise individually specified.

No luminaires shall have rough edges anywhere which may be liable to cause damage or injury. All edges shall be finished smoothed and painted as specified.

Every corner on each luminaire shall be cut to a radius.

Adequate numbers of knock-outs are to be provided for wiring and installation.

4.16.2 Fluorescent Luminaires

4.16.2.1 General

The luminaires shall comply in all respects with the requirements of SANS 11119 - 1976 and shall bear the SABS mark.

The luminaires and associated lamps, auxiliaries etc., will be required to operate under the following service conditions:

- Altitude 50m above sea level
- Relative Humidity up to 80 %
- Ambient Temperature 5°C to 45°C
- Service Voltage 230 Volts to 10 Volts

4.16.2.2 Construction

The luminaires shall be of simple but robust design and construction and shall each comprise a body section accommodating the ballast, starters, internal wiring, insulated and earth terminals, lamp holders, reflectors, frame and diffuser.

The body shall be substantial in design and shall be of not less than 0,8mm cold rolled sheet steel, suitably braced to ensure rigidity and robustness.

The luminaires shall be designed and constructed with adequate ventilation for the auxiliaries, ballasts, etc. which shall not be visible from the lamp compartment.

All ferrous parts shall be treated with a de-greasing agent and then zinc phosphate dipped. Finishing coats shall comprise a minimum of two applications of powdered polyester before baking. All paintwork, inside and out, shall be not less than 40 microns thick.

The channel section in which the ballasts, starters, control gear, terminals, etc., are located shall be accessible to provide ease of maintenance. The section shall be complete with knockouts, earthing terminal and 660 Volts insulated line connection block.

Internal wiring brackets shall be provided.

A substantial earthing terminal shall be securely attached to each luminaire body.

All chokes shall have terminal blocks for ease of maintenance.

Starter switches shall be suitable for the operation of the fluorescent tubes and shall comply with BS 3772 - 1975. Starters shall have R.F. and arc suppression capacitors.

4.16.2.3 Internal Wiring

The internal wiring shall be by means of high quality cables not subject to deterioration. The low voltage wiring shall not be less than 660 Volts grade and in the case of high voltage wiring the continuous voltage grade must be suitable for the open circuit voltage of the ballast.

All internal wiring between the terminal block, ballast, control gear and lamp holders shall be carried out in a neat and orderly manner. All internal wiring shall be harnessed where runs of more than one conductor occur.

Joints in the internal wiring shall be avoided as far as possible and where necessary shall be either soldered or by means of insulated brass connectors to withstand the full test voltage of the insulation of the associated wiring and cables.

4.16.2.4 Ballasts

Ballasts shall be single or two lamp type, totally enclosed, metal clad, sealed type complying with SABS 890 - 1977 and shall be power factor corrected to at least 0,95 at rated load. Ballasts shall be especially designed for use with lamps specified, under the service conditions mentioned above.

Control gear shall be of the switch-start type.

Low-Loss Ballasts

The power consumption must not be more than 8W for 65/58W ballasts and 6W for 40/36W ballasts.

The temperature rise of the winding must not be more than 35°C under normal, and not more than 60°C under abnormal operating conditions. (Abnormal operating conditions mean - the ballast is connected to its rated supply voltage and load with a 40 ohm resistor (40/36W ballast) or a 25 ohm resistor (65/58 ballast) instead of a lamp.

The power output of the ballast must not be less than 99% of the output yielded by a reference ballast when operating a reference lamp.

Low-loss ballasts must carry a 10-year guarantee.

4.16.2.5 Electronic Ballasts

The ballast must be a totally enclosed electronic unit (similar or equal to Econolite or Osram) and must have an efficiency of at least 95% and corrected power factor of 0,98 lagging. The ballast is to be designed for silent operation with filters for interference. No visible flicker of light may be apparent and no dark and bright zones may occur anywhere along the length of the lamps.

4.16.2.6 Lamp Holders

All lamp holders shall be suitable for T12 Bi-Pin lamps and shall be moulded from white impact-resistant polycarbonate.

Contacts are to be brass with electrical connections of the push-in/type.

4.16.2.7 Lamps

The lamps shall be suitable for spring loaded type holders and the colour shall be cool white except as noted. Locally manufactured lamps to SANS 11041 are acceptable for this Contract.

All lamps supplied shall be cool white “triphosphor” (colour 21) and shall be of the 26mm diameter type.

4.16.2.8 Diffusers

Where diffusers are called for, the diffuser shall consist of a glare-limiting, one-piece, injection-moulded acrylic prismatic lens, except as noted. The lens shall be housed in a tip-up, regressed hinged frame or as specified or detailed.

The sub-frame housing the diffuser shall be constructed from white painted steel plate reinforced or shaped to prevent sag or distortion of the diffuser panel. Leakage of light between the frame and diffuser is unacceptable.

4.16.2.9 Photometric Data

The suppliers shall submit complete photometric data of each luminaire offered.

The photometric data shall be compiled from tests conducted by an approved body on the Manufacturer's behalf, and shall be a true certified copy of the actual test performance of a sample luminaire. Where SABS test sheets are called for, these shall override any other test data.

4.16.3 Incandescent Luminaires

Housing: 0,8mm gauge steel unless otherwise noted, bonderized or equal, rust-protected or aluminium where specified, rigid construction. Baked enamel finish; concealed surfaces - matt black visible surfaces or colour and texture as selected by Architects.

Reflector: Minimum 85% reflectance.

Reflector cone (baffle) aluminium or approved equal, colour and texture as selected by Architect. Plastic materials shall not be used for reflector cones or aperture plates. Fixtures in which reflector cones are rivetted or welded to housing or where removal of cone requires pressure to be applied to finished surface of reflector, will not be accepted.

Lens: Louvred type, except as noted; colour as selected by Architect.

Lamps: All incandescent luminaires and lamps supplied shall be Edison screw fixing and lamps shall be Argenta or "Pearl" type.

4.16.4 Luminaires

The Contractor shall make provision for the installation and connection of all the luminaires. A PC sum for the supply of luminaires has been allowed.

4.16.5 Discharge Luminaires

4.16.5.1 Construction

The body shall be substantial in design and shall be of not less than 0,8mm cold rolled steel sheet suitably braced, or of cast alloy with minimum section thickness 1,5mm.

The luminaire shall not comprise more than two enclosures. Where two enclosures are necessary the connecting wiring shall be protected by flexible steel or aluminium conduit. All control gear and wiring shall be totally enclosed.

All ferrous parts shall be treated with a degreasing agent and then zinc phosphate dipped. Finishing coats shall comprise a minimum of two applications or powdered polyester before baking. All paintwork, inside and out, shall be not less than 40 microns thick.

The control gear enclosure in which the ballasts, starters, control gear, terminals, etc., are located shall be accessible to provide ease of maintenance. The section shall be complete with knockouts, earthing terminal and 660V insulated line connection block.

Internal wiring shall be securely saddled. Suitable strain relieving devices shall be provided for all wires leaving the enclosure.

All ballasts or chokes shall have terminal block connectors to simplify maintenance.

Enclosures shall be IP 22 for indoor use and IP 45 for exterior use.

4.16.5.2 Internal Wiring

The internal wiring shall be by means of high quality flexible stranded cables not subject to deterioration. The low voltage wiring shall not be less than 660V grade and in the case of high voltage wiring the continuous voltage grade must be suitable for the open circuit voltage of the ballast.

All internal wiring between the terminal block, ballast, control gear and lamp holders shall be carried out in a neat and orderly manner. All internal wiring shall be harnessed where runs of more than one conductor occur.

Joints in the internal wiring shall be avoided as far as possible and where necessary shall be either soldered or by means of insulted brass connectors to withstand the full test voltage of the insulation of the associated wiring and cables.

4.16.5.3 Lamps

Low Pressure Sodium - Rated lamp life shall be 18 000 hours or more based on a five hour per start burning cycle

Mercury Vapour - Unless otherwise specified only Deluxe white phosphor coated lamps shall be supplied - No self-ballasted systems will be considered

Metal Halide - Unless otherwise specified lamps with phosphor coating shall be supplied - Lamp/lamp holder combinations are to incorporate a locking pin device to ensure proper position of the arc-tube when in use

- Lamp manufacturer's data is to be provided to confirm that the burning position in the luminaire being offered is the correct one.

4.16.6 Compact Fluorescent Bulkhead Luminaires

Internal wiring must be carried out in high temperature silicone covered copper conductors and the control gear must be similar as described for fluorescent light fittings above.

Clear polycarbonate diffusers are to be used and each lamp is to be fitted with separate control gear and to comply with the international standards operating voltage 250V minimum.

4.17 EARTHING

4.17.1 General

The Contractor shall supply and install the complete earthing installation. The entire installation shall be properly and effectively earthed and bonded as prescribed in the Wiring Code (SANS 10142: 1993), AMEU: Code of Practice for the Application of Neutral Earthing on Low Voltage Distribution Systems, and in the Specification.

All earth conductors shall be stranded copper with or without green PVC insulation. The conductors shall comply with the technical specification for “PVC INSULATED CABLES”. All earth conductor sizes shall be determined in accordance with SANS 10142, where the earth does not form an integral part of the cable.

In general the following equipment shall be provided with separate earth installation, i.e. not just connected to other earth installations. The detail requirements for each of the following installations are specified below:

a) Main Earth
b) Telkom Earth

The following requirements apply in general:

A separate earth bar shall be provided for each of the transformers, stand-alone MV switchgear and main distribution boards. All other earth conductors shall be connected to the earth bars by means of bolts, nuts and washers.

Iron, lead and zinc shall not be used in direct contact with copper earth bars or conductors. Suitable bi-metallic or stainless steel connectors shall be employed wherever such a connection is required.

Jointing of lengths of earth conductor and T-off's therefrom shall be performed by means of suitable crimping ferrules. An overlap of minimum three times the width of the conductor shall be used to ensure proper contact. Where lug are used for connecting earth conductors, care shall be taken to ensure that the lugs are matched in size to both the conductors and the bolts they have to be connected with. Oversize lugs will not be accepted. The lug shall be crimped onto the conductor with an approved hydraulic type crimping tool. The lugs shall be so positioned on contact surfaces that the full contact area of each lug is in contact with the contact surface.

Wherever an earth conductor is looped from one piece of equipment to another, the conductor shall not be cut at or in between the pieces of equipment. At each connection point, the conductor shall be bent into a U-shape and the lug crimped onto the U-section. This will ensure that the continuity of the earth conductor is maintained even when the earth conductor has to be removed from the connection point of any individual piece of equipment. Wherever an earth connection is required to be made onto a painted surface, the paint shall be removed over a minimum, but sufficient area to ensure good contact between the lug and the surface. Exposed areas where paint has been removed, shall be coated with petroleum jelly before bolting on lugs. Once the lug is bolted on, any exposed area not covered by the lug shall be treated against corrosion and then painted to match the quality and type of finishing on the adjoining surfaces.

Cadweld spikes shall be minimum 2,4m long x 16mm in diameter and shall be driven into the ground until the tops are minimum 500mm below the final ground level. The earth conductor shall be clamped to the earth spike with a suitable Cadweld clamp.

Conductor clamps shall be provided to suit the type and size of rods provided and the type and size of conductor specified.

The material of the clamps shall be electrolytically compatible with the rod and conductor materials.

Where brazed or welded connections are specified, the supplier of the rods shall stipulate at least two types of metals which are compatible with the rod and conductor materials.

An adequate number of driving caps or bolts shall be supplied with the rods to protect the ends of the earthing rods whilst being driven into hard soil.

On completion, every earth installation shall be tested and the earth resistance reading recorded. The tests shall be witnessed by the Engineer or the Local Supply Authority.

All screws, bolts, nuts and washers to be used, shall be stainless steel.

Under no circumstances shall connection points, bolts, screws, etc. used for earthing be utilised for any other purpose. It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on equipment and materials that must be earthed where these are not provided. Unless earth conductors are connected to proper terminals, the ends shall be tinned and lugged. Lugs may be crimped, using mechanical or pneumatic tools designed for this purpose, on condition that evidence is submitted that the method used complies with the performance requirements of BS 4579, Part 1: “Compression Joints in Copper”.

All screws, bolts, nuts and washers to be used, shall be stainless steel.

4.17.2 Substation

An earth resistance of maximum 1 ohm is required, measured with all contributing earth wires connected to the earth bar.

3 x 30m lengths of 70mm² bare copper earth conductors shall be connected to the earth bar, one on the MV and one on the LV side of the transformer and shall be installed together with the cables running in the trenches and opposite directions from the transformer. If the earth resistance as measured should prove to be more than 2 ohm, one or more 2,4m long Copperweld earth spikes shall be installed and connected to the earth bar by means of 70mm² bare copper conductors.

4.17.3 Medium Voltage Cable

The cable armouring shall be connected to the earth bar of the equipment at each cable termination. Where jointing between lengths of MV cable occurs, the cable armouring of both cables shall be effectively connected.

4.17.4 Switchboards

A separate earth connection shall be supplied between the earth busbar of the main switchboard and the earth busbar of every sub-switchboard. These connections shall consist of bare or insulated stranded copper conductors installed along the same routes as the supply cables or in the same conduit as the supply conductors.

An earth resistance of maximum 10 Ohm is required, with all contributing earth wires connected to the earth bar.

4.17.5 Sub-Circuits

The earth conductors of all sub-circuits shall be connected to the earth busbar in the supply switchboard in accordance with SANS 10142.

All 16 Amp socket outlets, fluorescent and mercury vapour light fittings, fixed heater and hot water cylinders shall be earthed by means of 2,5mm² green PVC insulated copper conductors.

4.17.6 Ring Mains

Common earth conductors may be used where various circuits are installed in the same wiring channel in accordance with SANS 10142. In such instances the sizes of earth conductors shall be specifically approved by the Engineer. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

4.17.7 Low Voltage Cable

The cable armouring shall be bonded to earth at every termination of the cables. A third (1/3) of the armouring of each cable end shall be twisted together, crimped into a suitable lug and then bolted to the earth bar or earth connection point. A separate earth wire shall be installed together with the service connection cables, general area lighting circuits, etc. and connected to the earth connections at both ends of the cable. Size as indicated on the relevant drawings.

Where armoured cable is used, an earth conductor is to be installed with the armoured cable. If green PVC insulated conductors are available in the specified earth conductor sizes, it must be installed in preference to bare copper conductors.

4.17.8 Telkom Earth

A dedicated Telkom earth connection shall be provided at each Telkom distribution board. An earth resistance of maximum 3 Ohm is required.

The Contract shall supply and install a 10mm2 green PVC insulated earth conductor from the main Telkom drawbox to a 2,4m Cadweld earth spike. The earth conductor shall be installed in a 20mm dia PVC conduit between the main drawbox and the earth spike.

4.17.9 Non-Metallic Conduit

Stranded copper earth conductors shall be installed in the conduits and fixed securely to all metal appliances and equipment, including switch boxes, socket outlet boxes, draw boxes, switchboards, luminaires, etc. The securing of earth conductors by means of self-threading screws will not be permitted.

4.17.10 Flexible Conduit

An earth conductor shall be installed in all non-metallic flexible conduit. This earth conductor shall not be installed external to the flexible conduit but within the conduit with the other conductors. The earth conductor shall be connected to the earth terminals at both ends of the circuit.

4.17.11 Water Pipes

Metal cold water mains shall be bonded to the earth busbar in the main switchboard by solid 15 x 2mm copper strapping. All other hot and cold water pipes shall be connected by 12 x 0,8mm perforated or solid copper strapping (not conductors) to the nearest switchboard. The strapping shall be fixed to the pipe work by brass nuts and bolts against walls be brass screws at 150mm centres. In all cases where metal water pipes, down pipes, flues, etc. are positioned within 1,6m of switchboards, an earth connection consisting of copper strapping shall be installed between the pipe work and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each switchboard.

Water earthing must consist of a 10mm² copper wire connected from the distribution board to the nearest water pipe in the roof area.

Iron roofs, gutters, downpipes, etc. are to be interconnected in the same way. Iron roofs are to be connected at intervals not exceeding 15m by means of a 10mm² bare copper wire. The common earth conductor is to be installed under the roof, over its full length and to be firmly fixed to the upper purlin. It is to be bonded to the main earth conductor of all distribution boards.

4.17.12 Earthing in Accordance With the Wiring Code

In addition to the above measures for earthing, the Contractor shall supply and install all other earthing measures as required by the Wiring Code, SANS 10142.

4.18 EXCAVATIONS

4.18.1 Trenching

4.18.1.1 General

The Contractor will be responsible for all excavations and backfilling. The Contractor will be responsible to ensure that trenching and backfilling are done in accordance with the requirements of this Specification. The Contractor will also be responsible for the supply and installation of bedding sand and danger tape.

The Contractor shall, before trenching commences, familiarise himself with the routes and Site conditions and the procedure and order of doing the work shall be planned in conjunction with the general construction programme for other services and building requirements.

4.18.1.2 Existing Services

The Contractor shall acquaint himself with the positions of all the existing services such as stormwater pipes, water mains, sewer mains, gas pipes, telephone cables, etc. before any excavations are commenced. For this purpose he shall approach the Engineer, the Local Authority, the Local Supply Authority and any other authority which may be involved, in writing with regards to obtaining wayleaves.

In the event of damage to other services or structures during trenching operations the Contractor shall immediately notify the Engineer and institute repairs. The Contractor will be held responsible for damage to any existing services brought to his attention by the relevant authorities and shall be responsible for the cost of repairs.

4.18.1.3 Precautions, Warnings and Inconveniences

The Contractor shall take all the necessary precautions and provide the necessary warning signs, tapes and/or lights to ensure that the public and/or employees on Site are not endangered. The requirements of the Occupational Health and Safety Act, Act 85 of 1993, shall be strictly adhered to.

The Contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other Site constructions or other property.

Trenches across roads, access ways or footpaths shall not be left open. If trenches cannot be completed and backfilled immediately, the Contractor shall install temporary "bridges" or cover plates of sufficient strength to accommodate the traffic concerned.

4.18.1.4 Mechanical Excavators

Power driven mechanical excavators may be used for trenching operations provided that they are not used in close proximity to other plant, services or other installations likely to be damaged by the use of such machinery.

The use of power driven mechanical excavators shall be subject to the approval of the Engineer. Should the excavator produce trenches that exceed the required dimensions, payment based on volumetric excavation rates will be calculated on the required dimensions only.

4.18.1.5 Blasting

No guarantee is given or implied that blasting will not be required.

Should blasting be necessary and approved by the Engineer, the Contractor shall obtain the necessary authority from the relevant Government Departments and Local Authorities. The Contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

4.18.1.6 Routes

Trenches shall connect the points shown on the drawings in a straight line. Any deviations due to obstructions or existing services shall be approved by the Engineer beforehand.

The Engineer reserves the right to alter any cable route or portion thereof in advance of cable laying. Payment in respect of any additional or wasted work involved shall be at the documented rates.

The removal of obstructions along the cable routes shall be subject to the approval of the Engineer.

4.18.1.7 Shoring and Waterlogging

The Contractor shall provide shoring for use in locations where there is a danger of the sides of the trench collapsing due to waterlogging or other ground conditions. Refer to the Occupational Health and Safety Act, Act 85 of 1993.

The strength of shoring must be adequate for Site conditions prevailing and the shoring must be braced across the trench.

The Contractor shall provide all pumps and equipment required to remove accumulated water from trenches. Water or any other liquid removed shall be disposed of without any nuisance or hazard.

4.18.1.8 Trenching

Trenching shall be programmed in advance and the approved programme shall not be departed from except with the consent of the Engineer.

Trenches shall be as straight as possible and shall be excavated to the dimensions indicated in this specification. The bottom of the trench shall be of smooth contour, and shall have no sharp dips or rises which may cause tensile forces in the cable during installation and backfilling.

The excavated material shall be placed adjacent to each trench in such a manner as to prevent nuisance, interference or damage to adjacent drains, gateways, trenches, water furrows, other works, properties or traffic. Where this is not possible the excavated materials shall be removed from site and returned for backfilling on completion of cable laying. Surplus material shall be removed form site and disposed of at the cost of the Contractor.

Trenches over roads, access ways or footpaths shall not be left open. Temporary bridges or cover plates with sufficient strength to accommodate the traffic concerned shall be installed.

Prior to cable laying, the Engineer shall be notified to inspect the trench and all objects likely to cause damage to the cables either during or after laying shall be removed.

Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subjected to chemical or the damage or electrolytic action, the Engineer shall be notified before installing the cables. The Engineer will advise on the course of action to be taken.

4.18.1.9 Surveyors' Pegs

Extreme care shall be taken not to disturb surveyor's pegs. These pegs shall not be covered with excavated material. If the surveyors' pegs are disturbed, they shall be replaced by a qualified surveyor only and the Contractor will be liable for the cost involved, which cost the Contractor shall not recover from the Employer.

4.18.1.10 Dimensions of Trenches

Cable trenches for one or two cables shall not be less than 300 mm wide and need not be more than 450mm wide. This dimension shall be valid for the total trench depth. The width shall be increased where more cables need to be installed to allow for the spacings required between adjacent cables in a trench as per the SANS 10142.

Where cable joints are required to be made in the course of a cable run, a joint hole shall be excavated of sufficient size to enable the cable jointer to work efficiently and unimpeded. The trench width shall therefore be increased to provide the required joint hole.

Where trenches change direction or where cable slack is to be accommodated, the Contractor shall ensure that the requirements of the relevant SABS Specification regarding the bending radii of cables are met when determining trench widths.

Trenches shall be excavated to the following depths:

MV cables (1kV - 11kV):	950mm	(Minimum 800mm cover to top of cables)
LV cables (600 - 1000V):	750mm	(Minimum 600mm cover to top of cables)
Cable sleeves:	1150mm	(Minimum 1000mm to top of cable sleeves)

4.18.1.11 Classification of Excavated Materials and Measurement

Payment for excavations will be made on volumetric excavation rates calculated on the basis of the given maximum dimensions or the actual dimensions of the trenches, whichever is the lesser. All measurements for payments shall be made jointly by the representative of the Engineer and the Contractor and the Contractor shall obtain the signature of the Engineer's Representative including approval of such measurements.

No allowance shall be made for the breaking away or caving in of the trench sides, other earth movements or for trenches excavated in excess of the stipulated dimensions.

Volumetric excavation rates will be based on different types of excavated materials. Excavated materials will be classified as follows:

Soft rock and earth shall means rock and earth that can be loosened and removed by hand-pick and shovel and also a mechanical excavator.

Hard rock shall mean granite, quartzite sandstone, slate and rock of similar or greater hardness, solid shale and boulders in general requiring the use of pneumatic jack hammers to break the material in order to excavate thereafter by hand or mechanical means.

Very hard rock shall mean rock that can only be broken by means of explosives and thereafter removed by hand or mechanical means.

Wherever soft rock and earth is encountered, the Contractor can proceed to excavate the trenches at his convenience and in accordance with the program. Where hard rock and very hard rock are encountered, the prior approval of the Engineer shall be obtained before proceeding with the excavation. This requirement is stipulated in order to afford the Engineer the opportunity to determine whether an alternative cable route is justified.

The onus will be upon the Contractor to have the excavated hard rock and very hard rock classified and the extent thereof measured by the Engineer's Representative in order to determine the applicable rates for payment. Such classification and measurement shall take place prior to the backfilling of the trenches and shall be certified in writing by the Engineer's Representative.

4.18.1.12 Bedding Soil

The bottom of the trench shall be filled across the full width with a 75mm (minimum) layer of suitable soil sifted through a 6 mm mesh and levelled off.

Only sandy clay or loam soil with a satisfactory thermal resistivity (not exceeding 1.5EC m/W) may be used for this purpose. Sea or river sand, ash, chalk, pet, clinker or clayey soil shall not be used. The use of crusher sand is acceptable.

Where no suitable soil is available on Site, the Contractor shall import fill from elsewhere and make all the necessary arrangements to do so.

After cable laying is completed, a further layer of bedding shall be provided to extend to 75mm (minimum) above the cables.

The bedding under MV joints shall be fully consolidated to prevent subsequent settling.

4.18.1.13 Cable Sleeves

Where cables cross under roads, other services areas, etc, cables shall be installed in PVC, asbestos-cement or earthenware pipes as cable sleeves. Pitch fibre pipes are not acceptable because of the adhesion that occurs after a period of time between the pipe and the sheathing or outer serving of the cables.

Cable sleeves for road crossings will be supplied and installed by the civil Contractor. The Contractor shall supply and install all other cable sleeves required for the Works.

Sleeves shall be joined in accordance with the manufacturer's specifications to ensure a smooth inner surface along the full length of the sleeves. Sleeves shall cross roads and railway tracks at right angles. All sleeves shall be graded 1:400 for water drainage. Sleeves shall have a minimum diameter of 110mm for LV cables and 160mm for MV cables. They shall extend at least 1m beyond the road edge or kerb on both sides of the road.

Cable sleeves shall be installed to the spacings and depths required for the cables as specified for trenching above.

Prior to the installation of cable sleeves and pipes, the ends thereof shall be sealed to prevent the insides from being soiled during the installation process. PVC or other suitable wrapping shall be wrapped around the ends and secured by means of galvanised steel binding wire. The wrapping shall only be removed when the cables are being installed. During the installation of the cables, care shall be taken to prevent soil from being dragged into the sleeves and pipes by the cables. Upon completion of the installation of the cables, the ends of all sleeves and pipes shall be sealed with a non-hardening watertight compound. Sleeves and pipes intended for future use, shall retain the wrapping around the ends, or alternatively, be sealed with the same non-hardening watertight compound.

All sleeves intended for future use, shall be provided with 2mm diameter non-corrosive draw-wires which shall extend at least 1m on both end of the sleeves. The excess lengths in the draw-wires shall be coiled and buried at the sleeve ends.

4.18.1.14 Backfilling

The Contractor shall not commence with the backfilling of trenches without prior notification to the Engineer so that the cable installation may be inspected. Should the Contractor fail to give a timeous notification, the trenches shall be re-opened at the Contractor's cost. Such an inspection will not be unreasonably delayed.

For medium and low voltage cables (600V to 11kV), a coloured plastic marking tape shall be installed maximum 300mm above each of the medium and the low voltage cables. The tape shall be yellow, with skulls and crossbones with the words "ELECTRIC CABLE/ELEKTRIESE KABEL". These marking shall not be more than 1m apart from centre to centre. The total width of the tape, shall be 200mm more than the distance between

the outer cables in the trench and shall be installed with an overhang of 100mm beyond the outer cables in the trench. In the event of multiple layers of tape to achieve the required overall width, the layers shall overlap each other for at least 100mm.

Backfilling shall be undertaken with soil suitable to ensure settling without voids. The maximum allowable diameter of stones present in the backfill material is 75mm.

The Contractor shall have allowed in his tender for the import of suitable backfill material if required.

The backfill shall be compacted in layers of 150mm and sufficient allowance shall be made for final settlement. The Contractor shall maintain the refilled trench at his expense for the duration of the Contract. Surplus material shall be removed from Site and suitably disposed of.

On completion, the surface shall be made good to match the surrounding area.

In the case of roadways or paved areas, the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated.

4.19 INSPECTIONS, TESTING AND COMMISSIONING

4.19.1 Inspections by the Engineer

a) Engineer's responsibility:

Inspections by the Engineer will take place on a sampling basis only. The Engineer is not responsible to ensure that the Contractor meets with the requirements of the Specification, but will assist the Contractor in an effort to identify problem areas at an early stage. **At no time will an inspection by the Engineer alleviate the Contractor of his responsibility to provide the Employer with a Works which conforms in all respects with the requirements of the Specification and drawings.**

b) At manufacturers' premises:

Wherever applicable, manufacturers shall inspect and test equipment and materials in accordance with the requirements of this Specification and the applicable SABS specifications. The Engineer shall have the right to attend such inspections and/or tests and shall therefore be given notice of such intended inspections and tests. Notice shall be in writing and shall reach the Engineer at least forty eight (48) hours prior to the inspection or test time. The Engineer shall decide at his own discretion whether to attend the inspections or tests, or not.

Should the Engineer attend the inspections and or tests at the manufacturer's premises, such inspections shall be regarded as assistance only to the Contractor in an effort to identify any possible shortcoming at an early stage. The fact that the Engineer may attend the inspections or tests and approve the relevant equipment or materials at that stage, will in no way alleviate the Contractor of his responsibility to ensure that the equipment or materials meet with the requirements of the Specification and drawings**.**

c) On Site:

The Engineer will inspect the Works as the work progresses. Unacceptable work will be identified and the Contractor will be expected to rectify such work and to prevent the recurrence thereof.

d) Contractor to be liable for cost of aborted Practical Completion inspection by the Engineer:

Should the Engineer have been advised in writing by the Contractor of the completion of the Works and then find during the first Works Completion inspection that the Works are incomplete, the inspection will be aborted and the Contractor shall have to arrange for a further inspection upon completion of the outstanding work. Furthermore the Contractor will then be liable to pay the Engineer full professional fees on a time

and cost basis for the time wasted during the aborted inspection. Should the Contractor fail to settle the Engineer's account, the Engineer reserves the right to issue a variation order on the Contract to omit an amount of money equal to the cost involved in which case the Engineer's account will be submitted to the Employer for settlement.

4.19.2 Inspections by the Contractor

In terms of the Contract, the Contractor is responsible to ensure that the Works conform to all the requirements of the Specification. To this effect, it is recommended that the Contractor shall inspect all materials and equipment prior to the installation thereof. In addition, the Contractor shall regularly inspect the Works in order to ensure quality control.

Upon receipt of a written advice from the Contractor, requesting a practical or works completion inspection, the Engineer will conduct an inspection in the presence of the Contractor or his representative and compile a fault list.

Upon receipt of a written advice from the Contractor that the remedial work has been completed and that a further works completion inspection is requested, the Engineer will conduct a further inspection. Provided the Works are acceptable and all required documentation has been submitted, the Engineer shall then issue a works completion Certificate.

Upon receipt of a written advice from the Contractor that a final Completion inspection is required on the expiry of the Defects Liability Period, the Engineer will arrange for a final inspection (if deemed necessary by the Engineer). Provided the Works are acceptable, the Engineer shall then issue a final completion Certificate.

4.19.3 Requirements for Testing

The Contractor shall provide, at his own cost, the tools, instruments, equipment and consumables necessary for the performance of the tests as required. The Contractor shall further arrange for the tests to be performed at times suitable for the Engineer and the Employer. The Contractor shall perform the tests in the presence of and to the satisfaction of the parties represented.

In general the following tests shall be performed (if and as applicable):

a) Medium voltage equipment : Pressure test in accordance with the relevant SABS or IEC standards shall be performed at the manufacturers' premises.

b) Medium voltage cables : Continuity, DC pressure (to SANS 97-2010) and phase rotation tests to be performed by the Sub-Contractor. (Live MV phasing shall be carried out by qualified personnel only)

c) Low tension cables : Continuity and insulation resistance tests, balancing of load on phases, polarity, to be performed by the Contractor.

d) Test the electrical installation for continuity and insulation resistance of all electrical cables and perform all other tests required for the certificate of compliance in terms of the Occupational Health and Safety Act, Act 85 of 1993. Where required, electronic equipment shall be disconnected during these tests to avoid possible damage. The electrical contractor shall then issue a Certificate of Compliance in terms of the Occupational Health and Safety Act, Act 85 of 1993.

e) Test the performance of each of the following safeguards:

- Thermal over current protection for each motor
- Under and over voltage protection
- Incorrect phase sequence protection
- Phase failure protection
- Low water level protection

- Water flow measuring system and no flow protection relays
- High and low water pressure protection system

f) Run the pumps and test for direction for rotation and verify the current drawn to set the overhead relays.

g) Ascertain the pump duty point by measuring the pressure drop across the pump and verifying the flow rate on the pump curve.

h) On the successful completion of all the tests, the complete system shall be commissioned.

4.19.4 Certificates

The Contractor shall hand over the original copies of the required test certificates to the Engineer on completion of the project:

4.19.5 General

The installation shall not be considered complete until all of the requirements listed in this specification have been complied with.

A complete reticulation diagram showing all supply cables and switchboards shall be provided behind a plastic cover in the control room or adjacent to the main switchboard if not located in the coldroom.

The Contractor is to guarantee all the material and workmanship pertaining to the electrical installation and Specialist Contractors of this contract for a period of 12 months. The guarantee is to be valid for a full period from the date when the Engineer has accepted the installation in good working condition on the final hand-over date.

The only exclusion to the 12 months will be lamps of luminaires, which are to be guaranteed for a period of 6 months, and the fluorescent ballasts for a period of 5 years.

4.20 INSTRUMENTATION

4.20.1 General

All instruments will be 24VDC powered and will have a 4-20mA output. Where available or specified an output will be provided to indicate an error on the instrument i.e. flow meters, level sensors, pressure sensors etc.

All 4-20mA signals connected to the PLC analogue input cards will be fused before entering the card. Internal diagnostic functions must be used to enable the detection of errors in the instrumentation. All instrumentation should be provided with a MODBUS communication port where possible or specified.

All 4-20mA control signals and error signals will only be connected to the control unit or SCADA system. Signal re-transmission units shall be used for signals required for monitoring purposes. All signals not connected directly to the control panel will be connected to the nearest point on the bus system to transfer the signal to the SCADA respectively.

All instrumentation and supply must be provided with lightning and surge protection from the i.e. DEHN product range or similar and equal approved.

The instrumentation materials shall be compatible with Seawater (where in direct contact and humid sea air for outer surface). Typical acceptable materials for this application are duplex stainless steel, brass, plastic or polymer and SS316 for applications not in direct contact with water.

4.20.2 Level Measurement

4.20.2.1 Ultrasonic Sensors

4.20.2.1.1 General

Support or suspension brackets must be supplied with all sensors/emitters based on the specific application.

The transmitter shall be a single unit that can be mounted remotely form the sensor.

Preference will be given to “Smart” units with the ability for calibration and checking via an Alpha-numeric display interface. The transmitter must be able to give the output either in level or volume based on the container as applicable.

4.20.2.1.2 ements for Sensor/Emitter

Element	: Membrane
Material	: To suit the application
Electrical Connection	: 20mm ISO Conduit
IP Rating	: IP65
Temperature Limits	: -20 to 80OC

4.20.2.1.3 ements for Transmitters

Material	: To suit the application
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC
Calibration	: Independent adjustments for Span and Zero
Temperature Limits	: -20 to 60OC

4.20.2.1.4 mance

Accuracy	: 1% of Span or better
Repeatability	: 0.2% of Span
Dead Band	: Less than 0.2% of Span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 OC

4.20.2.2 Capacitance Level Transmitters

4.20.2.2.1 General

Suitable sensors of the rod or rope type must be used based on the application.

Suitable coating must be applied to surfaces that may be damaged by the process.

Transmitter shall be a single unit that can be mounted remotely form the sensor.

Preference will be given to “Smart” units with the ability to calibration and checking via an alpha-numeric display interface. The transmitter must be able to give the output either in level or volume based on the container as applicable.

4.20.2.2.2 ements for Probe

Length	: To suit the application
Material	: To suit the application
Temperature Limits	: -20 to 180OC
Pressure Limits	: Process Pressure up to 1000kPA or as applicable

4.20.2.2.3 ements for Transmitters

Material	: To suit the application
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC
Calibration	: Independent adjustments for Span and Zero
Temperature Limits	: -20 to 60OC

4.20.2.2.4 mance

Accuracy	: 0.1% of Span or better
Repeatability	: 0.2% of Span
Dead Band	: Less than 0.2% of Span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 OC

4.20.2.3 Hydrostatic Level Transmitters

4.20.2.3.1 General

Suitable probe of the rod must be used based on the application.
Suitable coating must be applied to surfaces that may be damaged by the process.

Preference shall be given to loop powered units

4.20.2.3.2 ements for Probe

Length	: To suit the application
Material	: To suit the application
Temperature Limits	: -20 to 80OC
Pressure Limits	: Process Pressure up to 1000kPA or as applicable

4.20.2.3.3 ements for Transmitters

Element	: Contite, diaphragm
Material	: To suit the application
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC
Calibration	: Independent adjustments for Span and Zero
Temperature Limits	: -20 to 60OC

4.20.2.3.4 mance

Accuracy	: 0.1% of Span or better
Repeatability	: 0.2% of Span
Dead Band	: Less than 0.2% of Span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 OC

4.20.3 Pressure Measurement

4.20.3.1 Pressure Transmitters and Differential Pressure Transmitters

4.20.3.1.1 General

Transmitter will be an electronic type based on capacitance principle.

Suitable mounting or connection to the process will be provided based on the application.

Preference will be given to “Smart” units with the ability to calibration and checking via an alpha-numeric display interface.

4.20.3.1.2 ements

Element	: Diaphragm Type
Material	: To suit the application
Electrical Connection	: 20mm ISO conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC
Calibration	: Independent adjustments for Span and Zero
Pressure Limits	: Up to 200% of process pressure
Temperature Limits	: Up to 100OC for the process
	: -20 to 60OC for the electronic equipment
Humidity Limits	: 0 to 100% Relative humidity non-condensating

4.20.3.1.3 mance

Accuracy	: 1% of Span or better
Repeatability	: 0.2% of Span
Dead Band	: Less than 0.2% of Span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 OC

4.20.3.2 Pressure Gauges

4.20.3.2.1 General

Gauges shall operate on the Bourdon Tube principle.

Gauges shall normally have a 100mm minimum nominal diameter. Gauges used on regulators shall normally have a 50mm minimum nominal diameter.

Gauges used on “Dirty” or viscous liquids shall be fitted with a diaphragm type chemical seal.

Suitable Glycerine filling shall be used based on the application.

4.20.3.2.2 ements

Material	: To suit the application
Connection	: NTP Male for the entry connection
Display	: Black lettering.
IP Rating	: IP55

4.20.3.2.3 mance

Accuracy	: 2% of Span or better
Over pressure	: 1.3 x full scale
Static pressure	: Upper limit 75% FSD of range
Fluctuating pressure	: Upper limit 66% FSD of range

4.20.3.3 Diaphragm Type Chemical Seals

4.20.3.3.1 General

Chemical seals shall be used when the media to be measured is viscous, corrosive or when it contains suspended solids.

Unit pressure shall be as per the application requirements

4.20.3.3.2 ements

Material	: To suit the application
Connection	: NTP connection
Safety Factor	: 2 x maximum process pressure

4.20.4 Temperature Measurement

4.20.4.1 Thermo-wells

4.20.4.1.1 General

Where temperature measuring elements have to be inserted into process vessels and process pipes, thermowells shall be provided.

Thermowells in pipes shall be placed that the tip is situated in the top third of the pipe.

Care should be taken to ensure that the natural frequency of the well does not influence the operation of the equipment.

4.20.4.1.2 ements

Material	: To suit the application
Diameter	: 8mm nominal Internal
	: 10mm nominal external
Connection	: NTP Male for the Process connection
	: NTP Female for the Bulb connection

4.20.4.2 Thermo-couples

4.20.4.2.1 General

Where temperature needs to be read at a remote location, thermo-couples shall be used for measurement.

The length shall be selected to ensure good thermal contact at the tip of the thermo-couple with the end of the thermo-well.

4.20.4.2.2 ements

Standards	: BS 1041 Relevant parts
Material	: Stainless steel or to suit the application
Type	: Type J, mineral insulated
IP Rating	: IP65
Diameter	: 6mm nominal OD

4.20.4.2.3 mance

Accuracy	: 1.5% up to 275 OC
	: 0.5% above 275 OC

4.20.4.3 RTD

4.20.4.3.1 General

Where accuracy better than thermo-couples is required, RTD’s shall be used.

The length shall be selected to ensure good thermal contact at the tip of the thermo-couple with the end of the thermo-well.

4.20.4.3.2 ements

Standards	: BS 1041 Relevant parts
Material	: To suit the application
Type	: PT 100
IP Rating	: IP65
Diameter	: 6mm nominal OD

4.20.4.3.3 mance

Accuracy	: 1% of Span or better
Repeatability	: 0.2% of Span
Dead Band	: Less than 0.2% of Span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 OC

4.20.4.4 Temperature Gauges

4.20.4.4.1 General

Bimetal coil or gas filled gauges shall be used based on the application.

Gauges shall have a 150mm minimum nominal diameter with an adjustable viewing angle. The Bulb length shall be selected to suite the application.

4.20.4.4.2 ements

Material	: To suit the application
Bulb Diameter	: 8mm nominal
Connection	: NTP Male for the Process connection
	: NTP Female for the Bulb connection
Display	: Black lettering marked in degrees centigrade

4.20.4.4.3 mance

Accuracy	: 1% of Span or better

4.20.4.5 Temperature Transmitters

4.20.4.5.1 General

Electronic transmitters shall be wired for the application (Thermo-couple or RTD).

Preference shall be given to integral units with a head mounted transmitter and an integral measuring element.

4.20.4.5.2 ements

Material	: To suit the application
Electrical Connection	: 20mm ISO conduit
Electrical Connection	: 20mm ISO conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC
Calibration	: Independent adjustments for Span and Zero
Temperature Limits	: -20 to 60OC
Humidity Limits	: 0 to 100% Relative humidity non-condensating

4.20.5 Flow Measurement

4.20.5.1 Magnetic Flow Meters

4.20.5.1.1 General

Suitable gaskets and earthing rings must be supplied based on the specific application.

Suitable coating must be applied to surfaces that may be damaged by the process.

Preference will be given to “Smart” units with the ability to calibration and checking via an alpha-numeric display interface. All data must be stored in non-volatile memory

4.20.5.1.2 ements for Sensor

Material	: To suit the application
Diameter	: DN25 – DN 2500 to fit piping application
IP Rating	: IP65 for integral type, Sensor IP68 for remote type
Temperature Limits	: -20 to 50OC
Measuring	: to suite application

4.20.5.1.3 ements for Transmitters

Material	: To suit the application
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC or 220V AC
Temperature Limits	: -20 to 50OC

4.20.5.1.4 mance

Accuracy	: 1% of Span or better
Repeatability	: 0.2% of Span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 OC
Medium Sensitivity	: 5uS/cm

4.20.5.2 Vortex Flow Meters

4.20.5.2.1 General

Suitable gaskets must be supplied based on the specific application.

Suitable coating must be applied to surfaces that may be damaged by the process.

Preference will be given to “Smart” units with the ability to calibration and checking via an alpha-numeric display interface. All data must be stored in non-volatile memory

4.20.5.2.2 ements for Sensor

Material	: To suit the application
Diameter	: DN15 – DN 300 to fit piping application
IP Rating	: IP65 for integral type, Sensor IP68 for remote type
Temperature Limits	: -20 to 50OC
Measuring	: to suite application

4.20.5.2.3 ements for Transmitters

Material	: To suit the application
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC or 220V AC
Temperature Limits	: -20 to 50OC

4.20.5.2.4 mance

Accuracy	: 1% of Span or better
Repeatability	: 0.25% of Span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 ^{O}C

4.20.5.3 Ultrasonic Flow Meters

4.20.5.3.1 General

Suitable gaskets and brackets must be supplied based on the specific application.

Suitable coating must be applied to surfaces that may be damaged by the process.

Preference will be given to “Smart” units with the ability to calibration and checking via an alpha-numeric display interface. All data must be stored in non-volatile memory

4.20.5.3.2 ements for Sensor

Material	: To suit the application
Diameter	: DN25 – DN 2500 to fit piping application
IP Rating	: IP65 for integral type, Sensor IP68 for remote type
Temperature Limits	: -20 to 50OC
Measuring	: to suite application

4.20.5.3.3 ements for Transmitters

Material	: To suit the application
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC or 220V AC
Temperature Limits	: -20 to 50^{O}C

4.20.5.3.4 mance

Accuracy	: 1% of Span or better
Repeatability	: 0.2% of Span
Dead Band	: less than 2% of span
Temperature Change Effect	: Less than 0.5% of maximum Span for each 10 OC

4.20.6 PH Measurement

4.20.6.1 pH Meters

4.20.6.1.1 General

Transmitter shall be a single unit that can be mounted remotely from the sensor.

Preference will be given to “Smart” units with the ability to calibration and checking via an alpha-numeric display interface.

4.20.6.1.2 ements for Probe

Length	: To suit the application
Material	: Glass
IP Rating	: IP68
Temperature Limits	: -20 to 100OC
Pressure Limits	: Process Pressure up to 1000kPA or as applicable
Measurement	: pH 0 to 14
Temperature Sensor	: Integrated PT100

4.20.6.1.3 ements for Transmitters

Material	: To suit the application
IP Rating	: IP65
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Supply	: 24V DC
Temperature Compensation	: Automatic
Temperature Limits	: -20 to 60OC

4.20.6.1.4 mance

Accuracy	: 0.5% of Span or better
Linearity	: 0.1%

4.20.6.2 Oxygen Analysers (Dissolved Oxygen)

4.20.6.2.1 General

Measurement for oxygen in water for normal applications shall be by amperomatic system covered with a membrane.

Measurement for oxygen in water for harsh conditions shall use a pair of electrodes which are mechanical cleaned or with optical (luminescence) measurement. Optical measurement shall also be used where there is insufficient flow.

Preference will be given to “Smart” units with the ability to calibration and checking via an alpha-numeric display interface. The transmitter must be able to give the output either as % of saturation, in mg/l or ppm.

4.20.6.2.2 ements for Probe

Material	: To suit the application
IP Rating	: IP68
Temperature Limits	: -20 to 50OC
Pressure Limits	: Process Pressure up to 1000kPA or as applicable
Measurement	: 0 to 20 mg/l or as required.
Temperature Sensor	: Integrated NTC

4.20.6.2.3 ements for Transmitters

Material	: To suit the application
IP Rating	: IP65
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA

Supply	: 24V DC
Temperature Limits	: -20 to 60OC

4.20.6.2.4 mance

Accuracy	: 1% of Span or better
Resolution	: 0.1%

4.20.6.3 Turbidity Analysers

4.20.6.3.1 General

The measurement shall use the standardised nephelometric 90O scattered light principle.

The sensors on the measuring probe must be self-cleaning.
Installation shall be according to manufacturers' specification to ensure accurate measurement.

Preference will be given to "Smart" units with the ability to calibration and checking via an alpha-numeric display interface.

4.20.6.3.2 ements for Probe

Material	: To suit the application
IP Rating	: IP68
Connection	: NTP connection
Temperature Limits	: -5 to 50OC
Measurement	: 0 – 1000 NTU

4.20.6.3.3 ements for Transmitters

Material	: To suit the application
IP Rating	: IP65
Electrical Connection	: 20 MM ISO Conduit
IP Rating	: IP65
Output	: 4-20 mA
Temperature Limits	: 0 to 50OC

4.20.6.3.4 mance

Accuracy	: below 40 NTU - 2% of reading
	: above 40 NTU - 5% of reading
Resolution	: 1%
Repeatability	: 1%

4.20.7 Switches

Switches shall be provided with a suitable type enclosure for the specific conditions.

Actuating switches shall be snap action micro switches.

All switches shall have two parallel normally open/close contacts and the differential shall be adjustable with the set-point adjustable over the full instrument range.

Where specific applications require it, other general accepted suitable methods shall be used.

4.20.7.1 Pressure Switches

4.20.7.1.1 General

Diaphragm type switches shall be used.

4.20.7.1.2 ements

Material	: Bronze or to suit the application
Process Connection	: NTP Male for the Process connection
Electrical Connection	: 20mm ISO Conduit
IP Rating	: IP65
Maximum Process Pressure	: 5000 kPa
Maximum Process Temperature	: 100 OC

4.20.7.2 Temperature Switches

4.20.7.2.1 General

Filled system or bimetallic switches shall be used.

Mounting shall be direct unless access to the head is difficult where capillary mounting may be used.

4.20.7.2.2 ements

Material	: Bronze or to suit the application
Process Connection	: NTP Male for the Process connection
Electrical Connection	: 20mm ISO Conduit
IP Rating	: IP65
Maximum Process Temperature	: 100 OC

4.20.7.3 Flow Switches

4.20.7.3.1 General

Paddle type switches shall have interchangeable paddles to suit the flow rate.

Thermal type switches shall have interchangeable switch point to suit the flow rate

4.20.7.3.2 ements

Material	: To suit the application
Process Connection	: NTP Male for the Process connection
Electrical Connection	: 20mm ISO Conduit
IP Rating	: IP65
Maximum Process Pressure	: 1000 kPa
Maximum Process Temperature	: 100 ^{O}C

4.20.7.4 Ultrasonic Switching

4.20.7.4.1 General

For level switching in a vessel, point source/ detector types shall be used.

Care shall be taken during installation to avoid interference with obstacles.

Compensation for temperature shall be done.

4.20.7.5 Capacitance Switching

4.20.7.5.1 General

Capacitance probes may be used for level switching.

Where the vessel is non-conductive or where the media have a varying moisture content, counter probes shall be used.

4.20.7.6 Conductivity Switching

4.20.7.6.1 General

Conductivity probes may be used for level switching.

Conductivity of the media with respect to the wall of the vessel or with respect to a reference probe shall be used.

4.20.7.7 Float Switches

4.20.7.7.1 General

For low level pump protection float switches could be used.

4.20.7.7.2 ements

Material	: To suit the application
Process Connection	: According to the application
Electrical Connection	: 20mm ISO Conduit
IP Rating	: IP65
Maximum Process Pressure	: 1000 kPa
Maximum Process Temperature	: 100 OC

4.20.7.8 Vibration Switches

4.20.7.8.1 General

Motor and pump vibration shall be monitored where required.

The application will determine the use single or multi channel configurations.

4.20.7.8.2 ements

Range	: 0 to 20mm/s
Outputs	: 2 potential free contacts
Electrical Connection	: 20mm ISO Conduit
IP Rating	: IP65

4.20.7.9 Proximity Switches

4.20.7.9.1 General

Switches shall operate on the magnetic field principle.

Mechanical adjustment of at least 35mm shall be provided on the mounting bracket

4.20.7.9.2 ements

Range	: 10 to 20mmOutputs

Indication	: 2 potential free contacts
Electrical Connection	: 20mm ISO Conduit
IP Rating	: IP65

4.20.8 Calibration

Before calibration the sensor shall be hydraulically tested to twice its specified working pressure. Factory calibration shall be carried out on the actual equipment supplied. A calibration certificate shall be submitted to the Engineer stating the accuracy and repeatability for various flow rates within the useful range of the meter.

4.21 PROGRAMMABLE LOGIC CONTROLLERS (PLC'S)

Each external motor control centre shall be provided with a PLC for local control. The structure of the PLC program will be presented to the Engineer before software development commences. The language used will be relay ladder logic and the descriptive language used in the program software will be in English.

Working programs shall be provided on CD/DVD, as well as printed program listings.

The programmable logic controller's shall generally comply with the following minimum requirements.

4.21.1 Design Description

- The controller system shall be an all-in-one design, with I/O expansion so the user can quickly and easily install service and replace the controller and expansion modules, if necessary. The supplier must have available a number of I/O options for the controller that include:

  1. Power: 24V DC
  2. Inputs: 24V DC sink, 24V DC source, 4-20mA Analogue, 0-10V Analogue, RTD and Thermocouple
  3. Outputs: Relay (some of which must have individual isolation), 24V DC source, 4-20mA Analogue, 0-10V Analogue and TRIAC

- The controller must be part of a larger family of packaged and modular programmable controllers that provide program transport (ability to move a customers' program between platforms in both directions), and also share programming tools, a common instruction set, and common communications to serial-based devices (computers, electronic operator interfaces, etc.).
- All hardware of the controller shall operate at an ambient temperature of -20° to 60°C (-4° to 140° F) with an ambient temperature rating for storage of -40° to 85°C (-40° to 185° F).
- The controller hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation.
- The controller shall have at least two dedicated serial ports which support RS-232-C signals. These ports must be capable of local and remote (via modem) programming, troubleshooting and data manipulation.
- The controller shall have at least one dedicated serial port which supports RS-485 signals. This port must be capable of local and remote programming, troubleshooting and data manipulation.
- The controller shall have at least one RJ-45 port which supports 10/100 Mbps EitherNet/IP. This port must be capable of local and remote programming, troubleshooting and data manipulation.
- The controller system shall be designed and tested to operate in high electrical noise environments, and must meet or exceed:

  - EN 61000-4-2 (ESD Immunity)
  - ENV 50204 (Radiated Immunity)
  - EN 61000-4-3 (Radiated RF Immunity)
  - EN 61000-4-4 (Fast Transient Immunity)
  - EN 61000-4-5 (Surge Transient Immunity)
  - EN 61000-4-6 (Conducted RF Immunity)
  - EN 55011 (Conducted and Radiated Emissions)
  - EN 61000-4-11 (Line Related Tests)

4.21.2 Main Hardware

- The CPU shall be a self-contained unit, and will be capable of displaying Ladder Rung program execution through its RS-232/RS-485 and EtherNet/IP communication ports. The CPU will control all I/O scanning and communications servicing.
- All components of the controller system shall be housed in a single chassis (power supply, embedded I/O circuitry, CPU, memory and communications shall reside in one enclosure).
- The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a “green” indicator when no fault is detected and a “red” indicator when a fault is detected.
- The packaged controller shall be designed to operate in a free air flow environment (convection cooling only, no fans or other air moving devices shall be required).
- The controller shall provide a simple embedded Human Machine Interface (HMI). This HMI must provide the ability to monitor/change user data and also to display messages and data to the user. The ability to receive numeric input from the HMI which can be utilized by the controller’s program must also be supported.
- The controller must provide a mechanism to manually set the communication port to a known state (factory out-of-box preferred). Systems that do not provide a mechanism to manually set the communications port to a known state are not acceptable.
- The main front panel of the controller shall include the following indicators: Power, Run, Fault and Force.
- Processor mode shall be selected by a command from a programming device. Available settings must include modes:

RUN:	Control program executing
PROGRAM:	Controller not executing, user program can be uploaded or downloaded
SINGLE SCAN TEST:	The PLC scans and solves the user program once, does NOT control the real world outputs, and stops
CONTINUOUS SCAN TEST:	The PLC continuously scans the user program, but does NOT control the real world outputs

- Non-volatile memory shall store the operating system, user program, and all user data to protect against memory loss in the case of power loss or system shut-down.

4.21.3 Power

- The packaged controller shall operate at 24VDC Class 2 SEL V
- All AC powered controllers with 24V DC inputs must be capable of supplying a minimum of 24V DC at 200mA to provide external 24V DC power for input devices (sensors, switches, etc.).
- The onboard power supply must be capable of supplying all necessary power to all subsystems (CPU, memory, local I/O, etc.) plus a minimum of seven expansion I/O modules without external wiring.
- In cases where the AC line is especially unstable or subject to unusual variations, it shall be possible to install a constant voltage transformer having a sinusoidal output waveform.
- At the time of power-up, the power supply shall inhibit operation of the processor and I/O modules until the DC voltages are within specifications.

4.21.4 Program Storage

- The program storage medium shall be a solid state non-volatile type.
- The controller shall be capable of addressing up to a minimum of 10K data words, where each word is comprised of 16 data bits.
- Available user memory shall consist of a minimum of 20K words of program and data.
- Controller shall support up to 128K bytes for data logging.
- Controller shall support up to 64K bytes for recipe storage.
- The controller must provide the capability to use a non-volatile memory module that can be inserted or removed while power is applied to the controller.
- The memory module must provide the capability to use a non-volatile memory module that can be inserted or removed while power is applied to the controller.
- The memory module must support the ability to selectively protect multiple areas of user data from being overwritten if/when a download occurs.
- Memory modules must be capable of write once read many operations. This is a write once feature that if enabled inhibits a user from clearing the program currently stored in the memory module.
- The memory module must support automatic program download whenever power is applied.

- The memory module must support the ability to detect if a fault is present during the power up sequence, if a fault is present download the program that is in the memory module and enter the run mode. If a fault is not present the controller proceeds normally without memory module intervention.
- The operator should be able to backup memory, including data and program logic onto a CD, DVD, hard disk, or memory module.
- The packaged controller system must be capable of storing the following data:

  - External output status
  - External input status
  - Timer values
  - Counter values
  - Signed integer numbers (16-bit)
  - Signed integer numbers (32-bit)
  - Binary data (bit, BCD, HEX)
  - ASCII string data
  - Internal processor status information
- The above listed data shall be distinguishable to the CPU by the addressing format. Managing the data into memory subsections shall be an automatic function of the CPU operating system. Data can be displayed in Binary, Hexadecimal or Decimal. Function-specific data such as processor status shall have dedicated displays that annotate the meaning of specific control bits and words within them and allow for selective control where appropriate.
- If contacts or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program.
- The controller must support a minimum of 12 pulse inputs. Pulse inputs allow a fast signal to be captured and held long enough for the controller to detect the signal, once read the signal is automatically reset.
- The number of times that a normally open (N.O.) and/or normally closed (N.C.) contact of an address can be programmed shall be limited only by the memory capacity to store these instructions.
- Ladder logic programs must have immediate access to sub-elements of control structures (timers, counters, sequencers, etc.) by word (presets, accumulators, etc.) and bit (status bits).

4.21.5 Inputs/Outputs - General

- A minimum of four isolated digital input groups, one isolated analog input group, six isolated digital output groups and one isolated analog output group shall be located on the self-contained controller. At least four relays shall be individually isolated.
- The system must support at least 112 discrete I/O points using expansion I/O modules.
- Isolation shall be between all internal logical and external circuits.
- Each input and output point shall have a visual indicator to display ON/OFF status.
- All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections.
- Inputs shall have adjustable filter time constants to improve input performance in high speed applications and to limit the effects of voltage transients.
- The system must be able to support seven expansion modules (input/output, discrete or analog).

4.21.6 Inputs/Outputs – Specific

The controller shall offer input/output hardware consisting of the following types:

- Standard Inputs:

  24V DC sink, 24V DC source, 4-20mA Analog, 0-10V Analog, RTD and Thermocouple

- High Speed Counter:

  Each controller with 24V DC inputs must have at least three HSC’s capable of detecting a 100kHz pulse stream built on board.

  Each HSC must be capable of detecting pulses as narrow as 5 microseconds (100kHz) and directly control (turn on or off) controller outputs independent of the processor scan.

Each HSC must be cable of detecting single ended inputs, quadrature inputs and high speed inputs with external controls (hold and reset).

Each HSC must be completely configurable (input filters, modes of operation, etc.) using computer based software. Runtime control of the HSC must be allowed through commands (instructions) in the user (ladder) program (reset accumulator, change presets, change output patterns and setpoints, enable/disable HSC operation, etc.).

Data and status within each HSC must also be accessible from external devices through the controller's communication ports.

- High Speed Inputs

  Each controller with 24V DC inputs must have at least 12 inputs that can catch and fold for one input's scan a 5 microsecond input signal.

  Each controller with 24V DC inputs must have four high speed inputs capable of generator an input interrupt. When used for input interrupt functionality, the controller must be capable of executing a predefined range of logic. Each input must be configurable to run its own user-defined logic block.

- Standard Outputs

  Outputs: Relay (some of which must have individual isolation), 24V DC source, 4-20mA Analog, 0-10V Analog and Triac.

  Relay outputs for DC devices which operate at 5-125V DC, with 2 amp continuous current capacity at 24V DC and 1 amp continuous current capacity 125V DC.

  Relay outputs for AC devices which operate at 5-264V AC with 5 amp continuous current capacity for UL508 up to 40°C (3A above 40°C) and 3 amp continuous current capacity for UL1604, Class 1, Division 2, Hazardous Locations, Groups A, B, C and D.

- High Speed Output

  Each controller with 24V DC outputs must have at least three high speed outputs. The outputs must be capable of generating PTO (pulse train output) signals. The PTO signals must be capable of generating motion profiles using either trapezoid or S-Curve acceleration and deceleration profiles.

4.21.7 Networking and Communications

- The Controller shall support direct connection to a programming computer equipped with a standard RS-232 serial port.
- The controller shall support direct connection to a programming computer equipped with a standard RS-485 port.
- The controller shall support direct connection to a programming computer equipped with a standard 10/100Mbps EtherNet/IP port.
- The controller shall support direct connection to a modem for remote programming functionality.
- The controller shall support full function peer-to-peer communications (program management, controller to controller messaging, etc.):

  a. When directly connected by an RS-232 cable, RS-485 cable or EtherNet cable.
  b. A "local" (hard wired) peer-to-peer network that supports up to 32 devices.
  c. The controller shall directly support EtherNet/IP peer-to-peer messaging. The controller shall support half-duplex slave communications on a network capable of at least 250 nodes. The half-duplex network shall support program upload/download, monitoring and peer-to-peer (slave-to-slave) communications.
  d. The controller shall support connectivity to up to 31 other devices across a DH-485 network.
  e. The controller shall support the DF1 Radio Modem protocol.
  f. The controller shall support Modbus RTU master and slave communications.

g. The controller shall support bi-directional ASCII communications to send initialization strings to a modem, text with embedded data to a printer or terminal, receive ASCII from smart scales, bar code devices, etc.
h. The controller shall provide the ability to change the RS-232 communications port between the out-of-box factory default settings and the user configuration settings. This operation must be allowed to occur at any time.
i. The controller must support baud rates from 300 to 38.4k baud.
j. The controller shall support Modbus/TCP over EtherNet.
k. The controller shall support DNP3 serially and over EtherNet.

4.21.8 Execution

- Interfacing and Peripherals

a. The programming means shall be a Microsoft Windows based desktop/portable.
b. Programming software must run on Windows 98/ME/NT/2000/2003 Server/XP or Vista environments.
c. The programming software and the controller shall support online editing.
d. The programming terminal shall be compatible for interfacing with an electrical service of either 120V AC, 50/60 Hz or 220V ACT, 50/60Hz.
e. The terminal shall provide for selecting the communication rate between 110 and38400 baud for RS-232-C communications.
f. The programming terminal shall be capable of displaying a rung consisting of a maximum of seven series elements and six parallel elements.
g. The means to indicate contact or output status shall be by intensification or colour change of the contact or output on the CRT screen. Each element's status shall be shown independently, regardless of circuit configuration.
h. The controller system shall be able to interface with a data terminal which is RS-232-C compatible (up to 38400 baud) to generate hard copy logic diagrams and/or message generation.
i. The system shall have the capability to interface to a CD, DVD and/or a hard disk for loading a user program into, or recording the contents of, the processor's memory. It shall be possible to load or record the entire contents or selected portions of memory.
j. The controller must also have a small easy to use operator interface (OI specifically designed to enhance operator interaction with the control system. The OI device should be panel mountable. Features required are menuing capabilities, security features, active display of data, limit test of entered data, and scaling of data to and from the controller. The system should make use of intuitive on screen programming features. All OI programs must be capable of being saved to disk and transported to other OI devices or programming computers. OI programs should be transferred via a RS-232 serial communications link between the computer and the OI device.

- Programming Techniques

a) The programming format shall be relay ladder diagram.
b) It shall be possible to program a maximum instruction matrix containing as many as 128 instructions.
c) The capability shall exist to change a contact from normally open to normally closed, add instructions, change addresses, etc. It shall not be necessary to delete and reprogram the entire rung.
d) It shall be possible to insert relay ladder diagram rungs anywhere in the program, even between existing rungs, provided there is sufficient memory to accommodate these additions.
e) It shall be necessary to issue a two part command in order to delete ladder rungs from memory. This will provide a safeguard wherein the operator must verify their intentions before erasing the entire program.
f) Latch functions shall be internal and programmable.
g) The system shall have the capability to address up to 10K words of data.
h) The system must support up to 255 data files. Each data file must be configurable from 1 to 255 data elements and type (timers, counters, integer [16- or 32-bit], string, message or PID) and any number of timers, counters and internal bits up to a maximum of 10K words or data.
i) All management of instructions and data in memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include

the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment, down-increment or both. All timer and counter data must be accessible from the ladder program and also any communications device.

j) Timer instructions shall include selectable time bases in increments of 1.0, 0.01, and0.001 second. The timing range of each timer shall be from 0 to 32,767 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

k) The controller shall use a signed integer data format. The signed integer format (-2,768 to 32,767) must be used throughout the controller (counters, storage registers, math operations, etc.).

l) The controller shall support signed integer math functions consisting of addition, subtraction, multiplication, division, scale with parameters and square root.

m) Instructions will be provided for file manipulation instructions such as "file fill", "first in-first out", "last in-first out" shall be supported by the system. Four function math instructions and instructions for performing "logical OR", "logical AND", "exclusive OR" and comparison instructions such as "less than", "greater than" and "equal to" shall be included within the system. All instructions shall execute on either single words, double words or files.

n) The system shall contain instructions for reading, writing and manipulation of ASCII data. Instructions such as string extraction, concatenation and byte swapping of data.

o) The system shall contain instructions which will construct synchronous 16-word shift registers. Additional instructions shall be provided to construct synchronous bit shift registers.

p) The controller shall have a jump instruction which will allow the programmer to jump over portions of the user program to a portion marked by a matching label instruction.

q) The controller shall have an instruction which will allow the programmer to display a combination of bits, integers and strings to the embedded HMI and optionally to receive bits, integers or long integers from the HMI.

r) In applications requiring repeatable logic rungs it shall be possible to place such rungs in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique label. The processor will support nesting of subroutines. The program format as displayed on the CRT shall clearly define the main program and all subroutines.

s) The program format shall display all instructions on a CRT programming panel with appropriate mnemonics to define all data entered by the programmer. The system shall be capable of providing a "HELP" instruction which when called by the programmer will display on the CRT a list of instructions and all data required to enter an instruction into the system memory.

t) At the request of the programmer, data contained in system memory shall be displayed on the CRT programming panel. This monitoring feature shall be provided for input/output status, timer/counter data, files and system status. Ladder logic rungs shall be displayed on the CRT with rung numbers in sequential order.

u) The system shall have the capability to enter rung comments above ladder logic rings. These comments may be entered at the same time the ladder logic is entered.

v) It shall be possible to manually set (force) either on or off all hardwired input or output points. Removal of these forced I/O points shall be either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

w) The execution of the program logic shall be accelerated by scanning the rung only until a positive decision as to the state of the outputs has been made. In many cases this will mean skipping over logic elements if the output condition has been predetermined.

x) A means to program a fault recovery routine shall exist. When a major system faults occurs in the system, the fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system will shut down.

y) An interrupt routine shall be programmable such that the routine shall be executed regularly. The interval at which the routine is executed shall be user-specified in the range of 1 to 32767 milliseconds in 1 msec increments. This routine must be able to close an asynchronous control loop consisting of 32 input points, 32 output points, 100 contact/coils, 10 addition instructions, 10 subtraction instructions and 32 circular comparison (limit) instructions while never exceeding a 3 millisecond interval. The measurement of this interval is from after the input filter delay time to the time that the physical outputs start to transition.

z) The ability to program ladder logic via symbols from the global database of the packaged controller shall exist.

aa) The CPU shall support indirect addressing of inputs and outputs, along with all data table words (integer, binary, timers and counters) for the software instruction set.
bb) The system shall support both bit and word level diagnostic instructions.
cc) To facilitate conditional event detection programming, output instructions shall include a “one shot” instruction which may be triggered on the low-to-high (rising) rung condition.
dd) The processor shall support Master Control Reset (Relay) type functionality to selectively disable sections of relay ladder logic.

- Quality Requirements

The controller shall be able to withstand conducted susceptibility tests as outlined in:

a.	ESD Immunity	EN 61000-4-2 4kV contact, 8kV air and 4kV indirect
b.	Radiated Immunity	ENV 50204 10V/m, 1000MHz
c.	Radiated RF Immunity	EN 61000-4-3 10V/M, 261000MHz (alternatively 80-1000MHz), 80% amplitude modulation, 900MHz keyed carrier
d.	Fast Transient Immunity	EN 61000-4-4 Power Supply, I/O: 2kV, 5kHz Communications Cable: 1kV, 5kHz
e.	Surge Transient Immunity	EN 61000-4-5 Unshielded Communications Cable: 2kV CM (common mode), 1kV DM (differential mode) Shielded Communications Cable: 1kV galvanic gun I/O: 2kV CM (common mode), 1kV DM (differential mode) AC Power Supply Input: 4kV CM (common mode), 2kV DM (differential mode) DC Power Supply Input: 500V CM (common mode), 500V DM (differential mode) AC/DC Auxiliary Output: 500V CM (common mode), 500V DM (differential mode)
f.	Conducted RF Immunity	EN 61000-4-6 10V, 150kHz to 80MHz
g.	Conducted Emissions	EN 55011 AC Power Supply Input: 150kHz to 30MHz
h.	Radiated Emissions	EN 55011 30MHz to 1000MHz
i.	Line Related Tests	EN 61000-4-11 AC Power Supply Input: Voltage drop: -30% for 110ms, -60% for 100ms Voltage interrupt: at voltage greater than -95% for 5 sec Voltage fluctuation: +10% for 15 minutes, -10% for 15 minutes DC Power Supply Output: Voltage fluctuation: +20% for 15 minutes, -20% for 15 minutes

The controller and its associated peripherals shall be listed or recognized by the following registrations: UL listed; CSA or CUL certified; CE certified and suitable for operation in Class I, Division 2, Groups A, B, C and D hazardous locations.

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4.22 HUMAN MACHINE INTERFACE (HMI)

4.22.1 General

Each motor control centre/PLC shall be provided with a touch screen operated graphical interface to facilitate the local manual control, control mode selection, pump motor monitoring, instrumentation monitoring, viewing of alarm lists, graphical trends.

4.22.2 Configuration

The following shall typically be provided on the overview screen but not necessarily be limited to:

- Control mode selection (OFF / MANUAL / AUTO / TELEMETRY)
- Pump motor control (Start / Stop / Reset) and status indication (Run / Trip / Available)
- Instrumentation (flow, pressure, level and signals as applicable)
- Functional icons (mimics)on the overview screen as required. Overview screen to be submitted to Engineer for evaluation prior to design development.
- Alarms
- Graphical trends

4.23 EQUIPMENT TYPE AND PREFERRED PRODUCT LIST

EQUIPMENT	GROUP	TYPE	PRODUCT
PLC's	Control	Electronic	Koyo PLC's
MPU's	Protection	Electrical	Siemens, ZEV MPU, ABB MPU
Contactors	Control	Electrical	ABB, Siemens, Moeller, GE, M&G, Specher & Show
Circuit Breakers	Protection	Electrical	ABB, Siemens, Moeller, GE, M&G, Sprecher & Show
Touch Panel	Control	Electronic	Siemens
Flow Sensors	Protection	Electronic	EGE
Lighting & Surge Protection	Protection	Electronic	Dhenn product range
Terminals	MCC	Electronic	Entraleck Terminal ABB, ABB ADO Terminals
Temperature transmitter (4 – 20mA)	Protection	Electronic	Endress Hauser, TMT 121 (temp)
Loop Isolators	Control	Electronic	Danntech
VSD's	MCC	Electrical	Zest, ABB, Schneider, Danfoss
Power Supplies	PSU System	Electrical	Victron
Battery Protector	PSU System	Electrical	Victron
12VDC/24VDC Converter	PSU System	Electrical	Victron
Telemetry Hardware	Monitoring System	Electronic	Spectrum, SSE
SCADA Software	Monitoring System	Electronic	Adroit, SSE, OPC
Enclosures	Monitoring System	Electrical	Perano, Cubic, Tubular
UPS	PSU System	Electronic	Meisner
Signal Converters	Control	Electronic	Endress Hauser

Flow Meter (Electronic)	Instrumentation	Electronic	Endress Hauser
Pressure Transducers	Instrumentation	Electronic	Endress Hauser
Level Sensors	Instrumentation	Electronic	Endress Hauser
Online Instrumentation	Instrumentation	Electronic	Endress Hauser
Online Turbidity	Instrumentation	Electronic	Endress Hauser, HACH
Online CL Meters	Instrumentation	Electronic	Endress Hauser
Flow Meter (Mechanical)	Metering	Mechanical	Kent, Meineke

4.24 SCHEDULES OF EQUIPMENT OFFERED

The Contractor shall complete the following schedules giving full details of the equipment and materials offered as applicable. Manufacturer's data sheet for the proposed instrumentation shall be included in the returnable schedules.

Low Voltage Cables

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	Aberdare	
Supplier		
Type	PVC/SWA/PVC copper	
Manufactured to SANS/IEC?	Yes	
Delivery period (weeks)		

Control Cables

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	Aberdare	
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period (weeks)		

Signal Cables

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	Aberdare	
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period (weeks)		

Current Transformers

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Ammeters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	ABB, Schneider	
Supplier		
Type	Digital, PANEL	
Manufactured to SANS/IEC?	Yes	
Delivery period		

Voltmeters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	ABB, Schneider	
Supplier		
Type	Digital, PANEL	
Manufactured to SANS/IEC?	Yes	
Delivery period		

Kilowatt-Hour Meters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	ABB, Schneider	
Supplier		
Type	Digital, PANEL	
Manufactured to SANS/IEC?	Yes	
Delivery period		

Running-Hour Meters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	ABB, Schneider	
Supplier		
Type	Digital, PANEL	
Manufactured to SANS/IEC?	Yes	

Magnetic Flow Meters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Supply Voltage		
Ingress Protection (Transmitter)		
Flange Size		
Tube Material		
Manufactured to SANS/IEC/BS?	Yes	

PH Meter

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Supply Voltage		
Ingress Protection (Transmitter)		
Flange Size		
Operating Principle		
Manufactured to SANS/IEC/BS?	Yes	

Residual Chlorine Meters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC/BS?	Yes	

Salinity Meters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC/BS?	Yes	

Variable Frequency Drives

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Rating		
Drive Method		
Rated Current		
Maximum Input Voltage Variation		
Output Voltage		
Output Frequency		
Operating Temperature Limits		
Manuals and other technical documents required with Tender		
Manufactured to SANS/IEC/BA?	Yes	

PLC

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Power Supply Voltage		
Power Supply Maximum Variation		
Power Supply Backup Facility		
Input/Output Cards Model No.		
Digital Capacity of Input/Output Cards		
Analogue Capacity of Input/Output Cards		
Total No. of Input/Output Cards required		
Processor Model No.		
Maximum No. of Processor Racks		
Digital Input/Output Capacity of Processor		
Analogue Input/Output Capacity of Processor		
Memory Capacity of Processor		
Extendibility of Memory of Processor		
Programming Language of Software		

PARTICULARS	SPECIFIED	OFFERED
Logic of Software		
Manuals and other technical documents required with Tender		
Manufactured to SANS/IEC/BA?	Yes	
Delivery period		

PLC Network

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Speed		
Protocol		
Manufactured to SANS/IEC/BS?	Yes	
Delivery period		

Ultrasonic Level Transmitters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Supply Voltage		
Transmitter Type		
Sensor Type		
Sensor Range		
Manufactured to SANS/IEC/BS?	Yes	
Delivery period		

Pressure Transmitters

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Sensor Range		
Manufactured to SANS/IEC/BS?	Yes	
Delivery period		

Light Switches and Socket Outlets

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Emergency Stop Buttons

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Flow Switches

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC/BS?	Yes	
Delivery period		

Conduit Non-Metallic

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	SA PVC or similar	
Supplier		
Type	20-, 25-, 32- and 50mm dia	
Manufactured to SANS/IEC/BS?	Yes	
Delivery period		

Galvanized Cable Tray

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC/BS?	Yes	
Delivery period		

Distribution Boards

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	MCB Switchboards or similar	
Supplier		
Type	Floor Standing & Surface Mounted	
Manufactured to SANS/IEC?	Yes	
No of doors	One	
Busbar current rating (A)	As specified	
Fault current rating (kA)	As specified	
Type of circuit breakers	CBI HY-MAG/FUCHS	
Delivery period (weeks)		

Earth Rods

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	Cadweld	
Supplier		
Type	2,4m x 16mm dia	
Manufactured to SANS/IEC?	Yes	
Delivery period		

Control Circuit Transformers

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Moulded Case Circuit Breakers and Isolators

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Panel Extract Fans

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Surge Arrestors

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Contactors

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type	AC3	
Manufactured to SANS/IEC?	Yes	
Delivery period		

Human Machine Interface

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Model		
Data Protocols		
Memory		
Type of Display		
Resolution of Display		
Delivery period		

Surface Mounted Watertight Isolators (Three Phase/Single Phase)

PARTICULARS	SPECIFIED	OFFERED
Manufacturer	Crabtree or Similar	
Supplier		
Type		
Manufactured to SANS/IEC?	Yes	
Delivery period		

Uninterruptible Power Supply

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type/Mode		
Input Voltage Rating		
Input Power Rating		
Output Voltage Rating		
Output Power Rating		
Battery Output (i.e. A/h)		
Heat Dissipation (W/m^2)		
Bridging Time		
Inverter/Charger Width (mm)		
Inverter/Charger Length (mm)		
Inverter Charger Height (mm)		
Battery Cubicle Width		
Battery Cubicle Length (mm)		
Battery Cubicle Height (mm)		
Manuals and other technical documents required with Tender		

PARTICULARS	SPECIFIED	OFFERED
Manufactured to SANS/IEC/BA?	Yes	
Delivery period		

Computers

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Processor		
Memory		
Storage Space		
Power Supply		
Operating System		
Manuals and other technical documents required with Tender		
Delivery period		

Computer Network (Switch)

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Speed		
Protocol		
Manuals and other technical documents required with Tender		
Delivery period		

Printers

PARTICULARS	SPECIFIED	OFFERED
Manufacturer		
Supplier		
Type		
Print Resolution		
Print Size Capability		
Maximum Pages Per Minute		
Manuals and other technical documents required with Tender		
Delivery period		

SCADA Software

PARTICULARS	SPECIFIED	OFFERED
Package		
Relational Database Management System		
Reporting Package		
Scan Points		
Anti-Virus Package		
Manuals and other technical documents required with Tender		
Delivery period		

C3.5 Management

C3.5.3 PLANNING AND PROGRAMMING

Programming

The Contractor must submit his construction programme within the time stated in the Contract Data and the Engineer shall be empowered to withhold all payment certificates until the Contractor has complied with his obligations in terms of this clause.

The programme is subject to the Engineers approval and remains so for the duration of the contract. If necessary, the Engineer may instruct the Contractor to adjust his programme to suit other activities.

This programme shall be in the form of a sloping bar chart or other time/activity form acceptable to the Engineer. The programme shall clearly show the anticipated quantities and values of works performed each month.

The unit of measurement in respect of the time periods of activities will be a week. The programme shall reflect at least the following information:

(i) A description of each of the major activities, which are to be carried out during the contract and the sequence in which they will be done.

(ii) The programmed time for carrying out each activity.

(iii) The dependencies which exist between the various activities and whether these are time-related or resources-limited or both.

(iv) The critical path of activities on which final completion of the Works is dependent.

(v) The amount of slack time for non-critical activities.

The following details shall also accompany the programme:

(i) Proposed number of working hours per day, working days per week, "pay weekends": if any, and any proposed holiday or other shut down periods.

(ii) Schedule of proposed labour resources (giving a breakdown of engineers/technicians, foremen, supervisions, artisans, skilled and unskilled labour) for each major activity.

(iii) Schedule of proposed plant resources (giving a breakdown of description and number of units) for each major activity.

A network-based programme according to the precedence method shall also be provided showing the various activities in such detail as may be required by the Engineer. The programme shall be updated monthly in accordance with the progress made by the Contractor.

If, during the progress of the work, the quantities of work performed per month fall below those shown on the programme, or if the sequence of operations is altered, or if the programme is deviated from in any other way, the Contractor shall, within one week of being notified by the Engineer, submit a revised programme and network.

If the programme has to be revised by reason of the Contractor falling behind his programme, he shall produce a revised programme showing how he intends to regain lost time in order to ensure completion of the works within the time for completion as defined in the Conditions of Contract or any granted extension of time as defined in the Conditions of Contract. Any proposal to increase the tempo of work must be accompanied by positive steps to increase production by either providing more labour and plant on site, or using the available labour and plant in a more efficient manner.

Failure on the part of the Contractor to submit or to work according to the programme or revised programmes shall be sufficient reason for the Engineer to take steps.

The approval by the Engineer of any programme shall have no contractual significance other than that the Engineer will be satisfied if the work is carried out according to such programme and that the Contractor undertakes to carry out the work in accordance with the programme. It shall not limit the right of the Engineer to instruct the Contractor to vary the programme should circumstances make this necessary.

It is in the Contractor's interest to give as much information as possible about times allowed for construction as well as resource or other limitations on programme times, since this programme will form the basis for any contractual negotiations about extensions of time once the contract is commenced. Failure to comply with any of these requirements will entitle the Engineer to use a programme based on his own assumptions to evaluate claims for extension of time for the completion of the work and/or for additional compensation.

Once approved by the Engineer in writing, this programme shall be known as the contract programme and shall be revised only as described below. Minor revisions to the contract programme may be introduced from time to time by mutual agreement between the Contractor and the Engineer. Should the Engineer require a major revision to the contract programme for whatever reason, the Contractor shall be notified in writing and such revision shall be submitted for approval to the Engineer within two weeks of receipt of such notification.

If a revised programme is issued, the effect on the initial critical path must be clearly indicated to the Engineer as must the steps required to be taken to ensure the completion of the contract within the stated Time of Completion.

The Contractor shall submit to the Engineer, at least three working days before each monthly site meeting, one paper print of the contract programme with detailed programmes (as described below) duly marked up to reflect the actual progress up to that date.

C3.5.3.2 Reporting

The Contractor shall submit to the Engineer at least three working days before each monthly site meeting a monthly progress report, which shall include the following:

(i) A summary of progress on site over the month immediately preceding the monthly site meeting. This shall be in the form of a detailed narrative to the contract programme.

(ii) Highlight activities running late, indicating what steps have (or will) be taken (e.g. reprogramming), additional plant and/or labour resources, etc.) to ensure that the specified date of completion is not overrun.

(iii) Status report of all plant employed on site.

(iv) Status report of all labour resources employed on site.

(v) Status report of all material on site.

No separate payment will be made for observing these requirements as it is deemed to be included in the amounts tendered for Section A: Preliminary and General

C3.5.4 METHODS AND PROCEDURES

C3.5.4.1 Methods

Construction methods must be of such a nature that no person, property or improvements in the vicinity of the works is endangered. The Employer accepts no responsibility for any work executed without written permission outside the site of Works.

C3.5.4.2 Site Instruction Book

A triplicate book supplied by the Engineer to be used for site instructions shall at all times be kept on the site and is only for the use of the Engineer.

C3.5.4.3 Site Correspondence Book

A triplicate book supplied by the Contractor to be used for site correspondence shall at all times be kept on the site and is only for the use of the parties associated with the execution of the Works and that is represented on the monthly contractual meeting.

C3.5.4.4 Dealing with Water

The Contractor is responsible for the control of storm water from adjoining areas, the site and ground water. No additional payment will be made and it will be deemed to be included in the rates of the relevant items.

C3.5.4.5 Survey Beacons

The Engineer will provide benchmarks with levels and coordinates. The Contractor's attention is drawn to clause 5.1.2 of SANS 1200 A. The Contractor must confirm the correctness and accuracy of the benchmarks provided before the commencement of any construction works and must confirm acceptance of the benchmarks in the site correspondence book. The Employer accepts no responsibility for incorrect benchmarks in the event that the Contractor failed to follow the above checking and acceptance procedure.

C3.5.4.7 Drawings

Only figured dimensions shall be used and drawings shall not be scaled unless so instructed by the Engineer. The Engineer will supply any figured dimensions, which may have been omitted from the drawings.

C3.5.4.9 Existing Services

The positions of known existing services are shown on the drawings. The Contractor shall note that although the drawings have been prepared using available information they show only the approximate positions of existing services and shall be a guide only.

Before the Contractor commences operations, he must discuss with and have the approval of the Employer, authority or owner concerned regarding the method he proposes to use for relocating or safe-guarding any services and existing works he may encounter during construction.

The positions of existing services shown on the Drawings are given in good faith and no guarantee can be given that:

- these services actually are in the approximate positions indicated.

- that these are the only services in the vicinity, and
- that the nature and description of these services are correct.

The Contractor shall be responsible to locate and safeguard any existing service or work he may encounter during construction and shall obtain clearance from the Employer, authority and the Engineer before commencing work in the proximity of existing services or works.

The Contractor shall be responsible for any damage to such existing services and works in the execution of this contract and shall reimburse the Employer, authority or the owner concerned for any repairs required and for damages.

The Contractor shall be responsible for immediately notifying the Engineer and the authorities concerned regarding any damage caused to public services and existing works.

The Authority concerned shall carry out any alternations to public services unless the Contractor is instructed otherwise.

The Contractor shall provide the necessary assistance during any operations necessary in connection with the removal, alternations or safeguarding of any public service.

C3.5.4.10 Testing and Quality Control

The Contractor shall engage the services of an approved independent testing laboratory for the testing of materials and the quality testing of layer works, to ensure that his work conforms to the specifications. No separate payment will be made for such testing by an approved laboratory, the costs of which will be deemed to be included in the Contractor's tendered rates for the various items of work requiring testing in accordance with the specifications.

C3.5.4.11 Certificates of Payment

The Engineer's certificate will be issued only after receipt by them of a draft certificate prepared by the Contractor at their own expense in the form prescribed by the Engineer. The cost of duplicating and delivering copies of the certificate to the Contractor, the Engineer and the employer shall be borne by the Contractor.

Before any payment for materials on site is certified by the Engineer, the Contractor shall submit to the Engineer for approval cessions from each of the Contractor's suppliers vesting ownership of materials delivered for use on the Site or any authorised extended Site to the Contractor.

C3.5.4.12 Construction in Limited Areas

In certain cases working space may be limited. The method of construction in these restricted areas will depend largely on the Contractor's plant. However, the Contractor must note that measurement and payment will be according to the specified cross-sections and dimensions irrespective of the method used to achieve these cross-sections and dimensions, and that the rates and prices tendered shall be deemed to include full compensation for any difficulty encountered while working in limited areas and narrow widths, and that no extra payment will be made, nor will any claim for payment due to these difficulties be considered.

C3.5.4.15 Samples

The Contractor shall at his own cost, supply all samples that may be required. Material or wok not conforming to the approved samples shall be rejected. The Engineer reserves to himself the right to submit samples to any test to ensure that the material represented by the sample conforms to the requirements of the specifications.

C3.5.4.16 Manufacturer's Instructions

The recommendations of the manufacturers of patented materials must be strictly adhered to regarding the use, mixing, application, fastening, etc. thereof except when otherwise instructed in writing by the Engineer.

C3.5.4.17 Proprietary Materials

Where proprietary materials are specified it is to indicate the quality or type of materials or articles required, and where the terms "or other approved" or "or approved equivalent" are used in connection with proprietary materials or articles, it is to be understood that the approval shall be at the sole discretion of the Engineer.

C3.5.4.19 Workmanship and Quality Control

The onus to produce work which conforms in quality and accuracy of detail to the requirements of the specifications and drawings rests with the Contractor, and the Contractor shall, at his own expense, institute a quality-control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and technical staff, together with all transport, instruments and equipment, to ensure adequate supervision and positive control of the works at all times.

The costs of all supervision and process control, including testing thus carried out by the Contractor shall be deemed to be included in the rates tendered for the related items of work.

The Contractor's attention is drawn to the provisions of the various standardized specifications regarding the minimum frequency of testing that will be required for process control. The Contractor shall, at his own discretion, increase this frequency where necessary to ensure adequate control.

On completion of every part of the work and submission thereof to the Engineer for examination, the Contractor shall furnish the Engineer with the results of all relevant tests, measurements and levels to indicate compliance with the specifications.

C3.5.4.20 Transport of Material

All costs of transporting material, including overhaul, shall be included in the applicable tendered rates. All references in the specifications to transport, overhaul and haul distances shall be deleted irrespective of whether or not the deletion is included in these Specification Data.

C3.5.4.21 Liaison with Local authorities

The Contractor will have to liaise with local authorities regarding the following matters:

(a) Dealing with traffic.

(b) Locating of existing underground services.

(c) Protection of existing services during construction.

All the relevant authorities were notified of above operations. It is then the Contractor's onus to immediately contact all these authorities and to accommodate their involvement in his programme of work. The Contractor should also warn the authorities at least 48 hours before the actual work commence. Compensation for delays, losses or accidents will not be considered should the Contractor at any time have failed to keep the local authorities informed.

The engineer or Employer must immediately be notified, should the Contractor experience any problem regarding work, which involves a local authority.

C3.5.4.23 Community Liaison and Community Relations

In all dealings with the community and workers employed from within the community, the Contractor shall take due cognisance of the character, culture and circumstances of the community involved and shall at all times use his best endeavours to avoid the development of disputes and to foster a spirit of co-operation and harmony towards the project. The Contractor shall at all times, keep the Engineer fully informed on all matters affecting the Contractor and the community, and shall attend all community meetings relating to the project as may be reasonably required by the Engineer. All matters concerning the community shall be discussed and where possible, resolved at such meetings.

Where any resolution of a community meeting shall be contrary to the terms and provisions of the Contract, the Contractor shall not give effect thereto without a prior written instruction from the Engineer. Where the Contractor is of the opinion that any instruction of the Engineer issued in terms of this clause will result in the incurring of additional costs which were not provided for in his tendered rates and/or that a delay in the progress of the works will result, he shall be entitled to submit a claim

C3.5.4.24 Format of communication

All communication regarding the contract shall be channelled through the Engineer and / or his duly authorised representative.

C3.5.4.25 Management meeting

Management meetings shall be held once a month for the duration of the contract on dates and times to be agreed.

C3.5.4.26 Daily records

Daily records of site activities must be kept accurately. This would include record of plant, personnel, site and weather conditions.

C3.5.4.27 Normal working hours

Normal working hours shall be between 07:00 and 17:00 on weekdays from Mondays to Fridays and between 07:00 and 13:00 on Saturdays, should the Contractor choose to work on Saturdays, excluding Public holidays

C3.5.4.28 Interference with RIM staff and operations

The Contractor shall ensure that none of his staff interfere in any way with any municipal staff member or their functions.

Any member of the Contractor’s staff found to be interfering with municipal staff or operations in any way shall be removed from the site and shall not be allowed to return.

C3.5.5 ENVIRONMENTAL MANAGEMENT ACTIONS AND PLAN

C3.5.5.1 Environmental Management Requirements

Before starting work on site the Contractor shall present to the Engineer his Environmental Management Plan for approval. He shall also appoint an Environmental Management Officer in writing and give a copy of the letter of appointment to the Employer.

The Environmental Management Specifications are included in the Particular Specifications and must be referred to when compiling the Environmental Management Plan.

C3.5.5.2 Minimal disturbance to environment

The site and surroundings are to be kept clean from building rubble, waste etc. throughout the duration of the contract. Roads used for transporting material shall be kept clean, and dirt free on a daily basis. No separate payment will be made for this and it will be deemed to be included in the rate for the relevant items.

Stacking of cut-down trees and vegetation on-site is not allowed, as this is a possible fire-hazard.

C3.5.5.3 Site maintenance

During the progress of the work upon its completion, the site of the works shall be kept and left in a clean and orderly condition. The Contractor shall at all times store materials and equipment for which he is responsible in an orderly manner, and shall keep the site free from debris and obstruction.

C3.5.6 HEALTH AND SAFETY

C3.5.6.1 Health and Safety Requirements

Before starting work on site the Contractor shall present to the Engineer his Health and Safety Plan for approval. He shall also appoint a Health and Safety Officer in writing and give a copy of the letter of appointment to the Employer.

The Health and Safety Specifications are included in the Particular Specifications and must be referred to when compiling the Health and Safety Plan.

Please also refer to Schedule K and L and to the requirements of the Construction Regulations of 2014.

The Contractor is to implement measures and adhere to these conditions for the duration of the contract. The tendered rates shall be an all-inclusive sum for adhering to the Health and Safety Specification and Health and Safety Plan.

C3.5.6.2 Safety

The Contractor must take the safety of the residents and their property into account during the planning and execution of the works. All open trenches, services, material and machines must be protected and clearly marked.

C3.5.6.3 Access to Site by Public

The Contractor shall erect fences and employ sufficient security personnel to prevent unauthorised access to the site by members of the public. Notices prohibiting access to the site shall be clearly displayed at all access points.

The notice shall be in English, Afrikaans and the most commonly used local language.

C3.5.6.4 Barricades and Lighting

All excavations and openings in walls and slabs into or through which a person may fall shall be securely barricaded at all times in accordance with the requirements of the applicable Occupational Health and Safety Regulations.

C3.5.6.5 Operational Acceptance Period for Mechanical and Electrical Plant

When the Tests on Completion have been successfully completed to the satisfaction of the Engineer, an Operational Acceptance Period shall start and shall consist of a continuous period of operation under full load conditions of four weeks. During this time the Contractor shall demonstrate the proper working of the equipment provided. All Plant shall operate trouble-free during the full four week period, failing which the Plant shall be repaired or replaced and the Operational Acceptance Period repeated, again over a four week period.
During the Operational Acceptance Period the Contractor shall monitor and record the performance of the Plant and carry out all necessary servicing and adjustment required, including routine and other maintenance in accordance with the instructions contained in the Operation and Maintenance Manuals relevant to the Plant.

C3.5.6.6 Tests after completion of the Operational Acceptance Period

The tests after completion of the Operational Acceptance Period shall demonstrate to the Engineer that it has performed in accordance with the specifications for the 4 week period and will continue to do so. This shall include supporting documentation of recordable performance trends over the 4 week period (e.g. flow, pressure, temperature, alarms, water levels, etc.).
The M&E Works shall only qualify for a Taking-Over certificate once the Operational Acceptance Period is successfully concluded and all identified snags at the tests after completion of the Operational Acceptance Period has been attended to.

C3.5.6.7 Training the Employer's Staff for Mechanical and Electrical Plant

During the Operational Acceptance Period the Contractor shall train the Employer's operating staff and instruct them in the proper operating and maintenance procedures for the equipment concerned. This shall include troubleshooting procedures in the case of malfunctioning of equipment.
Training shall take place for the duration of the commissioning period and the Contractor shall submit a comprehensive training schedule to the Engineer for approval. The schedule shall indicate the time and date of the training, the type of training, the target group for the training, the duration of the training, training materials provided, name of person presenting the training, etc.
The training schedule shall be submitted to the Engineer not less than 4 weeks prior to the intended commencement date of the training, to allow comments to be made and incorporated. This period is also required to allow the Employer to make scheduling arrangements in order to ensure the availability of staff members for training.
Where the Employer's staff works on a shift basis the Contractor shall allow for the fact that certain training sessions may have to be presented more than once in order to allow all relevant staff members to attend.

C3.6 ANNEXURES

ANNEXURE A: DRAWINGS

ANNEXURE B: PROJECT HEALTH AND SAFETY SPECIFICATION

ANNEXURE C: PROJECT LABOUR REPORT

ANNEXURE D: ENVIRONMENTAL MANAGEMENT SPECIFICATION

ANNEXURE A: DRAWINGS

Drawing Number	Title
D22009DWG-C001-04DT	Locality Plan
D22009DWG-C002-04DT	Existing Plant Layout
D22009DWG-C003-04DT	Desalination Plant Typical Flow Diagram

GREENFIELD RESOURCES
INTEGRITY | EFFICIENCY | AGILITY

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e-mail: admin@gfrsa.co.za

Client / Employer
ROBBEN ISLAND MUSEUM

Project
ROBBEN ISLAND DESALINATION WORKS

Plan Description
LOCALITY PLAN

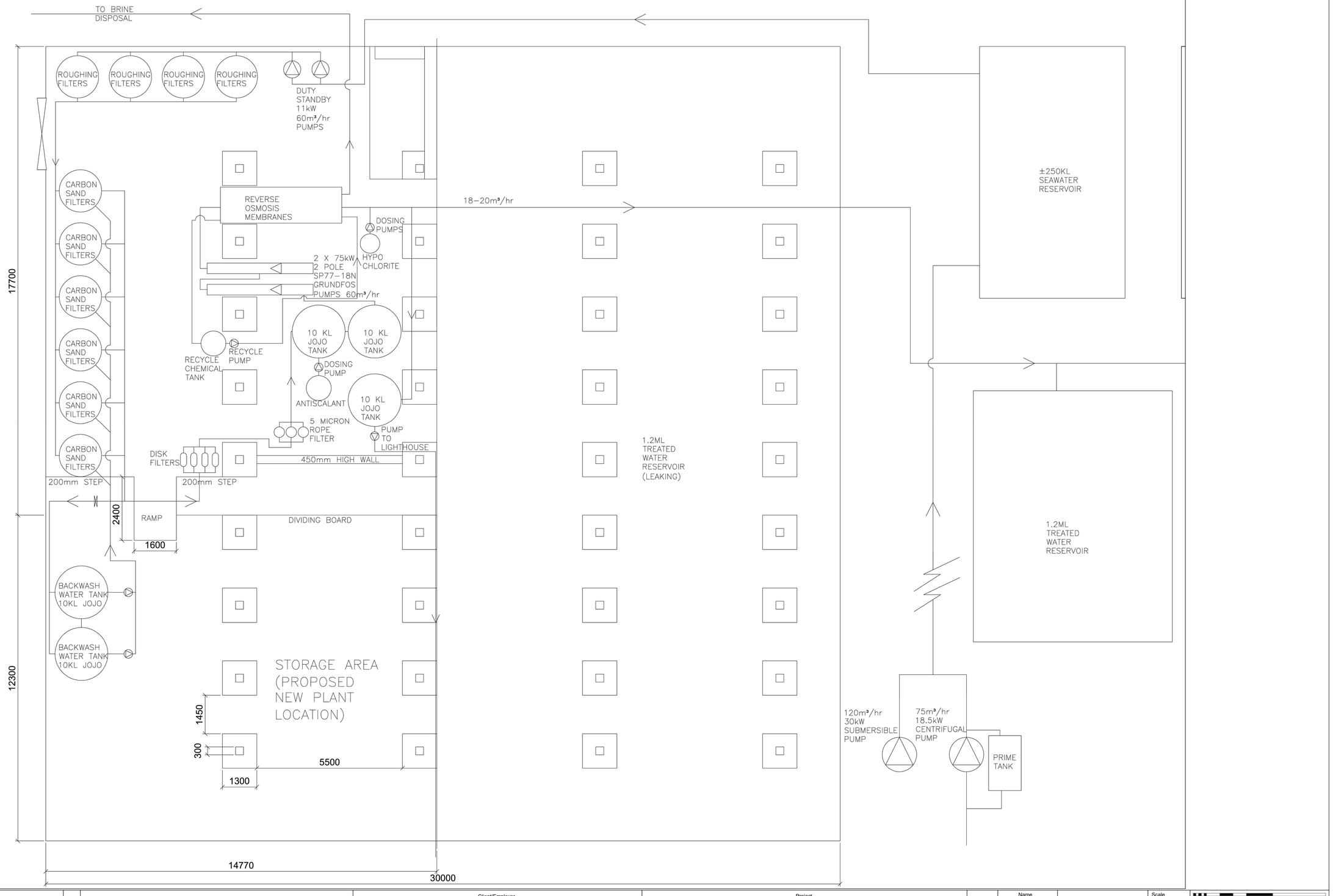
	Name	
Designed	D. Tshuma	
Drawn	D. Tshuma	
Checked	T. Nezandonyi	
Approved	T. Nezandonyi	

Scale: 1:250
0 5 10 15 20mm
ORIGINAL SIZE A3

Contract No.: P-D22009

Drawing No.: D22009DWG-C001-04DT

Revision: 0



Rev.	Date	Description	Rev. by
A	06/06/2025	FOR TENDER	

GREENFIELD RESOURCES
INTEGRITY | EFFICIENCY | AGILITY

Unit 13,Block 3, Falcon Crest
142 South Street,
P O Box 0157,
Centurion,
Gauteng,

Tel: +27 12 643 0357
e-mail: admin@gfrsa.co.za

Client/Employer

Robben Island MUSEUM

Project

DESIGN AND BUILD OF A REVERSE OSMOSIS DESALINATION PLANT

Plan Description

EXISTING PLANT LAYOUT

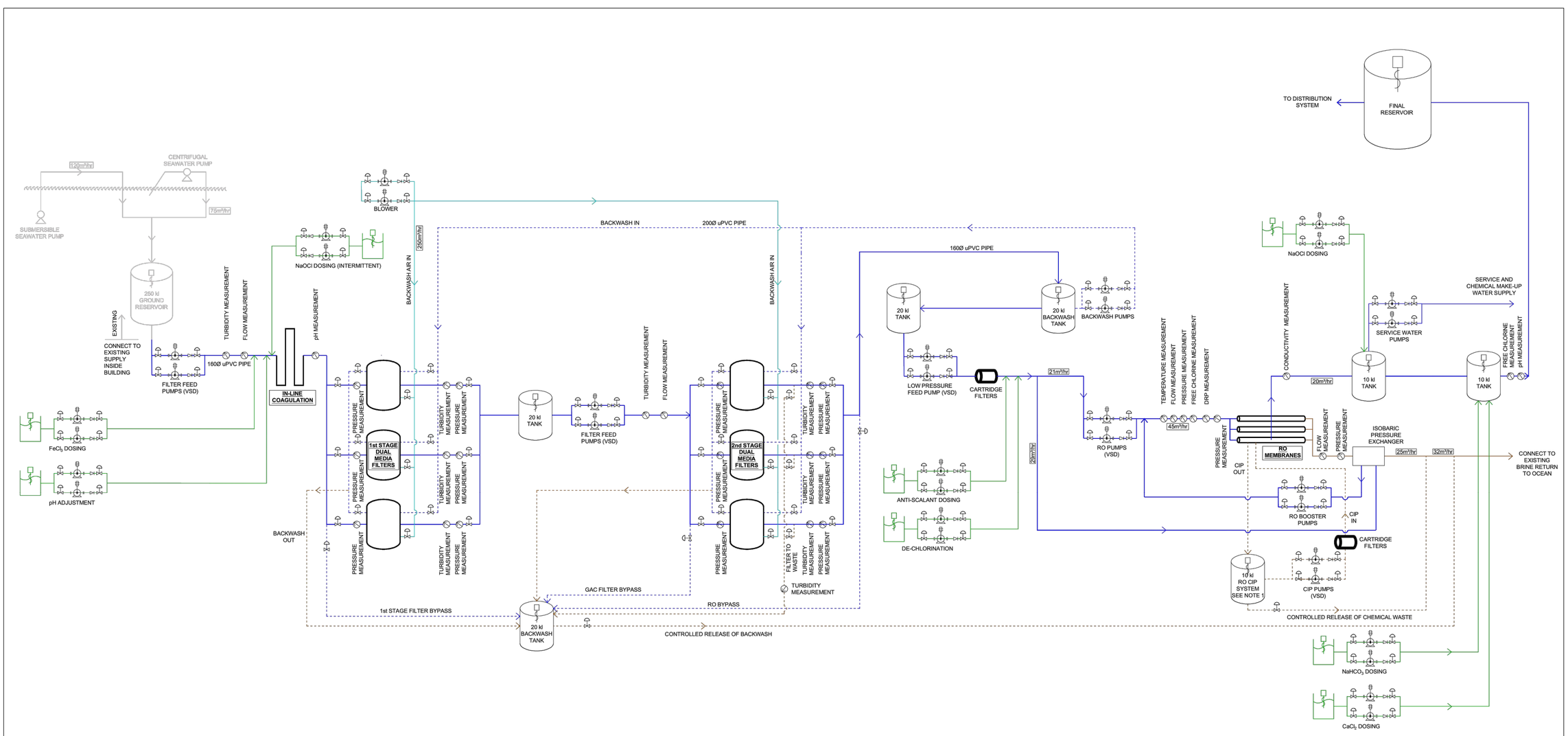
	Name	
Designed	D. Tshuma	
Drawn	D. Tshuma	
Checked	T. Nezandonyi	
Approved	T. Nezandonyi	

Scale: NTS (0 5 10 15 20 30 50mm) ORIGINAL SIZE A2

Contract No.: P-D22009

Drawing No.: D22009DWG-C002-04DT

Revision: 0



* NOTE 1:
- NaOH DOSING
- H_2SO_4 DOSING
- NaOCl DOSING

LEGEND

- DOSING LINE
- MAIN PROCESS LINE
- BACKWASH IN
- BACKWASH OUT
- BRINE TO OCEAN
- BACKWASH AIR IN
- EXISTING WORKS

TYPICAL
FOR INFORMATION ONLY

Rev.	Date	Description	Rev. by
A	06/06/2025	FOR TENDER	

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Project

DESIGN AND BUILD OF A REVERSE OSMOSIS DESALINATION PLANT

Plan Description

PROPOSED DESALINATION PLANT
TYPICAL PROCESS FLOW DIAGRAM

	Name	
Designed	D. Tshuma	
Drawn	D. Tshuma	
Checked	T. Nezandonyi	
Approved	T. Nezandonyi	

Scale: NTS
0 5 10 15 20 30 50mm
ORIGINAL SIZE A2

Contract No. P-D22009

Drawing No. D22009DWG-C003-04DT

Revision 0

ANNEXURE B: PROJECT HEALTH AND SAFETY SPECIFICATION

PREAMBLE TO SCHEDULE

This document is to be read in conjunction with all other contract documents, including die Project Specific Health and Safety Specification included under section C.3.6. Before any work begins, the Contractor must answer this specification with a document called a SAFETY PLAN. This bound document must be presented to the Employer for written approval before the work begins.

The Safety Plan is to be both site specific and company specific. Once approved, the Safety Plan remains with the Client and the principal contractor then makes a further copy to be kept at the site office.

At the end of the project, the day-to-day safety documents are collated and presented to the Client as part of the SAFETY FILE. See item 4 of the specification.

The Contractor shall take notice of the exposure to hazardous biological agents on this site and shall ensure that all labour undergo the necessary medical examinations before they access the site.

For easy reference the sections of the Construction Regulations 2014 are listed at the end of the Specification.
In his Safety plan the appointed Principal Contractor must show how he plans to :

HEALTH AND SAFETY SPECIFICATION

FOR

DESIGN BUILD AND COMMISSION OF A REVERSE OSMOSIS DESALINATION PLANT, ROBBEN ISLAND PROJECT

ROBBEN ISLAND MUSEUM

FOREWORD

This Health and Safety specification has been compiled under the guidelines of the Occupational Health & Safety Act no.85 of 1993 and amended Construction Regulations.

Huge emphasis is placed on the requirements of the New Construction Regulations 2014 under the Occupational Health and Safety Act and the Baseline Risk Assessment that form the basis of this specification. Contractors are encouraged to not only read these two documents in isolation but must consider the By-Law Relating to Community Fire Safety 11257 and Relevant National Building Regulations SANS Codes 10400.

Should there be any contradiction between then document and the Act; the Act must take preference except where explicitly stated.

Similarly, where this document is silent on a specific Health & Safety requirement, the Act must be used as the minimum requirement.

Should you be unclear about anything set out in this document, please contact this office.

Ensuring you of our best intentions and service at all times

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND

1.1 Background to The Health and Safety Specification

The Construction Regulations (February 2014) place the onus on the Client to prepare a preconstruction Health and Safety specification, highlighting all risks not successfully eliminated during design setting standards for Health and Safety during construction phase. The Health and Safety Specification will be based on the findings of the Baseline Risk Assessment.

1.2 Purpose of The Health and Safety Specification

To assist in achieving compliance with the Occupational Health and Safety Act 85/1993 and the promulgated Construction Regulations (February 2014) to reduce incidents and injuries. This specification shall act as the basis for the drafting of the construction phase Health and Safety plan by the Principal Contractor.

The specification sets out the requirements to be followed by the Principal Contractor and their contractors so that the Health and Safety of all persons potentially at risk may receive the same priority as other facets of the project e.g., Cost, programme, environment, quality etc.

2. DEFINITIONS

Agent	means a competent person who acts as a representative for a client.
Angle Of Repose	means the steepest angle of a surface at which a mass of loose or fragmented material will remain stationary in a pile on the surface, rather than sliding or crumbling away.
Bulk Mixing Plant	means machinery, appliances or other similar devices that are assembled in such a manner so as to be able to mix materials in bulk for the purposes of using the mixed product for construction work.
Client	means the Western Cape Government
Competent Person	means a person who- (a) has in respect of the work or task to be performed the required knowledge, training, and experience and, where applicable, qualifications, specific to that work or task: Provided that where appropriate qualifications and training are registered in terms of the provisions of the National Qualification Framework Act, 2000 (Act No.67 of 2000), those qualifications and that training must be regarded as the required qualifications and training. and (b) is familiar with the Act and with the applicable regulations made under the Act.
Construction Manager	means a competent person responsible for the management of the physical construction processes and the coordination, administration, and management of resources on a construction site.
Construction Site	means a workplace where construction work is being performed.
Construction Supervisor	means a competent person responsible for the management of the physical construction processes and the coordination, administration, and management of resources on a construction site.
Construction Vehicle	means a vehicle used as a means of conveyance for transporting persons or material, or persons and material, on and off the construction site for the purposes of performing construction work.
Construction Work	means any work in connection with - a) the construction, erection, alteration, renovation, repair, demolition or dismantling of or addition to a building or any similar structure. or

	b) the construction, erection, maintenance, demolition or dismantling of any bridge, dam, canal, road, railway, runway, sewer, or water reticulation system. or the moving c) Page 7 of 79 d) of earth, clearing of land, the making of excavation, piling, or any similar civil engineering structure or type of work.
Contractor	means an employer who performs construction work.
Demolition Work	means a method to dismantle, wreck, break, pull down or knock down of a structure or part thereof by way of manual labour, machinery, or the use of explosives.
Design	in relation to any structure, includes drawings, calculations, design details and specifications.
Designer	means- a) a competent person who- I. prepares a design. II. checks and approves a design. III. arranges for a person at work under his or her control to prepare a design, including an employee of that person where he or she is the employer. or IV. designs temporary work, including its components. b) an architect or engineer contributing to or having overall responsibility for a design. c) a building services engineer designing details for fixed plant. d) a surveyor specifying articles or drawing up specifications. e) a Contractor carrying out design work as part of a design and building project. or an interior designer, shopfitter, or landscape architect.
Excavation Work	means the making of any man-made cavity, trench, pit, or depression formed by cutting, digging, or scooping.
Explosive Actuated Fastening Device	means a tool that is activated by an explosive charge and that is used for driving bolts, nails, and similar objects for the purpose of providing fixing.
Fall Arrest Equipment	means equipment used to arrest a person in a fall, including personal equipment, a body harness, lanyards, deceleration devices, lifelines, or similar equipment.
Fall Prevention Equipment	means equipment used to prevent persons from falling from a fall risk position, including personal equipment, a body harness, lanyards, lifelines, or physical equipment such as guardrails, screens, barricades, anchorages, or similar equipment.
Fall Protection Plan	means a documented plan, which includes and provides for- a) all risks relating to working from a fall risk position, considering the nature of work undertaken. b) the procedures and methods to be applied in order to eliminate the risk of falling. and c) a rescue plan and procedures.
Fall Risk	means any potential exposure to falling either from, off or into.
Health And Safety File	means a file, or other record containing the information in writing required by these Regulations.
Health And Safety Plan	means a site, activity, or project specific documented plan in accordance with the client's H&S specification.
Health And Safety Specification	means a site, activity or project specific document prepared by the client pertaining to all health and safety. Page 8 of 79 requirements related to construction work.
Material Hoist	means a hoist used to lower or raise material and equipment, excluding passengers.
Medical Certificate Of Fitness	means a certificate contemplated in CR 7(8).
Mobile Plant	means any machinery, appliance or other similar device that is able to move independently and is used for the purpose of performing construction work on a construction site.
Principal Contractor	means an employer appointed by the client to perform construction work, used

	interchangeably with the term "Principal Contractor".
"Professional Construction Health And Safety Agent	means a person holding registration as a Professional Construction Health and Safety Agent in terms of the Project and Construction Management Act (Act No. 48 of 2000).
"Professional Engineer Or Professional Certificated Engineer	means a person holding. registration as either a Professional Engineer or Professional Certificated Engineer in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000).
Professional Technologist	means a person holding registration as a Professional Engineering Technologist in terms of the Engineering Profession Act, 2000.
Scaffold	means a temporary elevated platform and supporting structure used for providing access to and supporting workmen or materials or both.
Shoring	means a system used to support the sides of an excavation and which is intended to prevent the cave-in or the collapse of the sides of an excavation.
Structure	means- a. any building, steel, or reinforced concrete structure (not being a building), railway line or siding, bridge, waterworks, reservoir, pipe or pipeline, cable, sewer, sewage works, fixed vessels, road, drainage works, earthworks, dam, wall, mast, tower, tower crane, bulk mixing plant, pylon, surface and underground tanks, earth retaining structure, or any structure designed to preserve or alter any natural feature, and any other similar structure. b. any falsework, scaffold or other structure designed or used to provide support or means of access during construction work. or (b) any fixed plant in respect of construction work which includes installation, commissioning, decommissioning, or dismantling and where any construction work involves a risk of a person falling.
Suspended Platform	a working platform suspended from supports by means of one or more separate ropes from each support.
Temporary Works	means any falsework, formwork, support work, scaffold, shoring or other temporary structure designed to provide support or means of access during construction work.
The Act" Or "OHS Act	means the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).
Tunnelling	means the construction of any tunnel beneath the natural surface of the earth for a purpose other than the searching for or winning of a mineral.

2.2 References

a) Occupational Health and Safety Act (85 of 1993)
b) Construction Regulations, 2014
c) Compensation for Occupational Injuries and Diseases Act (130 of 1993)
d) Department of Employment and Labour, Workplace Preparedness: COVID-19 (SARS-CoV-19 virus), 2020 guideline.
e) Disaster Management Act (57 of 2002)
f) Hazardous Substances Act (85 of 1973)
g) Prevention of Environmental Pollution Ordinance Act (21 of 1981)
h) Project and Construction Management Act (48 of 2000)

and any other act or regulation passed in terms of, or as amendments to, the above.

3. PROJECT DIRECTORY

Project Client: Robben Island Musuem Contact Person: Ms Seithati Dutywa	Tel: +27 21 413 4242 e-mail: seithatib@robben-island.org.za
Project Manager: Greenfield Resources Contact Person: Mr A Madziwanzira	Tel: +27 12 643 0357 e-mail: admire@gfrsa.co.za
Project Civil Engineer: Contact Person:	Tel: e-mail:
Project Electrical Engineer: Contact Person:	Tel: e-mail:
Project Structural Engineer: Contact Person:	Tel: e-mail:
Project Quantity Surveyor: Contact Person:	Tel: e-mail:
Construction Safety Agent: Contact Person:	Tel: e-mail:
OTHER PARTIES DIRECTORY	
Department of Labour for submission of Annexure 2: Notification of Construction Work WESTERN CAPE	Tel: e-mail:
PROJECT DETAILS	
Description of Works: The design, manufacture, installation, commissioning and acceptance period and 6 months trial operation of an appropriate desalination system that would satisfy this requirement of the Employer. The requirement is for a reverse osmosis (RO) desalination facility that could produce desalinated water at a rate of 220m3/day (instantaneous production capacity of 12.22 m3/h), but with supporting infrastructure such as electrical supply, MCC, LV installation, HVAC, sea water abstraction pump and manifold replacement.	
Provisional Start Date: July 2025	
Completion Date: April 2026	
Contract Duration: 9 months	

4. HEALTH AND SAFETY SPECIFICATION

4.1 Scope

This specification covers the requirements for eliminating and mitigating incidents and injuries on **Design Build and Commission of a Reverse Osmosis Desalination Plant, Robben Island** Project.

The scope also addresses legal compliance, hazard identification and risk assessment, risk control and promoting a Health and Safety culture amongst those working on the project. The specification also makes provision for the protection of those persons other than employees.

4.2 Provision for Health & Safety Cost

The Principal Contractor and their contractors shall make adequate provision for the cost of Health & Safety Measures during the construction process as required by the Construction Regulation 5(1)(g).

5. INTERPRETATIONS

5.1 Application

This specification is a compliance document drawn up in terms of the South African legislation and is therefore binding. It must be read in conjunction with relevant legislation as noted previously.

6. MINIMUM ADMINISTRATIVE REQUIREMENTS

6.1 Notification of Intention to Commence Construction Work

A client who intends to have construction work carried out, must at least 30 days before that work is to be carried out apply to the provincial director in writing for a construction work permit to perform construction work if the intended construction work starts from the 7th of August 2018 and will –

1. exceed 365 days and will involve more than 3600 person days of construction work.

2. the tender value limit is grade 7, 8 or 9 of the Construction Industry Development Board (CIDB) grading

CIDB Grading chart

Tender Value Range Adjustments TVR)

CIDB Grade	Current TVR	Proposed Adjustment TVR
1	200 000	500 000
2	650 000	1 000 000
3	2 000 000	3 000 000
4	4 000 000	6 000 000
5	6 500 000	10 000 000
6	13 000 000	20 000 000
7	60 000 000	60 000 000
8	130 000 000	200 000 000
9	No Limit	N/A

Construction work permit:
Condition 1:

- is intended to exceed 365 days; or will involve more than 3600 person days of construction work; or

Condition 2:
Condition 2 is dependant on the Construction Industry Development Board (CIDB) grading, which are as follows:

- Grade 7 = R60 000 000
- Grade 8 = R130 000 000
- Grade 9 = No limit

If a construction work permit is not required for projects that forms part of the tender, then a Notification of Construction to the Department of Labour must be completed as below explained.

The appointed Principal Contractor shall notify the Provincial Director of the Department of Labour in writing that construction work commences as per the Annexure 2 in terms of CR 4.

A copy of the Notification must be placed in the Principal Contractors Health and Safety File on site and one copy shall be sent to the Client.

The Principal Contractor must ensure that the Notification of Construction Work is completed at the start of the project and kept on file for the duration of the project.

6.2 Assignment of Contractor's Responsible Persons to Manage and Supervise Health and Safety on Site.

The Principal Contractor shall submit management and supervisory appointments as well as any relevant Appointments in writing (as stipulated by the OHSA and Construction Regulations), prior to commencement of work. Proof of competency must be included.

Note: All appointments shall be done by the Chief Executive Officer/Managing Director or his/her assistant in terms of Section 16 of the OHS Act 85/1993 with exception to the Construction Manager in terms of Construction Regulation 8. The Construction Manager shall be full time on site unless an Alternate Competent Construction Manager has been appointed in writing.

6.3 Competency of Principal Contractor Responsible Persons

The Principal Contractors' competent persons for the various risk management portfolios shall fulfil the criteria as stipulated under the Definition of Competent in accordance with the Construction Regulations (February 2014). Proof of competence for the various appointments must be included prior to start of work.

6.4 Compensation for Occupational Injuries and Diseases Act (Coida) 130 Of 1993.

The Principal Contractor and their contractors shall submit a valid Letter of Good Standing from their Compensation Insurer-FEM or Compensation Commissioner to the Client's Representative as proof of registration before they commence work on site.

Note:
A client must ensure before any work commences on a site that every Principal Contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer as contemplated in the Compensation for Occupational Injuries and Diseases Act, 1993 (Act No. 130 of 1993).

Principal Contractor must ensure prior to work commencing on the site that every contractor is registered and in good standing with the compensation fund or with a licensed compensation insurer as contemplated in the Compensation for Occupational Injuries and Diseases Act, 1993.

6.5 Occupational Health and Safety Policy

The Contractor and their contractors shall submit a Health and Safety Policy signed by their Chief Executive Officer. The Policy must outline objectives and how they will be achieved and implemented by the Company / Contractor.

6.6 Health and Safety Organogram.

The Principal Contractor and their contractors shall submit an organogram with contact numbers, outlining the Health and Safety Site Management Structure including the relevant appointments / competent persons. In cases where appointments have not been made, the organogram shall reflect the intended positions. The organogram shall be updated when there are any changes in the site Management Structure and must be site specific.

6.7 Preliminary Hazard Identification and Risk Assessment

The Principal Contractor and their contractors shall develop Risk Assessments and Method statements by a competent person for the risk that they foresee during construction.

Note, the Principal Contractor shall ensure that a competent Risk Assessor is appointed in writing and shall be Full Time on site for the duration of the project.

Principal Contractor to provide a 14-day Look Ahead Hazard Identification Risk Assessment (HIRA) for upcoming activities before they are encountered on a bi-weekly basis and forward an electronic copy to the appointed Health and Safety Agent. Contractor to ensure that provision is made should physically impaired/challenged employees be employed.

Furthermore, the Principal Contractor and their contractors to ensure that Daily Safe Task Instruction/ Planned Tasked Observations are conducted prior to any activity with proof placed on file. Contractors may use their own Formats/Templates.

The following is a site-specific source of risks that have been identified but is not limited to and must as a minimum, be appropriately addressed by the Principal Contractor in their Health & Safety Plan with Control Measures but is not limited to:

Site Establishment
- Offloading of containers/site office
- Secure / Safe Storage of Material, Plant & Equipment
- Ablution Facilities
- Eating facilities
- Vehicle Access to Site

- Location of existing Services
- Dealing with existing structures and Traffic
- Provision for drinking water for all staff

Crane Management System (i.e., All Cranes)
- Competency and Medical Certificates of Operator
- Load Test Certificates
- Rescue Plan
- Crane Management Plan/System to be provided.
- (Emergency Procedures)
- CR 23 and Driven Machinery Regulations (2015) must be adhered to
- Relevant Inspections conducted by an LMI as per DMR 18 (2015)

Hoarding & Access Control
- Public Liability / Access Control / Compliance to Section 9
- Site needs to be Adequately Secured.
- Relevant Construction Warning Signage
- Daily inspections with proof placed on file.
- Hoarding to be in line with approved Design Drawings

Public Liability
- Effect of Construction Work on members of the public and existing property e.g. Neighboring Property
- Noise Control
- Dust Control
- Temporary lighting
- Relevant signage
- Hazardous Chemical Substances

Working near existing services
- Identification and protection of existing services
- Electrical Cables, Telkom, Data etc.

Plant & Machinery
- Principal Contractor to provide designated area should any plant and machinery be parked at night. Plant to be fully secured to avoid possible unauthorized access.

Unplanned collapse of Material or structures- Contractor to provide control measures.
- Principal Contractor to provide adequate protection to avoid falling objects e.g., Crash Decks, Catch Nets, Apron Fans etc. or any other similar protection as and where needed. Principal Contractor to assess all work areas prior to start of work.
- Structure to be inspected periodically by a competent person to render the structure safe. The structure to be maintained in such a manner so that it remains safe for continuous use.
- Records of inspections and maintenance are to be kept on file and must be made available on request to an inspector.
- Principal Contractor to provide full method statement and risk assessment.

Asbestos
- Principal Contractor to provide a method statement on how asbestos will be removed.
- Relevant signage to be displayed
- Site demarcation/no go areas
- Appropriate PPE to be worn

- Decontaminating/wash area
- Awareness session to be held weekly
- Site storage of Asbestos in close bin and double bagged
- Removal of asbestos to Vissershok
- Compliance to Asbestos work plan and Asbestos Regulations GNR 155 of 10 February 2002.
- Safe disposal certificates on file.

Civils Work
- Compliance to Construction Regulation 23
- Excavation & Compliance to Construction Regulation 13
- Persons/Equipment falling into Excavations.
- Edge Protection
- Asphalt
- Paving
- Road Cleaning to be maintained daily.

The Use of Troxler's: Contractors to ensure compliance and provide i.e.
- License for use of Troxler and density material and equipment
- Leak Test Certificates
- Calibration Certificate
- Procedure when transporting with relevant signage displayed.
- Risk Assessments
- Proof of Competency for operators

Procedure to identify underground HV/Electrical Cables
Compliance to the Driven Machinery Regulations (2015)

Traffic Management Plan to include but is not limited to i.e.:
- Scheduling of traffic management
- Inspections for during night traffic management
- Delivering of Material and Equipment
- Signage, Competent Flagmen and Compliance with all relevant regulation and legislation.
- Plan to be Monitored and Reviewed at least monthly (Every 30 Days) or as the building programme/activities changes.
- Adequate barriers and delineators to be provided and placed strategically as needed.
- Procedure for maintaining road signage.
- All employees/ visitors to wear Hi-Viz vests always.
- Competent Flagmen shall be provided and readily available to assist with all Deliveries.

Demolition during construction phase
- Adequate measures to ensure the safety of public
- Identifying services of live services
- PPE
- Relevant signage to be displayed
- Noise- Procedure to control noise to be in place.
- Use of Portable Power Tools
- Combustibles
- Housekeeping
- Demolition method statement
- Dust inhalation

Lifting and Installation Procedures
- Principal Contractor to submit Full Method Statements of their lifting and installation procedures e.g., manually, or mechanically.

- All lifting equipment to comply with Driven Machinery Regulation (2015)

Waste Management Plan/System to be implemented.

- Rubble to be stored neatly in bags/bins and collected as needed.
- Principal Contractors to provide sufficient Bins / Bags always and must be removed on a regular basis or as and when needed.
- All hazardous material to be stored separately and must be disposed of at an authorized landfill site. Proof of Disposal to be provided.
- Rubble shall not be allowed to accumulate on site and shall be removed at regular intervals.

Hot Works

- Principal Contractors and their contractors to ensure that Fire Equipment and adequate precaution measures are in place when grinding, welding / hot works etc. including PPE and demarcation.
- Hot work permits to be issued once the area has been inspected by a responsible person and declared safe with proof placed on file. (Note- All permits should not exceed one (1) working day)
- Compliance with CR 25& 29

Temporary Flammable Liquid/Material Storage

- Principal Contractor to ensure that adequate ventilation is provided with Relevant Signage and Fire Precautions provided.
- Adequate Fire Equipment to be readily available.
- Compliance with all relevant legislation and regulations including the Community Fire Safety By-law Compliance and CR 25& 29.

Temporary Works

- Competent Temporary Works Designer to be appointed in writing
- Erecting and Stripping of Temporary Works
- Authorization for stripping to be given by the structural engineer
- Design Drawings issued by a competent person
- Casting of Concrete
- Drilling / Cutting into Slab
- Adequate Edge Protection- No Danger Tape
- Authorization to be provided in writing by a competent person (Before Concrete Pour) and Handover Certificates/Signed off by a Competent Person before Stripping any temporary works structures
- Daily Inspections to be conducted

Structural Steel

- Principal Contractor to submit Task Specific Method Statements and Task Specific Risk Assessments of their lifting and installation procedures e.g. Manually or Mechanically.
- Full compliance with CR 9, 10, CR 23 and DMR 18 (2015)
- Guide Ropes shall be used as far as reasonably practicable when busy with all lifting operations to assist with possible uncontrolled loads especially during inclement weather and restricted areas.
- Only competent persons to conduct operations
- Task Specific Fall Protection & Rescue Plan
- All work areas shall be adequately demarcated with spotters' present.

Working near of Electrical Cables

- Contractor to provide full method statement and risk assessment when working on live electrical Cables. Must be communicated to all staff prior to the activity.

- All Staff must be provided with the relevant Personal Protective Equipment (PPE)

Procedure to identify HV/Electrical Cables
Electrical Installations – High and Low Voltage
Compliance to the Driven Machinery Regulations (2015)

Safe Use of Portable Electrical Equipment
- Electrical Drilling Machine
- Angle Grinder
- Kango / Jack Hammer
- High Pressure Equipment
- Any Other Equipment used by Principal Contractor.

Emergency Preparedness
- Emergency Evacuation Plan with Relevant Emergency Numbers
- Revision of Emergency Plan
- Principal Contractor to monitor site conditions and conduct Evacuation Drills as and when needed with proof placed on file (Roll call, report to be placed on file etc.)
- Enough workers are Trained (Competent) in the use of Fire Extinguishing Equipment
- Emergency assembly point to be established with the relevant signage displayed.
- Air horn/alarm/siren to be provided on site.

Manual and Mechanical Handling
Mechanical Installations

Protection of Storm Water System
- Method to Prevent Run Off into Storm Water System

Health Hazards
- Storage of hazardous materials
- Working with cementitious material
- Dust
- Noise
- Contaminated land
- Vibration
- Inhaling of Bituminous and cementitious material
- Exposure to Anime bases epoxy products

Water Environments
- Working close to water
- Contaminated land/water
- Water Pollution
- Working in close proximity of water

<u>Additional Activities foreseen on site.</u>

- Public Safety- Relevant precautions to be taken (Hoarding/Physical Barriers, signage etc.)
- Process to move equipment, tools, scrap material, etc. to and from elevated positions.
- Storage/control of Hazardous substances
- Wet Works
- Concrete Works

- Use of Temporary Access
- Kerbing
- Breaking up of Existing Pavements
- Asphalt
- Mole Barriers
- Paving
- Unforeseen activities

N.B. A risk assessment will be performed for all unplanned work and submitted to Health and Safety Agent for approval prior to work commencing.

Principal Contractors and their contractors to ensure that the risk assessments, as well as other risks identified by them, are updated at least every 30 days or as the risk changes are recorded and communicated to all relevant parties with proof placed on file- CR 9. Note: All reviews must be signed off by the appointed Risk Assessor.
Note: All identified risks and hazards must be based on a documented method (method statements)

Furthermore, the Principal Contractor and their contractors shall provide a Monitoring and a Review Plan including a Risk Register indicating all activities.

Note: Principal Contractor must ensure as far as is reasonably practicable, ergonomic related hazards are analysed, evaluated, and addressed in a risk assessment.

6.8 Fall Protection Plan: Erecting and Working on Scaffolding, Working at Heights, and Working near Excavation Edges

Working at heights includes any work that takes place in an elevated position. The Principal Contractor and their contractors must submit a risk/task-specific Fall Protection Plan in accordance with Construction Regulations 10. The Fall Protection Plan must be job specific, be reviewed at least monthly (Every 30 Days) or as the risk changes or after any incident. Contractors to ensure that medicals are provided for all persons exposed to elevated positions.

Scaffolding must comply with the requirements of **SANS 10085-1:2004.** Scaffolds are used extensively by Contractors and strict control measures must be in place to prevent Unauthorised alterations to scaffolding such as removing ties and scaffold boards.
Competent persons to be appointed in writing to:

- erect scaffolding (Scaffold Erector/s)
- act as Scaffold Team Leaders
- inspect Scaffolding daily and after inclement weather (Scaffold Inspector/s).
- **The Scaffolding must comply with SANS 10085:1-2004, fully cladded including, Crash Decks etc. as and when needed.**

Written Proof of Competency of above appointees to be available on Site.
Where scaffolding or work from scaffolding may negatively affect the public, it must include a scaffold fan/apron or access tunnel. Shade cloth must be used to enclose the scaffolding below the first fan/apron. Should the scaffolding be adjacent to an existing pavement of similar public walkway, a pavement **gantry and crash deck** will be required (overhead protective structure).

All employees working on heights must have a Medical Certificate issued by an Occupational Health Practitioner (OHP)
Note, The Principal Contractor shall provide a programme for the training of

employees working from a fall risk position and the records thereof.

A fall protection plan must include.

a) a risk assessment of all work carried out from a fall risk position and the procedures and methods used to address all the risks identified per location.
b) the processes for the evaluation of the employees' medical fitness necessary to work at a fall risk position and the records thereof.
c) a programme for the training of employees working from a fall risk position and the
d) records thereof.
e) the procedure addressing the inspection, testing and maintenance of all fall protection equipment; and
f) a rescue plan detailing the necessary procedure, personnel and suitable equipment required to affect a rescue of a person in the event of a fall incident to ensure that the rescue procedure is implemented immediately following the incident.

6.9 Health and Safety Officer 8(5)

The Principal Contractor shall provide a Part-Time on site depending on the contract value and combined discretion of the client and Health and Safety Agent, with proof of SACPCMP registration, proof of SACPCMP examination date or payment placed on file.

Important Note: Part-Time Safety Officer will be discussed and agreed upon based on the extend of work.

All contractor that has been appointed by the Principal Contractor shall ensure that they appoint a Part Time safety officer that will visit the site at least twice a week.

Note: "No contractor may appoint a construction health and safety officer to assist in the control of health and safety related aspects on the site unless he or she is reasonably satisfied that the construction health and safety officer that he or she intends to appoint is registered with a statutory body approved by the Chief Inspector and has necessary competencies and resources to assist the contractor", however an exemption was issued and all Safety Officers/Practitioners must now provide confirmation of application for registration of the construction health and safety discipline with the SACPCMP should he/she not be registered as yet.

6.10 Medicals

The Principal Contractor to ensure that all his or her employees including all appointed contractors have a valid medical certificate of fitness specific to the construction work to be performed and issued by an Occupational Health Practitioner in the form of an Annexure 3.

6.11 Health and Safety File (HSF)

The Principal Contractor and their contractors shall, in terms of CR 7(1), maintain the HSF on site always. The HSF is a file with permanent records containing information on aspects of the construction project - which will be necessary to ensure the health and safety of any persons who may be affected by the construction work.

The HSF must include all documentation required in terms of the Act and Regulations and must also include a list of all Contractors on site that are accountable to the Principal Contractors and the agreements between the parties and details of work being done.
The Principal Contractors shall appoint a suitably qualified person to prepare the HSF and to keep it up to date for the duration of the contract.

Health and Safety Requirements as per the framework contract:

Note that all contractors appointed by the Principal Contractor must provide the below documentation as a minimum depending if they are working on the Preventative or Corrective Maintenance contract.

Contractor Requirements
Health and Safety File that includes but is not limited to the below: 1) Notification of Construction Work to Department of Employment Labour 2) COIDA Letter of Goodstanding 3) Health and Safety Policy 4) Health and Safety Plan 5) Risk Assessments 6) Method Statement and Safe Work Procedure 7) Fall Protection Plan (if required) 8) Section 37.2 Mandatory Agreement 9) Contractor Appointment 10) Appointment Letters • Competency Letters 11) Emergency Procedures (in line with the premises) 12) Incident & Accident Procedure 13) Inspection Registers 14) Training • Induction • Toolbox Talk

6.12 The HSF Shall Include At Least The Following Information:

a) Notification of Construction Work (CR 3) or construction work permit depending on the contract.
b) Copy of OHSA (updated) (GAR 4.)
c) Proof of Registration and good standing with a COIDA Insurer (CR 5(1)(j) (The Principal Contractors shall submit a letter of good standing with the compensation Insurer, at the tender stage).
d) OHSP agreed with client including the underpinning Risk Assessment/s & Method Statements CR 9(1)
e) Designs/drawings including scaffolding and form work.
f) A list of Contractors (Sub-Contractors) including copies of the agreements between the parties and the type of work being done by each Contractor (CR 7)
g) Appointment/Designation forms h) Registers
h) Inductions

The HSF/CD shall be handed over to the Client on completion of the contract. It must contain all the documentation as set out above, or as instructed, as well as any handed to the Principal Contractor by any subcontractors together with a record of all drawings, designs, materials used and other similar information concerning the completed project.

6.13 Health and Safety Representative(S)

The Principal Contractor and their contractors shall ensure that competent Health and Safety Representative(s) are appointed under consultation and trained to carry out their functions as soon as the total workforce has reached a number of 20 employees or more. Should the Principal Contractor and their contractors have less than 20 employees, then the accumulative amount shall apply. The appointments must be in writing. The Health and Safety Representative shall carry out regular inspections at least monthly, keep records and report all findings to the Responsible Person forthwith and at Health and Safety meetings.

Note: The Principal Contractor and their contractors shall ensure that all certificates provided are issued by an accredited service provider as required by the National Qualification Framework Act 67/2000.

The number of representatives for each contractor shall be as per Section 17 of the OHS Act 85/1993, but as a minimum, The Principal Contractor shall appoint at least one competent Health and Safety Representative on the project.

6.14 Health and Safety Committees

Principal Contractor shall organize at least monthly Health & Safety meetings. Minutes and records shall be kept. Principal Contractors Health & Safety representative and responsible person shall attend this meeting. Principal Contractor to ensure that all Contractor Representatives attend these meetings.

Note: These meetings shall be conducted regardless how many contractors are appointed.

6.15 Health and Safety Training

6.15.1 *Induction*

Principal Contractor shall ensure that all (including site visitors etc.) undergo site- specific induction presented by a competent person and proof placed in the Safety File prior to start of work. Employees to carry proof of inductions.

6.15.2 *Awareness*

The Principal Contractor shall ensure that, on site, toolbox talks take place at least once per week. These talks should deal with risks relevant to the construction work at hand. A record of attendance shall be kept in the Health and Safety file. All Principal Contractors have to comply with this minimum requirement. Contractors to ensure that the discussion is recorded on file (Topics with notes).

The Principal Contractor must ensure that the relevant signage is clearly displayed on site, employees are kept informed and up to date with the latest news regarding COVID 19.

- Awareness Training in small groups
- Providing workers with up-to-date education and training on COVID-19 risk factors and protective behaviours (e.g., cough etiquette and care of PPE).

6.15.3*Health and Safety Site Rules*

The Principal Contractors must develop a Set of Site-Specific Health and Safety Rules that will be applied to regulate the Health and Safety aspects on Site. Security and Access control must be included in the rules and those non-employees or visitors will not be allowed on site unaccompanied.

The Principal Contractor must also familiarize and take into account the client's site rules.

6.15.4*Competency*

In accordance with the Construction Regulation the Principal Contractors shall appoint, in writing, competent persons (in addition to the Construction Managers – CR 8 (1)(2) & Construction Supervisor/s-8(7)(8) responsible for supervising construction work for the following work situations that may be expected on the site of the works, as applicable to the project.

A competent person may be appointed for more than one part of the construction work with the understanding that the person must be suitably qualified and able to manage and supervise at the same time the construction work on all the work situations for which he/she has been appointed.

The appointment of competent persons to supervise parts of the construction work does not relieve the Principal Contractors from any of his responsibilities to comply with all requirements of the Construction Regulations.

Note: The Principal Contractor and their contractors shall ensure that all certificates provided are issued by an accredited service provider as required by the National Qualification Framework Act 67/2000 and the South African Qualifications Authority (SAQA).

6.16**Environmental**

Environmental terms and conditions are to be adhered to. All relevant legislation and bylaws are to be adhered to. All necessary permits are to be applied for by the contractor such as transport permits, possession permits and flammable certificates.

The site is situated in a region where high winds and seasonal rain can be expected and with strong south-easterly winds during the summer months.

7. GENERAL RECORD KEEPING

The Principal Contractor and their contractors shall keep and maintain Health and Safety records to demonstrate compliance with this Specification, with the OHS Act 85/1993, and with the Construction Regulations (February 2014).

The Principal Contractor and their contractors shall ensure that all records of incidents / accidents, emergency procedures training, inspections, audits, etc. are kept in a Health and Safety file held in the site office.

The Principal Contractor must ensure that every contractor keeps and maintains its own Health and Safety file and must be readily available at all times. (The file must include the Contractor's health and safety plan). These records are crucial for inclusion in the Principal

Contractors' consolidated health and safety file for handover to the Client on completion of construction work.

8. HEALTH AND SAFETY AUDITS, MONITORING AND REPORTING

The Client's Health & Safety Agent shall conduct monthly Health and Safety audits/inspections with follow up audits of the work. Operations including a full audit of physical site activities as well as an audit of the administration Health and Safety. The Health and Safety Agent may conduct unannounced visits as and when needed.

Preventative Maintenance:

- **The Health and Safety Agent will contact the Principal Contractor to arrange any audits.**
- **The Principal Contractor must inform the Health and Safety agent on a daily basis of his activities and location.**

The Principal Contractor and their contractors are obligated to conduct similar audits on their contractors.

Detailed reports of the audit findings and results shall be reported on at all levels of project management meetings.

Copies of the reports shall be kept on file and must be readily available for inspection. The Principal Contractor must audit their contractors and keep records of these audits in their Health and Safety files and must be available on request.
Note: The Principal Contractor shall ensure that all contractors documentation is assessed and approved prior to start of work with proof placed on file.

8.1 Internal Audits/Inspections

The Principal Contractor's safety manager/responsible person must conduct weekly inspections/audits with a detailed report. A copy of these inspections/audits must be placed on file for perusal by the Health and Safety Agent.

Principal Contractor to provide a Corrective Action Plan within 3 days for all non-compliances noted in the Audits conducted by the Client's Health and Safety Agent. Note: An electronic copy must be sent to the Client Representative including the appointed Health and Safety Agent.

9. EMERGENCY PROCEDURES

The Principal Contractor/s shall submit a detailed Emergency Procedure and Evacuation Plan with assembly point and contact details in the case of any emergency. The procedure shall detail the response plan including the following key elements:

- List of key competent personnel; Details of emergency services.
- Actions or steps to be taken in the event of the specific types of emergencies; Information on hazardous material/situations.
- Emergency procedure(s) shall include, but shall not be limited to, fire, spills, accidents to employees, use of hazardous substances, bomb threats, major incidents/accidents, etc.

The Principal Contractors shall advise the Client, Agent, Engineer, and all relevant authorities forthwith, of any emergencies, together with a record of action taken. This shall be confirmed in writing as soon as possible after the incident.

A contact list of all service providers (Fire Department, Ambulance, Police, Medical and Hospital, etc.) must be maintained and available to site personnel. These procedures shall form part of the OHSF. The Principal Contractor to ensure that the relevant staff is trained to perform such duties as required by the OHS Act. All emergency procedures must be monitored on a regular basis and must be in line with the building program.

The Emergency/Evacuation plan and routes must be revised on a regular basis for all employees and contractor (including staff) should any unforeseen event take place during the implementation phase/s of the project.

Evacuation Drills must be conducted as and when needed. Contractor to assess all activities to ensure this is implemented with proof placed on file.

10. FIRST AID BOXES AND FIRST AID EQUIPMENT

The Principal Contractor and their contractors shall appoint in writing First Aider(s).

The appointed First Aider(s) are to be sent for accredited first aid training. Valid certificates are to be kept on site. All Contractors with more than 5 employees shall supply their own first aid box. Principal Contractor with more than 10 employees shall have trained, certified first aider on site at all times & First aid Box adequately stocked always.

10.1 RESCUE

The procedure to rescue persons from contact with a live conductor cannot definitely be laid down for all cases. However, certain principles and methods are outlined which all persons working on electrical apparatus or assisting in such work should know.

Rescue when travelling to, from site and working on site:
The Principal Contractor to provide procedures for rescuing persons in danger of drowning.

11. ACCIDENT / INCIDENT REPORTING AND INVESTIGATION

Injuries are to be categorized into first aid, medical, disabling, and fatal. The Principal Contractor and their contractors must stipulate in its construction phase Health and Safety plan how it will handle each of these categories. When reporting injuries to the Client, these categories shall be used. All contractors must investigate and report on the 4 categories of injuries to the Principal Contractor at least monthly.

Contractors must investigate injuries and accidents involving their employees within seven days of the incident in the form on Annexure1 (General Administrative Regulations) and forward a copy on the investigation report to the Principal Contractor forthwith.

All incidents reportable in terms of the provision of Section 24 of the OHS Act 1993 must be reported to the local Dept. of Labour in the prescribed manner.
Should construction work be finished within 3 days after any occurrence, the investigation shall be conducted before such construction work is completed.

The Principal Contractor and their contractors must report all injuries to the Client in the form of a spreadsheet, which includes all contractor injuries/incidents including near misses, property damage and man-hours worked for the month as well as the cumulative total. This report must be done on a monthly basis and must form part of the Principal Contractor's progress report.

The Principal Contractor shall immediately notify the Client and Client's Health & Safety Agent of any hazardous or potentially hazardous situations that may arise during the performance of construction activities immediately or within 24 hours by means of a flash report.

In case of any Section 24 Incident, the Principal Contractor shall ensure that the Health and Safety Agent verify and peruse the report and all relevant documentation before it is sent to the Department of Labour.

All cases of occupationally acquired COVID 19 to be reported to the department of labour in accordance with General Administrative Regulation 8 and Section 6 of the Notice (CF/03/2020) on Compensation for Occupationally-Acquired Novel Corona Virus Disease (COVID 19).

The Health and Safety Agent will be notified immediately together with the professional in the event of any infection.

Occupationally- acquired COVID -19 is a disease contracted by an employee as defined in the COID Act arising out of and in the course of his or her employment.

- **If a staff member or visitor presents with symptoms related to the disease the following actions should be taken:**

12. HAZARDS AND POTENTIAL SITUATIONS

The Principal Contractor shall immediately notify the Client and Client's Health & Safety Agent of any hazardous or potentially hazardous situations that may arise during the performance of construction activities.

13. PERSONAL PROTECTIVE EQUIPMENT (PPE) AND CLOTHING

The Principal Contractor shall ensure that all workers are issued and wear but is not limited to i.e., hard hats, protective footwear, Hi-Viz vests and overalls; lifejackets. The Principal Contractor and their contractors shall make provision and keep adequate quantities of SANS approved PPE on site always.
Contractors to provide control measures should employees continuously fail to use the prescribed PPE.

Contractors to provide control measures should employees continuously fail to use the prescribed PPE.

For the reasons underlying the Department of Health's requirement, the Principal Contractor must –

- provide each of its employees, free of charge, with a minimum of two cloth masks, which comply with the requirement set out in the Guidelines issued by the Department of Trade, Industry and Competition, for the employee to wear while at work and while commuting to and from work: and
- require any other worker to wear masks in the workplace.
- Every employer must ensure that workers are informed, instructed, trained, and instructed as to the correct use of cloth masks.
- An employer must make appropriate arrangements for the washing, drying, and ironing of cloth masks in accordance with the Guidelines referred in clause 31.1 recommendations.

- Staff should be encouraged to cover their mouths and noses with tissues when they cough or sneeze irrespective if they are wearing a mask.
- Enforcement of the provision of tissues for workforce and visitors.
- Used tissues should be thrown in the trash. (note: that all trash bins must be clearly marked hazardous and treated as such)
- Provision of posters displaying guidelines for proper covering should be displayed in key strategic locations such as close to eating areas, bathrooms & site notice boards etc.

One of the Western Cape Department of Health's top priorities is to ensure that our front-line healthcare workers, who are caring for those with COVID-19, have the required N95 respirators and/or medical masks so that they are protected when undertaking their duties and helping us save lives.
There is a global shortage of these masks. All contractors are requested to not obtain or use these, so that we can ensure enough supply to the frontline healthcare workers in our hospitals and clinics.

Cloth masks as a minimum will be mandatory PPE on site. No person will be allowed to enter the site unless they are wearing a cloth or similar mask which covers the nose and mouth outlined by Section 5 (1)a of the amended Disaster Management Act 57 of 2002 (April 2020)
PPE spotters to be appointed to monitor the usage of PPE throughout the site.
Note no employees will be allowed on site without a high viz vest.

14. OCCUPATIONAL HEALTH AND SAFETY SIGNAGE

The Principal Contractor shall provide adequate on-site OHS signage. Including but not limited to: "no unauthorized entry", "report to site office", "site office", and "hard hat area". Signage shall be posted up at all entrances to site as well as on site in strategic locations e.g., Access routes, entrances to structures and buildings, scaffolding and other potential risk areas / operations. All Contractors to adhere.

15. CONTRACTORS

The Principal Contractor shall ensure that all Contractors appointed by them comply with this Specification, the OHS Act 85/1993, and Construction Regulation (February 2014).

The Principal Contractor may only appoint a contractor after approving the contractor's health & safety plan with proof placed on file. The Principal Contractor must audit each of its Contractors at least monthly, with audit reports filed in the health & safety file on site.
The audit must include an administrative assessment as well as a physical inspection of the contractor's health & safety system.

The Principal Contractor must stop any Contractor from carrying out construction work that is not in accordance with the Principal Contractor's or Contractor's health & safety plan or if there is an immediate threat to the health and safety of persons.

The Principal Contractor shall take all reasonable steps necessary to ensure co-operation between all Contractors to enable each of those Contractors to comply with the provisions of these regulations.

The Principal Contractor must ensure that their contractors are registered and in good standing with a recognized compensation fund or with a licensed compensation insurer prior to work commencing on site.

The Principal Contractor must ensure that potential Contractors submitting tenders have made provision for the cost of health and safety measures during the construction process; The Principal Contractor shall discuss and negotiate with their Contractor the contents of the health and safety Plan and shall finally approve that plan for implementation.

16. NO-GO AREAS

Principal Contractor and their contractors to avoid all no-go areas and ensure that all relevant parties/employees and visitors are adequately informed. **These areas will be identified by the Client.**

17. PHYSICAL REQUIREMENTS

17.1 Demolition During Construction Process- (Method Statement/Procedure)

The Client/Principal Contractor must ensure that a demolition permit is obtained from the Local Authority prior to demolition work commencing on site. Proof of the permit must be placed on file for inspection.
The Principal Contractor and their contractors shall always appoint a competent person in writing to supervise and control all Demolition work on site.
Prior to any demolition work being carried out, the Principal Contractor shall submit a method statement and a detailed engineering survey for approval by the Client/Engineer. Acceptance will then be issued to the Principal Contractor to proceed with the demolition work. The Principal Contractor shall ensure that demolition work complies with the Construction Regulations section 14 (February 2014). Principal Contractor to ensure that:

All Demolition work to comply with the Engineers methodology, procedures, requirements, and drawings.

- Work should be carried out by competent operatives experienced in demolition work under the control of an experienced, competent supervisor.
- Restricted areas and safe distances should be established.
- Underground services to be considered, including electrical cables, water mains, etc. (If Applicable)
- All services should be disconnected prior to demolition.
- Adequate precautions against accidental collapse of the structure or adjacent structures should be in place.
- Pre-stressed reinforced concrete should be demolished under supervision of a suitability qualified and experienced engineer. (If Applicable)
- Measures should be taken to protect the public, e.g., 2m high fence, debris fans, etc.
- Floors should not be overloaded.
- All plant and equipment should be suitable for the task, well maintained, and inspected and tested in accordance with legislation.
- Work at heights should be minimized.
- Measures should be taken to protect persons working at height, e.g., working platforms, harness, nets, etc.
- Appropriate personal protective equipment (PPE) should be worn.
- Adequate Dust Control

Removal of Asbestos
The Principal Contractor must ensure the safe removal of Asbestos off site as required by the Occupational Health and Safety Act 85/1993 and the Asbestos Abatement Regulations 2020. A safe work procedure or method statement detailing the removal process and steps to be taken to contain the asbestos and waste must be drafted and placed on file.

The Principal Contractor must appoint a registered asbestos contractor to remove all related asbestos materials off site if the Principal Contractor is not a registered asbestos contractor.

17.2**Asbestos**

- Provide an asbestos work plan in full compliance with the OHS Act, 1993, as amended, the Asbestos Abatement Regulations 2020 relating to demolition* work (*as defined in AR 1) to be performed by a Registered Asbestos Contractor (RAC) and brief the RAC on the details contained therein.
- Notification of Asbestos Work given to the Department of Labour regarding the asbestos work as soon as the RAC is appointed
- Monitor the activities of the RAC to ensure compliance with the Asbestos Regulations of the OHS Act, 1993, as amended, according to the following inspection schedule or as prescribed by the AIA.
- Conduct asbestos air monitoring, associated laboratory tests and submit test results and reports. The reports shall include for remedial work/action to be taken by the RAC, where applicable, and the AIA shall brief of the RAC accordingly, all according to the following schedule:
- Feedback of tests results, inspections, and respective reports to be available within at least 2 (two) working days of the said test, inspection etc.
- Conduct a final inspection at the conclusion of the work and issue a site clearance certificate and job completion report certifying that all asbestos waste has been safely and correctly disposed of in full compliance with the Asbestos Abatement Regulations 2020 of the OHS Act, 1993, as amended."

17.3 Cranes (All) including a Crane Management Plan, Rescue Plan & (Emergency Procedures)

The Principal Contractor and all Contractors shall ensure that lifting machinery and tackle is inspected before use and thereafter in accordance with the Amended Driven Machinery Regulations (2015). There must be competent lifting machinery and lifting tackle inspectors who must inspect the equipment daily or before use, considering that:

- Contractors to plan carefully when crane work is required. Overhead electrical cables to be kept in planning.
- All lifting machinery and tackle must carry a load test certificate and must have an inspector register.
- All lifting machinery and tackle have a safe working load clearly indicated,
- Regular inspections and servicing are carried out.

Note: Records are kept of inspections and of service certificates conducted by an approved LMI

- There is proper supervision in terms of guiding the loads that includes a trained banksman/rigger to direct lifting operations and check lifting tackle,
- Rescue Plan to be provided.
- Inventory to be provided and updated as and when needed.

The operators are competent as well as physically and psychologically fit to work and in possession of a medical certificate of fitness to be available on site.

17.4 High & Low Voltage Electrical Installations

Should high voltage electrical lines/fencing be present on the site perimeter, the Contractor must take extra caution and demarcate as far as reasonably practicable. These demarcations must be maintained for the duration of the construction work. The minimum safety clearances as per Electrical Machinery Regulations must be adhered to.

The Principal Contractor and their contractors must ensure that prior notice is given to Local Authority Electrical Department of any work involving electrical installation. A lock-out certificate must be issued to the relevant Principal Contractor. The Principal Contractor must ensure that a lock-out procedure is adhered to by his/her employees whenever required. The Principal Contractor must ensure that safety measures stipulated in the Electrical Installation Regulations, Machinery Regulations, General Machinery Regulations and Construction Regulations are always adhered to.

All installations must comply with SANS 10142 & the regulations of the OHS Act 85/1993 and Construction Regulation 24.

All temporary electrical installations must be inspected at least weekly with proof placed on file.

17.5 Edge Protection and Penetrations

The Principal Contractor and their contractors must ensure that all exposed edges and openings are guarded at all times until permanent protection has been erected.
The Principal Contractor has the following options when contemplating the protection of openings, slabs and edges:

- A physical barrier at the edge of the opening, which must be strong enough to carry the weight of **any** person in the process of falling.
- External façade scaffold with fully boarded platform with a handrail.
- Any other suitable means of protection may be used that will prevent a fall.
- Timber to be nailed on all penetrations, alternatively any other means of protection may be used that will prevent a fall.
- Any person working on an unprotected slab/deck to wear fall arrest and prevention equipment devices, like safety harness, life lines etc.

The Principal Contractors' risk assessment must include these items. E.g. all other openings and areas where a person may fall. **All Lifelines shall be certified as per the relevant standards and Anchorage points shall be load/pull tested by a competent person**

Note: Danger Tape and shade cloth shall not serve as edge protection.
Furthermore, the Principal Contractor shall provide adequate control measures to avoid Falling Objects especially at all walkways

17.6 Roof Work

Roof work will include but is not limited to, the installation of **Structural Steel.** All roof work must be conducted in accordance with Construction Regulation 10. A
fall protection plan must be prepared by a competent person who should evaluate, revise and amend the plan at least monthly (30 Days) or after any change in activity or incident. Rescue Plan to be provided including methodology and key personnel to perform such rescue.

All employees shall be in possession of Working at Heights Training issued by a competent person who has at least proof of training as an Assessor/Facilitator
The plan must also include the following but is not limited to,

- How the roof work was planned/Method Statements
- That the roof workers are competent (trained, experienced, knowledgeable)
- Lifelines (Proof of Certification) and anchor points (Load/Pull Tested) are provided and installed by a competent person and with proof placed on file
- That no Roof work is carried during inclement weather or where conditions are hazardous to workers.
- That fragile material/areas are demarcated, and signs posted;
- That suitable platforms are provided where fragile materials exist;
- That there are suitable and sufficient guardrails or barriers and toe boards or other similar means of protection to prevent the fall of any person, material or equipment.
- Rescue Plan
- All employees exposed to heights must be declared medically fit by an Occupational Health Practitioner. (Annexure 3)

Note: The Principal Contractor and their contractors shall ensure that all lifelines are certified, and all Safety Harnesses shall be inspected daily by a competent person and recorded at least monthly with proof of inspections placed on file. Furthermore, The Principal Contractor and their contractors shall ensure that Double Lanyard with Scaffold/Pylon Hooks are used as a minimum requirement and shall assess the fall risk
at all times. All Safety Harnesses shall be inspected on a Daily basis by a competent person and recorded at least monthly with proof of inspections placed on file

17.7 Construction Vehicles

Construction Vehicles and Mobile Plant may be inspected by the Client prior to being allowed on a project site and suppliers of hired vehicles, plant and equipment will be required to comply with this specification as well as the OHS Act and Regulations.

Construction Vehicles and Mobile Plant (CV & MP) to be:

- of acceptable design and construction
- maintained in good working order.
- used in accordance with their design and intention for which they were designed.
- Operated/driven by trained, licensed competent and authorised operators/drivers. No unauthorised persons to be allowed to drive or operate CV & MP.
- Operators and drivers of CV must be in possession of a valid medical certificate declaring the operator/driver physically and psychologically fit to operate or drive CV.
- fitted with adequate signalling devices to make movement safe including reversing.
- excavations and other openings must be provided with sufficient barriers to prevent CV from falling into same
- Provided with roll-over protection, appropriate seat fitted which shall be used during CV operations.
- inspected daily before start-up by the driver/operator/user and the findings recorded in a register/logbook.
- CV to be fitted with two head and two taillights whilst operating under poor visibility conditions, in addition they shall be equipped with ‘hazard warning’ lights, which must be used whenever the CV is on site.

- No loose tools, material etc. is allowed in the driver/operator's compartment/cabin nor in the compartment in which any other persons are transported.
- CV used for transporting persons must have seats firmly secured and sufficient for the number of persons being transported.
- Operators to be issued with Personal Protective Equipment as required and identified by the Risk Assessments.
- Only licensed and road worthy vehicles will be allowed on the public roads.

No person may ride on a CV except in a safe place provided by the manufacturer for this purpose.

The construction site must be organized to facilitate the movement of CV so that pedestrians and other vehicles are not endangered. Traffic routes are to be suitable, sufficient in number and adequately demarcated.CV left unattended after hours adjacent to roads and areas where there is traffic movement must be fitted with lights reflectors or barricades to prevent moving traffic meeting the parked CV.

In addition, CV left unattended after hours must be parked with all buckets, booms etc. fully lowered, the emergency brakes engaged and, where necessary, the wheels chocked, the transmission in neutral and the motor switched off and the ignition key removed and stored safely.

Workers employed adjacent to, or on public roads must wear reflective safety vests.
All CV inspection records must be kept in the OH&S File.

The type and size of construction vehicles that the Contractors intends using on the existing road is subject to the approval by RIM prior to importing to the Island. Any damages caused to the roads used during the construction shall be repaired to the satisfaction of RIM and the Engineer and at the cost of the contractor. The island has a speed limit of 40km/h.

17.8 Excavations, Shoring, Dewatering or Drainage

The Principal Contractor and any relevant Principal Contractor shall make provision in their tender for shoring, dewatering or drainage of any excavations as per this specification.
The Principal Contractor shall make sure that:

- Excavations/trenches are inspected before every shift, after blasting, after unexpected fall of ground, after substantial damage of supports, and after rain.
- A record of these inspections must be kept.
- The location and nature of all existing services must be established before trenching operation is undertaken.
- Safe work procedures have been communicated to the workers.
- The safe work procedures are enforced and maintained by the Principal Contractor's and Contractors' Responsible Persons always.
- Safe access/egress is provided to all levels.
- No load, material, plant, or equipment is placed or moved near the edge of any excavation or trench which may undermine the stability of the same unless adequate teps are taken to prevent the sides from collapsing.
- All excavations and trenches that are adjacent to public access routes must be barricaded and illuminated. The barrier shall be at least orange plastic webbing of 1m height (day and night) with delineators and orange traffic lights for night-time.
- All excavations next to existing buildings to be carefully monitored during such an operation.

- Permit to be provided by competent person prior to entering the Excavation.

Should an HV cable be discovered, the Principal Contractor and their contractors shall cease all current works and activities, make the area safe and then immediately contact the Electrical Consultant/Principal Agent to provide a method statement prior to re-commencement. Proof of Communication shall be provided.

Furthermore, the Principal Contractor and their contractors shall ensure that the excavated sides are battered and include considering dewatering/creating site run offs during winter.

All heaps of materials either forming part of the excavations or imported for use in construction shall be kept covered during high winds to prevent contamination of surrounding in-situ soils.

17.9 Erosion and Sedimentation Control

The Contractor shall take all reasonable measures to limit erosion and sedimentation due to the construction activities and shall, in addition, comply with such detailed measures as may be required by the Scope of Work.

Where erosion and/or sedimentation, whether on or off the Site, occurs, rectification shall be carried out in accordance with details specified by the Engineer.

Where erosion and/or sedimentation occur due to the fault of the Contractor, rectification shall be carried out to the reasonable requirements of the Engineer, at the Contractor's cost.

The Contractor shall ensure that the City's storm water system is kept free from sediment arising from the Works.

Any runnels or erosion channels developed during the construction period or during the vegetation establishment period shall be backfilled and compacted, and the areas restored to a proper condition. Stabilisation of cleared areas to prevent and control erosion shall be pro-actively managed by the Contractor. The method of stabilisation shall be determined in consultation with the Engineer.

17.10 Existing Structures

Any adjacent structures that may be affected by work must be considered in the planning process. Precautionary measures must be detailed and applied to prevent damage, uncontrolled collapse of existing structures and/or loss to property and persons during the entire construction phase.

17.11 Confined Space Entry (If Applicable)

The Principal Contractor to prepare a confined space procedure in line with General Safety Regulation (5) OHS Act including Task Specific Risk Assessments, Method Statements and Emergency Procedures.

17.12 Temporary Works and Support Work for Structures

The Principal Contractor shall ensure that the provisions of Section 12 of Construction Regulations (February 2014) are adhered to.

These provisions must include but not be limited to ensuring that all equipment used is examined for suitability before use, that all Temporary Works and support work is inspected by a competent person immediately before, during and after placement of concrete or any other imposed load and thereafter daily until the Temporary Works and support work has been removed. Records of all inspections must be kept in a register on site. Temporary Works Design Drawings shall be provided by a competent person for all Temporary Works Structures.

Note: Authorisation shall be provided in writing by a competent person before concrete is poured and before any temporary works structure is removed with proof placed on file. The Principal Contractor shall ensure that all employees erecting temporary works (False Work, Formwork, Support Work) are competent to perform such work, including the Temporary Works Designer, Temporary Works Supervisor and Temporary Works Inspector.

17.13 Deliveries

The contractor will need to engage the Project Manager to agree delivery times during the day for various activities, preferably at least 24hours notice.

Delivery of materials and the safe movement of construction vehicles will be always controlled by the Contractor to alleviate any congestion or interference with the northern delivery yard operations and public delivery roads for access/egress.

Principal Contractor shall ensure vehicle management procedures are in place by way of flagmen control during contractor deliveries.

- No contractor vehicles are to be left unattended during deliveries.
- Existing parking bays, other than what has been agreed for the use by the Contractor, are not for the contractor or construction vehicles.

17.14 Hazardous Chemical Substances (HCS)

The Principal Contractor working with Hazardous chemical substances to obtain copies of all the (MSDS) Material Safety Data Sheets and this to be kept on site in the Health and Safety File. Risk Assessments to be compiled. First Aider to have copies of MSDS.

All hazardous waste shall be disposed of at an authorised landfill site and proof of disposal shall be provided upon request. Employees shall be provided with suitable PPE including Respirators as and when needed. Adequate control measures shall be taken to avoid possible exposure to employees and members of the Public.

17.15 Stacking of Materials

The Principal Contractor shall ensure that there are sufficient appointed stacking supervisors, and all materials and equipment are stacked and stored safely. Double handling of material should be avoided and for this purpose, pallets and other stacking options should be used.

17.16 Removal of Rubble & Debris

The Principal Contractor must ensure the safe removal of debris and rubble from all levels where demolition occur. A safe work procedure or method statement detailing the removal process and steps to be taken to contain the debris and rubble must be drafted and placed on File.

17.17 Permits

All relevant permits must be obtained from Local Authority (where needed) before any demolition and construction work commences. (Site hoarding permit, demolition permit, way leaves etc.)

17.18 Access Routes

On the Site and, if so required, within such distance of the Site as may be stated by the Engineer, the Contractor shall control the movement of all vehicles and construction equipment, including that of his suppliers, so that they remain on designated routes, are distributed so as not to cause an undue concentration of traffic, and that all relevant laws are complied with.

In addition, the movement of such vehicles and construction equipment shall be planned and operated to minimise disruption to regular users of the routes.
As far as possible the Contractor shall use existing access and haul routes. Damage to existing access roads because of construction activities shall be repaired to the satisfaction of the Engineer, using material like that originally used. The cost of the repairs shall be borne by the Contractor. New temporary access or haul routes may only be established with the prior approval of the Engineer. The rehabilitation of such routes shall be to the Contractor's own cost and to the approval of the Engineer.

Any directional signage required by the Contractor for the purposes of directing the movement of his own vehicles and construction equipment (or that of his subcontractors or suppliers) must be of a design and in a location approved by the Engineer. Directional signage may not be erected in such a manner that it interferes with sight lines or pedestrian movement.

17.19 Plant and Machinery

17.19.1 *Pressure Equipment Regulations*

The Principal Contractor and their contractors shall comply with the Pressure Equipment Regulations and SANS 10087, including:

- Providing competency and awareness training to the operators,
- Providing PPE or clothing,
- Inspect Equipment regularly and keep record of inspections,
- Providing appropriate firefighting equipment (Fire Extinguishers) on hand.
- Correct storage of cylinders

17.19.2 *Fire Extinguishers and Firefighting Equipment*

The Principal Contractor shall provide adequate, regularly serviced fire-fighting equipment located at strategic points on site, specific to the classes of fire likely to occur. The appropriate notices and signs must be posted up as required. All fire extinguishers to be handled and inspected by competent persons in compliance with CR 29.

The Principal Contractor to provide an initial Fire Risk Assessment. Note: The Principal Contractor shall ensure that sufficient and suitable storage is provided for all flammable liquids, solids, and gases.

The Principal Contractor shall ensure that sufficient number of workers is trained in the use of Fire Equipment.

17.19.3*Hired Plant and Machinery*

The Principal Contractor shall ensure that any hired plant and machinery used on site is safe for use. The necessary requirements as stipulated by the OHS Act 85/1993 and Construction Regulations (February 2014) shall apply. The Contractor shall ensure that operators hired with machinery are competent and that certificates are kept on site in the Health and Safety file. All relevant Contractors must ensure the same.

17.19.4*General Machinery*

The Principal Contractor shall ensure compliance with the amended Driven Machinery Regulations (2015), which include inspecting machinery regularly, appointing a competent person to inspect and ensure maintenance, issuing PPE or clothing, and training those who operate machinery.

17.20**Portable Electrical Tools**

The Principal Contractor and their contractors shall ensure that the use of all portable electrical tools follows relevant legislation.

The Contractor shall ensure that all electrical tools, electrical distribution boards, extension leads, and plugs are kept in safe working order. Regular inspections and toolbox talks must be conducted to make workers aware of the dangers and control measures to be implemented e.g., Personal protection equipment, guards, etc.

A competent person to undertake routine/daily inspections and records are kept. Only authorized trained persons to use the tools, the safe work procedures to apply. Awareness training to be carried out and compliance enforced at all times, and PPE and clothing are provided and maintained.

Note: All power tools shall be inspected by the Authorised Operator on a daily basis with proof placed on file.

17.21**Water Environments**

The Principal Contractor to ensure that they provide adequate controls measures when working in, over or in close proximity to water. Principal Contractor to ensure adherence to Construction Regulations 26.

18. PUBLIC AND SITE VISITOR'S HEALTH AND SAFETY

Both the Client and the Principal Contractor have a duty in terms of the OHS Act 85/1993 to do all that is reasonably practicable to prevent members of the public and site visitors from being affected by the construction activities. Site visitors must be briefed on the hazards and risks they may be exposed to and what measures are in place or should be taken to control these hazards and risks. A record of these inductions must be kept on site in accordance with the Construction Regulations.

Appropriate Nets, Canopies, Hoarding. Fencing, Gantry's, and Crash Decks etc. must be provided to protect members of the public and their vehicles passing / entering the site, in accordance with Construction Regulation 27. Sufficient Safety, direction Signage and Flagmen to be placed to direct traffic near the site.

Principal Contractor to ensure that no unauthorized persons enter the construction area by implementing access control measures / registers.
Site visitors must not be left alone to walk the site but must be accompanied by an employee of the principal contractor.

19. NIGHT WORK

Adequate lighting/illumination to be provided where required with backup generators. Security to be provided as and when needed. All emergency procedures to be in place. Adequate PPE to be provided for all employees e.g., Hi-Viz Vests.

20. WORKING HOURS

Working Hours to be agreed with the Client for reasons that facilities might be in use by end users. Alternative arrangements to be agreed upon in advance to avoid any Health and Safety incidents.

21. OCCUPATIONAL HEALTH

21.1 Disinfecting of Surfaces

The Principal Contractor must ensure that all work surfaces and equipment are disinfected before work begins, regularly during the working period and after work ends.

Tables, chairs, benches, car seats and dashboards, toilets, common areas, door handles, shared electronic equipment should also be regularly cleaned and disinfected.

- Wear disposable gloves when cleaning and disinfecting surfaces. Gloves should be discarded after each cleaning. If reusable gloves are used, those gloves should be dedicated for cleaning and disinfection of surfaces for COVID-19 and should not be used for other purposes. Consult the manufacturer's instructions for cleaning and disinfection products used. Clean hands immediately after gloves are removed.
- For disinfection, diluted household bleach solutions, alcohol solutions with at least 70% alcohol, and most common EPA-registered household disinfectants should be effective.
- Diluted household bleach solutions can be used if appropriate for the surface. Follow manufacturer's instructions for application and proper ventilation. Check to ensure the product is not past its expiration date.
- It is recommended to prepare and maintain a cleaning schedule for all facilities.
- Project staff members can practice routine cleaning of frequently touched surfaces (for example tables, doorknobs, light switches, handles, desks, toilets, faucets, sinks) with household cleaners and EPA-registered disinfectants that are appropriate for the surface, following label instructions.
- Labels contain instructions for safe and effective use of the cleaning product including precautions you should take when applying the product, such as wearing gloves and making sure good ventilation is available during the use of the product.
- For vehicles: cleaning can be done on door handles & seats by using wipes & sanitizer, it is not recommended to use bleach on seats.
- Currently there is no specification in regard to the control of air-condition/windows.

Note: Cleaning of surfaces and appliances to be done frequently daily.

21.2 Noise

Tasks identified where noise exceeds 85 dBA. All reasonable steps to be taken to reduce noise levels at the source. Hearing protection to be used where noise levels cannot be reduced below 85dBA.

21.2.1 Noise Induced Hearing Loss

Where noise is identified as a hazard the requirements of the NIHL regulations must be complied with and the following must be included / referred to in the Health and Safety Plan:

- Proof of training with regards to these regulations.
- Risk assessment
- Monitoring carried out by an AIA and done according to SABS 083.
- Medical surveillance programme established and maintained for the necessary employees.
- Control of noise by referring to:
- Engineering methods considered.
- Admin control (number of employees exposed) considered.
- Personal protective equipment considered/decided on.
- Describe how records are going to be kept for 40 years.

21.3 Dust

Principal Contractor to ensure that employees working with grinders, drills, etc. are issued with dust masks and dust exposure to be minimized at all times. Suitable measures to be implemented by the Principal Contractor to ensure that members of the public are not detrimentally affected by such activities. Working Area to be fully clad with a Hundred Percent Shade Cloth or anything similar.

21.4 Welfare Facilities

The Principal Contractor to provide at least one sanitary facility for every 30 employees on site, including changing facilities & hand washing facilities. Safe and adequate eating areas must be provided. Waste bins must be strategically placed and emptied regularly. Safe and clean storage areas must be provided for workers to store personal belongings and personal protective equipment.

21.5 Waste Management

Principal Contractor must implement their waste management in line with Environmental Terms and Conditions.

- **Disposal of any gloves or masks** – The Principal Contractor shall dispose of all used gloves and masks as hazardous waste. Hazardous waste bins lined with plastic bags shall be used. The bags will be sealed after with records of safe disposal placed on file.

- **Disinfectant solution** – The Principal Contractor will provide adequate supplies of disinfectant at the entrances and workstations where the use of water and soap for cleaning is not practical. If disinfectant dispensers are not refilled it should be disposed with other hazardous waste.

- **Wastewater -** Wastewater at washing points, toilets, and bathrooms to be contained in a drainage system that prevent surface spills. Wastewater contained in containers must be sealed before transportation or disposal.

All certificates of safe disposal will be kept on file.

21.6 Alcohol and Other Drugs

The Principal Contractor and their contractors to ensure that no alcohol and other drugs are allowed on site. No person may be under the influence of alcohol or any other drugs while on the construction site. Any person on prescription drugs must inform his/her superior, who shall in turn report this to the Contractor forthwith. Any person suffering from any illness / condition that may have a negative effect on his/her safety performance must report this to his/her superior, who shall in turn report this to the Principal Contractor forthwith.
Any person suspected of being under the influence of alcohol or other drugs must be sent home immediately, to report back the next day for a preliminary inquiry. The Contractor concerned must follow a full disciplinary procedure and a copy of the disciplinary action must be forwarded to the Principal Contractor for his records. No Smoking is allowed on site.

22. ANNEXURE A- ACKNOWLEDGEMENT OF H & S SPECS

Annexure A: Acknowledgement of Health and Safety Specification

Acknowledgement of Receipt of the Health and Safety Specifications:

I,_____representing.

_____Contractor

Have satisfied myself with the content of the construction Health and Safety Specification and shall ensure that the Contractor and its personnel comply with all obligations / requirements in respect thereof.

Signature of Principal Contractor	**DATE**
Signature of Client Agent	**DATE**

COMMENTS:

23. ANNEXURE B APPOINTMENT OF PRINCIPAL CONTRACTOR

Appointment of Principal Contractor

IN TERMS, OF

OCCUPATIONAL HEALTH AND SAFETY ACT, ACT 85 OF 1993 & CONSTRUCTION REGULATIONS 2014

CONSTRUCTION REGULATION 5(1)(k)

I, …… Client Responsible Person,
for…… do hereby appoint:
……as the Principal Contractor
of……*Project.*

Responsibilities:

- *Prepare a Health and Safety Plan to comply with the requirements of the Construction Regulation 5(1)(b), and in compliance with the Health and Safety Specification for the Project.*
- *Ensure co-operation between all contractors to enable each of those contractors to comply with the provisions of these regulations.*
- *Provide all contractors with the required safety specification for their area of responsibility.*
- *Appoint each contractor in writing in accordance with Construction Regulations.*
- *Ensure implementation of the contractor's health and safety plan.*
- *Stop contractors from working if not in accordance with the client specification.*
- *Provide health and safety information to contractors should their design change.*
- *Ensure all contractors are registered and in good standing with the compensation commissioner.*
- *Ensure contractors submitting tenders have made provision for health and safety during construction.*
- *Ensure risk assessments are conducted & the identified controls are communicated to all employees and visitors.*
- Ensure Compliance to Occupational Health and Safety Act 85/1993, Construction Regulations 2014, Community Fire Safety Bylaw and Relevant Sans Codes.

Signature: …… **Date:** ……

Client / Principal Agent

Acceptance

I, …… hereby accept and acknowledge that I understand the requirements of this appointment.

Signature: …… **Date:** ……

24. Baseline Risk Assessment

Baseline Risk Assessment for Health and Safety Specification: Design Build and Commission of a Reverse Osmosis Desalination Plant, Robben Island Project		
Activity	**Hazard**	**Control Measure**
Off-loading of Material/deliveries and	• Possible load falling • Public Safety-potential injuries to workers and members of the public	• All work areas to be adequately demarcated-All Activities to done under supervision. • Ensure a spotter is available when needed. • Once site has been secured it must be maintained to avoid unauthorised. • Site security to be available. • Relevant construction signage to be displayed. • Contractors to be aware of live services e.g., electrical cables.
	• Possible Collision/contact with property or stationary vehicles, workers, and members of the public	• Driver to be in possession of a valid driver's licence. • All notices and signs to be obeyed. Driver to adhere to the speed limits. Employer and Driver to ensure that he is not intoxicated and must be of sober habits.
Carrying of material	• Possible Contact with fellow employees and results into possible injuries.	• Employees to take caution when walking on site. • Employees to keep material as close to themselves or structure as possible to avoid possible contact with persons. • Ensure your vision is not obstructed. • Watch your blind spots and get assistance when carrying heavy and large objects
	• Possible Falling material and possible foot and body injuries	• Operatives to ensure that all material are adequately secured. • Appropriate PPE to be worn always. • Do not carry material in precarious (dangerous) positions so as to obstruct your vision etc.
	• Possible Ergonomics /Possible back injuries	• Employees to ensure that they use correct bending techniques. Please get assistance when lifting heavy objects.
Working with Cement (Bagging/Plasterin g, Mortar etc.)	• Cement dust, Respiratory problems.	• Only Competent Persons to conduct Activities. Task Specific Risk Assessments to be provided. • Dust masks to be used when spending even short periods of time in high dust areas and when using concrete saws/cutters or cement mixers.
	• Possible Contact with cement dermatitis, skin burns, skin irritation	• Avoid contact with the skin as far as reasonably practicable. Remove clothing that has been contaminated by wet concrete. • Wear suitable PPE e.g., Gum boots. • Wash hands thoroughly after contact and use a barrier cream.
	• Possible Eye injuries	• Follow Safety instructions (MSDS) when using concrete additives.
	• Faulty hand tools and the excessive inhalation of cement dust.	• Hand tools to be in good condition. Persons mixing mortar should wear dust masks when required.
Working with Hazardous Substances	• Possible Respiratory problems.	• Respirators to be used when spending even short periods of time. Adequate ventilation required. Ensure that all containers are clearly identified when decanting
	• Dermatitis, Skin burns, Skin sensitization	• Avoid contact with the skin as far as reasonably practicable. Use barrier cream if possible.
	• Possible Eye injuries	• Remove clothing that has been contaminated by wet hazardous substances.
		• Wear suitable PPE as listed below. Wash hands thoroughly after contact and use a barrier cream.
		• Follow Safety instructions (MSDS) as indicated by the MSDS.

Storage of Hazardous Substances	• Possible Explosion/fires Possible	• Comply with CR 25 & CR 29. Store all Hazardous Substances in the correct categories. Store all flammable material separately. Ensure relevant signage is clearly displayed. Adequate fire extinguishers to be readily available. Fire Risk Assessment to be conducted by a competent person. Hazardous bins to be provided
Working at Heights including but is not limited to Scaffolds, Rope Access and Ladders.	• Possible Fall of persons, Possible Death	• Task Specific Method statements and Risk Assessments required as per CR 9. • All work to be done under supervision. • Compliance with Fall Protection Plan. • All exposed to heights to medically fit issued by OHP/OHN. • Scaffolding to be SANS 10085-1:2004 compliant. • Daily inspections to be conducted as per CR 12. PPE to be worn always. • Rope Access work must comply with Construction Regulations 18 which includes and not limited to: • Competent and appointed Rope Access Supervisors • Competent and licensed rope access operators • The design, selection and use of the equipment and anchors • Life lines to be installed as and when needed and must be secured to a fixed structure • How the roof work was planned/Method Statements. • That the roof workers are competent (trained, experienced, knowledgeable) • Life lines (Proof of Certification) and anchor points (Load • Tested) are provided and installed by a competent person and with proof placed on file • That no Roof work is carried during inclement weather or where conditions are hazardous to workers. • Rescue Plan
	• Possible Falling Objects / Equipment. Falling/slipping	• As far as reasonably practicable, all equipment to be tied to rope. • No Items to be thrown from elevated positions but must be safely lowered. • No persons to work underneath overhead work area or ground. • No work on open structures at heights during inclement weather. • No work on scaffolding during wet conditions/inclement weather.
Scaffold erecting & dismantling	• Possible Falling of persons, Collapse of Scaffold structures and damage property and employees.	• Design Drawings required. • Work on scaffolds to be coordinated by appointed scaffold supervisor. • Lanyard to be used when erecting & dismantling scaffolding. (Scaffold erectors) Compliance with SANS 10085-1:2004, CR 12 and CR 16. • All scaffolding to be inspected daily and after inclement weather and findings recorded in a register. • Fully boarded platforms must always be provided. • Only those employees who are authorised may be on the scaffold. • Where safe platforms cannot be erected, safety harnesses are compulsory.
		• Guard rails and toe boards compulsory. • PPE required for persons working on scaffolding: safe shoes; hardhats. • Area below to be cordoned off. • Platforms to be cleaned daily. • Only competent erectors to change structure of scaffold. • No overloading of scaffold. PPE used: Safety boots,

		helmets, overalls.
Working with Power Tools	• Possible Contact with moving parts.	• Task Specific Method statements and Risk Assessments required as per CR 9. • Only competent personnel should operate these tools.
		• Machines to be checked before use, guards are correctly fitted and work properly.
	• Noise above 85Dba	• Employees to be issued with relevant PPE including hearing protection.
	• Possible Malfunction of Blade	• Blades should be regularly inspected to ensure they are sharp/good condition
	• Possible Back Injuries	• Employees to be trained on proper lifting and bending techniques.
Working with Hand Tools	• Possible Eye injury	• Visual checks must be completed by operatives on tools prior to their use. • Eye protection is to be provided and used whenever work is done using cold chisels or other tools where there is risk of flying particles or other pieces of the tool breaking off.
	• Possible Injury to hands, feet, and body	• Tools are required to be suitable for the purpose for which they to be used. • Open bladed knives, screwdrivers, and other sharp tools are to be carried and used so as not to cause injury to the user or others.
	• Possible Tripping over tools	• Tools should not be left lying around, they constitute a severe tripping hazard, and they are liable to get damaged.
Lifting Operations	• Uncontrolled release of material	• Task Specific Method Statements and Risk Assessments required with proof of communication. • Rescue Plan and task specific Fall Protection Plan required, to be compiled by competent person. • Competent Banksman/Rigger to be readily available
		• Banksman/Rigger to have signalling device. • No person to be under suspended load. • No Crane operations when banksman/Rigger is not available or present. • Only appointed banksman/rigger to assist with lifting operations.
Working alongside public roads	• Motor vehicles hitting employees	• Employees must work within demarcated area. • Only crossroads at pedestrian crossings. • Reflective vests to be worn to ensure visibility. • Traffic Management Plan in place.
Material access to site	• Possible Public Safety- potential injuries to workers and members of the public. • Possible multiple, injury to staff. • Possible damage to property.	• Access route to and from the site will be clearly demarcated and identifiable as per the design report rules. • Contractor will make the relevant resources available to carry material to and from site. • Flagman placed to control traffic when delivery trucks enters or leave work area. • Flagman will wear reflective vest. • Traffic management Plan will be in place as per SARTSM Chapter 13. • Signage will be inspected daily.
Traffic accommodation method statement	• Getting run down by-passing traffic. • Leaving material in road causing accidents • Mobile plant crossing active road, causing accident. • Signage falling into roadway causing obstruction/accident. • Placement of signage	• Workers to work with designated work way. Hi viz vest to always be worn. Look left and right before crossing the road. • Workers and supervisors to ensure all material is kept within working area. Area to be checked before shift ends for material in roadway. • Flags man to be present when crossing or entering active road.

	workers getting hit by oncoming traffic	
Worker's levelling materials by hand	• Injury to body/misuse of equipment. • Being hit by oncoming traffic or hitting other traffic	• Training to be given to all employees on the safe work procedures of the operation. Corrects PPE to be worn. • Supervisor to be present always while work commence. • Corrects PPE to be worn. • Traffic control to warn all road users. • Training to be given to all employees on the safe work procedures.
Demolition	• Uncontrolled or premature collapse of structure • Dust control (Possible dust inhalation) • Temporary stockpiling of rubble (Overloading) • Possible Damage to existing services	• Competent person appointed in writing to control demolition. • Demolition operation inspected regularly to prevent premature collapse. • Structural engineering survey report obtained before demolition commences. • Existing services to be located and made safe before demolition commences. • Appropriate personal protective equipment issued. • Back propping to engineer's approval • Undertaking to wear signed and wearing enforced. • Wetting of work area. Dust Masks • Get permissible loading from engineer • Use dedicated areas • Wayleaves or drawings to be obtained from Engineer/Client. • Mark out of structure. • Approval to be obtained from engineer before demolition commences
Temporary Works	• Possible fatalities/ • injuries • Possible Collapse • of Structure	• Task Specific Risk Assessment s and Method • Statement Required prior to activity • Compliance with CR 12. • Competent Contractor to be appointed • Temporary Works designer to be appointed • Design drawings to be approved by engineer and must be current.
		• Handover Certificates required Before Concrete • Pours and Before Stripping any Temporary • Works material (Proof to be placed on file) • Task specific risk assessment to be compiled • and Formwork to be inspected daily by • competent person with proof placed on file
Handling of asbestos related products.	• Possible exposure to Asbestos fibres.	• Monitoring of exposure to be done once a week by AIA. • Asbestos PPE to be issued, ex. FFP2 dust must, disposable full asbestos overalls. • All workers to make use of the decontaminating area will be established prior to work starting. • Disposal of asbestos to be done at Vissershok and obtaining of an Asbestos disposal certificate.
Electrical Installations	• Possible Electrocution, even fatal. Damage to equipment	• Task Specific Method statements and Risk Assessments required as per CR 9. • Competent contractor to be appointed if necessary. • Equipment to be used to detect live/high voltage cables. • Restricted areas to be identified. • All installations must comply with SANS 10142 & the regulations of the OHS Act 85/1993 and Construction Regulation 24 and Electrical Installation Regulations • Toolbox Talks to be conducted on Risk Assessments with declarations / acknowledgement signed daily. • Relevant PPE to be used. • Lockout procedures to be provided where applicable.

		• Only competent persons to be used with proof of competency to be provided.
		• CoC must be issued for all electrical installations. • All temporary electrical installations to be inspected at least weekly and prior to use. • All cables to be treated as live
LV, MV and HV Installations	• Possible electrocution • Possible multiple injuries • Possible fatalities	• All works to be conducted under supervision Contractor to meet Eskom safety requirements. • Only competent Employees to perform electrical works with proof of competency to be provided. • Relevant PPE to be provided to all employees conducting works. • Lock out procedures to be put in place as and where required.
Work at Heights/Roof Work including Cladding, Trusses and Purlins, Structural, etc.	• Possible Fall of persons, • Possible Death	• Task Specific Fall Protection Plan, Risk • Assessments and Method Statements required • PC shall comply with CR 9 and CR 10. • All employees shall be in possession of Working at Heights Training issued by an Accredited • Service Provider • All work to be done under supervision. • Compliance with Fall Protection Plan. • Rescue kit to be available on site. • PPE to be worn at all times. • Life lines to be installed as and when needed and must be secured to a fixed structure • How the roof work was planned/Method Statements. • That the roof workers are competent (trained, • experienced, knowledgeable)

Note:

The above list is by no means exhaustive and should not be limited to these activities but must cover all activities that forms part of the said construction work. Each activity must be split down to individual tasks and all associated hazards identified and listed in the risk assessment. This ensures that the critical tasks and subsequent critical hazards are not missed.

All Activities are to be re-assessed by the Principal Contractor and their contractors prior to start of work and must be communicated with all relevant employees with proof placed on file.

NB:
Although some of the work related to health and safety work is mentioned /noted in certain measured items in the bill of quantities it remains the contractor's responsibility to allow in his tender price for all work related to health and safety and the requirements as per this Health and Safety Specification and the OH'S Act 85/1993.

Additional Information/General Notes

1. All work operations shall be limited within site boundary.

2. The roads shall be kept clean at all times and deliveries and vehicle movement will be limited to reduce noise levels or interruption within the area.

3. Principal Contractor to adhere to site speed limits and inform their delivery companies of the same. The site speed limit is 40km/h

4. Where unidentified services are located on site, the contractor is to report this immediately to the principal agent and is to adequately protect these services until identified and the necessary instruction issued by the principal agent.

5. Park all vehicles in designated area as provided by the Client.

6. Avoid loitering.

7. Principal Contractor and their Contractors to only use access routes that has been identified by the Client.

8. Adequate signage and demarcation required.

9. The Principal Contractor and their contractors shall avoid using any of the facilities, unless authorization has been granted in writing from the Client/Principal Agent.

10. Principal Contractor to only work in the areas allocated by the client.

11. Working hours shall be confirmed with the Client.

12. No flammable liquids or other materials that are deemed to be a fire risk will be permitted on site without permission. When required, such materials must be stored in a compliant storage facility. Details of such a proposed storage facility must be presented to the Consultants for their consideration and will require Landlord and Tenant sign off. No flammable materials may be left in the building overnight.

13. All site personnel and workmen must wear presentable, clean and tidy company uniforms, with their required PPE. The name of the contractor's company must be clearly printed on the uniform.

14. The Contractor shall conform to any relevant Code of Conduct for Contractors working on Robben Island.

15. The Contractor is to provide each of his workers on the island with an ID-card with the following information displayed on said card: Surname and initial(S) of employee

    - ID-number
    - Photograph (passport type)
    - Name of Firm (employer)

Important Note:
The Health and Safety Specification was compiled with the input of all Designers. The Principal Contractor must ensure that continuous monitoring of risk and hazards are conducted.

ANNEXURE C: PROJECT LABOUR REPORT

ANNEXURE C: PROJECT LABOUR REPORT

Project/Contract Name:							Budget: (tick one) Capital	✓	Operating	
Project/Contract Number:							WBS No./Cost Centre No.:			
Contractor:							Project/Contract Start Date:			
Consultant:							Project/Contract End Date:			
CLO Name:		CLO ID Number:					Project/Contract Value (incl. allowance for escalation/excl. VAT):			
Month:							Project Labour Intensity Target/ Specified Minimum Targeted Labour Contract Participation Goal:			
Total value of work done to date (incl. escalation/excl. VAT):										
Number of workers	Name	Surname	ID Number/DOB	Targeted Labour (Y/N)	Daily Rate	Number of days worked this month (incl. training)	Disabled (Y/N)	Number of training days this month	Course Name	Training Service Provider
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
	Totals for sheet									
	Sheet of									

Signatures

Contractor: ---------- Date ----------

Consultant/Project Manager: ---------- Date ----------

ANNEXURE D: ENVIRONMENTAL MANAGEMENT SPECIFICATION

DRAFT ENVIRONMENTAL MANAGEMENT PLAN

PROPOSED DESIGN, BUILD AND COMMISSION OF A REVERSE OSMOSIS DESALINATION PLANT, ROBBEN ISLAND

In terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014 (as amended).

July 2022

Prepared for:

Robben Island Museum

DJEC Project Number:

2022/35

Author:

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Picture reference:
https://www.google.com/search?q=robben+island&rlz=1C1GCEA_enZA965ZA965&sxsrf=ALiCzsbk7AiKGsWALn8rjn-kUKdS5aIU-A:1656928179117&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiW96K8-t74AhUSi_0HHQxuA9cQ_AUoAXoECAIQAw&biw=1517&bih=694&dpr=0.9#imgrc=NQe_NAPjZlDsUM

THE ENVIRONMENTAL ASSESSMENT PRACTITIONER
Doug Jeffery Environmental Consultants (Pty) Ltd. P.O. Box 44 Klapmuts 7625 Tel: 021 875 5272
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DJEC REFERENCE NUMBER
2022/35

Report issued by:
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Report date of issue:		
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DEFINITIONS

In this EMP any word or expression to which a meaning has been assigned in the NEMA or EIA has that meaning, and unless the context requires otherwise –

Alternatives are different mechanisms for achieving the general purpose and need of the proposed activity or development. Alternatives may be in terms of location, activity, processes, timing, or "do nothing" (i.e., "no-go" option).

Assessment is the evaluation, judgement, organising, rating, interpreting and communication of information which is relevant.

Biota is the animal and plant life of a particular region, habitat, or ecosystem.

Clearing means the clearing and removal of vegetation, whether partially or in whole, including trees and shrubs, as specified.

Contractor - The Contractor has overall responsibility for ensuring that all work, activities, and actions linked to the delivery of the contract, are in line with the Environmental Management Programme and that Method Statements are implemented as described.

Construction activity is any action taken by the Contractor, the Sub-contractors, suppliers, or personnel in undertaking the construction work, otherwise referred to as "works".

The **construction area** is all areas used by the Contractor to carry out the required construction activities. This includes all offices, accommodation facilities, testing facilities/laboratories, batching areas, storage & stockpiling areas, workshops, spoiling areas, access roads, traffic accommodation (e.g., bypasses), etc.

A **construction camp** is the area designated for key construction infrastructure and services, including but not limited to offices, overnight vehicle parking areas, stores, the workshop, stockpile and lay down areas, hazardous storage areas (including fuels), the batching plant (if one is located at the construction camp), designated access routes, equipment cleaning areas and the placement of staff cooking and eating areas and ablution facilities, waste and wastewater management.

The **Developer** [The Robben Island (RIM)] is the person or legal entity that has made an application to the competent authority for environmental authorizations and who will have the overall responsibility to adhere to the relevant legislation and comply with the environmental authorisation.

An **ecosystem** is a biological community of interacting organisms (plants and animals) and their physical environment.

Endangered species are species of plant or animal which has been categorised by the International Union for Conservation of Nature (IUCN) Red Data List as likely to become extinct.

Endemic refers to a plant or animal species that are native or restricted to a certain area or range.

The **environment** is the surroundings within which humans exist and that are made up of -

- land, water, and atmosphere.
- micro-organisms, plant, and animal life.
- any part or combination of the above and the interrelationships among and between them.
- the physical, chemical, aesthetic, and cultural properties and conditions of the foregoing that influence human health and well-being.

Environmental Authorisation is the permission required from the competent authority for an activity as listed according to the NEMA EIA Regulations, 2014 (as amended).

Environmental Impact refers to any change to the environment, whether desirable or undesirable, that would result directly or indirectly from any construction activity.

Environmental Management ensures that environmental concerns are included in all stages of development to ensure that the proposed activity or development is done sustainably and does not exceed the carrying capacity of the surrounding local environment.

Hazardous Substances is a substance governed by the Hazardous Substances Act, 1973 (Act No. 15 of 1973) as well as the Hazardous Chemical and Substances Regulations, 1995.

Indigenous is a "native" species of plant or animal that occurs naturally in a particular place or region and was not artificially or intentionally introduced.

Invasive Alien Plants are all undesirable vegetation, defined as but not limited to, all declared category 1 and category 2 plants in terms of the National Environmental Management: Biodiversity Act, 2014 (Act No. 10 of 2004), as amended.

Local Authority is referred to as the "Council" – the local municipal authority that operates or is responsible in said area.

Method Statement means a written submission by the Contractor to the Employer's Representative in response to this EMP or a request by the Employer's Representative and ECO. The Method Statement must set out the equipment, materials, labour, and method(s) the Contractor proposes using to carry out an activity identified by the Project Manager when requesting the Method Statement. This must be done in such detail that the Project Manager and ECO can assess whether the Contractor's proposal is in accordance with this specification and/or will produce results in accordance with this specification.

Rehabilitation means returning an area impacted by activities/works to its original or better condition before the impacts from the activities/works have occurred.

Significant impact means an impact that may, but its magnitude, duration, intensity, or probability, have a notable effect on one or more aspects of the environment.

Solid waste means all solid waste, including construction debris, hazardous waste, excess cement/ concrete, wrapping materials, timber, cans, drums, wire, nails, food, and domestic waste (e.g., plastic packets and wrappers).

Spoil means excavated material which is unsuitable for use as material in the construction works or is material which is surplus to the requirements of the construction works.

Topsoil means a varying depth (up to 300 mm) of the soil profile irrespective of the fertility, appearance, structure, agricultural potential, fertility, and composition of the soil.

Works means the Works to be executed in terms of the Contract.

ACRONYMS AND ABBREVIATIONS

CA	Competent Authority
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ER	Employer's Representative
HWC	Heritage Western Cape
I&AP	Interested and Affected Party
IAP	Invasive Alien Plants (please see definition above)
LUPO	Land Use Planning Ordinance
MS	Method Statement
MSDS	Material Safety Data Sheet
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998) as amended
NEM: WA	National Environmental Management Waste Act, 2008 (Act No. 59 of 2008), as amended
NHRA	National Heritage Resources Act, 1998 (Act No. 25 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998), as amended
PPE	Personal Protective Equipment
RIM	Robben Island Museum
SDF	Spatial Development Framework
SDP	Site Development Plan
WUL	Water Use Licence - in terms of the National Water Act 1998 (Act 36 of 1998)

1. INTRODUCTION

Doug Jeffery Environmental Consultants (Pty) Ltd was appointed by the Proponent, ***Robben Island Museum (RIM)***, to compile an Environmental Management Plan (EMP) which will be used to design and construct a reverse osmosis (RO) desalination facility on Robben Island. The EMP will be used to promote and ensure environmental monitoring, control and management associated with the establishment of a RO desalination facility as described in **Section 3** of this EMP.

This EMP contains management requirements and recommendations made by *Doug Jeffery Environmental Consultants*, as well as in terms of best practice. Should the future approvals contain requirements (conditions) that contradict any points in this EMP, the requirements (conditions) in the authorisation supersede this EMP. This EMP should be reviewed and updated to include any additional recommendations and any conditions of authorisation should the project be authorised.

Section 28 of NEMA provides for the Duty of Care principle that "*…obliges every person who causes, has caused, or may cause significant environmental degradation to take reasonable measures to prevent such degradation from occurring, continuing, or recurring*". This clause formsthe underpinning philosophy of this EMP.

The Robben Island Museum (RIM) must ensure that this EMP forms part of any contractual agreements with a Contractor(s) and Sub-contractors for the execution of the proposed project. The Contractor must make adequate provisions in their budgets for the implementation of the EMP.

It is then the responsibility of the RIM to undertake the following:

- Ensure that all requirements of the EMP are met for the duration of the construction works are completed on site. The RIM always has the ultimate responsibility to ensure compliance with South African legislation.
- Appoint an Environmental Control Officer (ECO) to monitor the implementation of the construction phase of the EMP. The appointed ECO will monitor any other aspects covered in this document or its appendices that specifically calls for an ECO to be involved.
- Bind all Contractors undertaking work on these sites, to the specifications in this same EMP, as well as appendices and any amendments thereto.

1.1. PURPOSE OF THIS EMP

The purpose of this EMP is to ensure that the environmental impacts and management of the various aspects of the construction of the reverse osmosis (RO) desalination facility on the receiving environment are managed, mitigated, and kept to a minimum (i.e., the **outcome** of implementing the EMP). The EMP must provide easily understood and clearly defined **actions** that must be implemented during each phase of the proposed development. The EMP is a dynamic document that is flexible and responsive to new and changing circumstances.

The document is binding on the RIM, all Contractors and Sub-contractors and visitors to the site. It must be included in any tender documents or agreements, as well as contractual documents between the RIM and any Contractors. Copies of this EMP must be kept on-site and all **senior personnel** are expected to familiarise themselves with the requirements of this EMP.

1.2. STATUS OF THIS EMP

It is of utmost importance that this EMP is read in conjunction with any legally obtained authorisations that include any aspects of the proposed reverse osmosis(RO) desalination facility. This EMP is considered as a dynamic document that must be reviewed and updated continually.

The EMP is valid for the duration of the project with each applicable phase corresponding to the identified requirements.

2. EMP PHASING

2.1. PLANNING, DESIGN AND PRE-CONSTRUCTION PHASE

The pre-construction phase refers to the design phase of the project. This will ensure that any requirements and best practice mechanisms are built into the planning or design phase to be developed in the construction and operational phase.

2.2. CONSTRUCTION PHASE

The construction phase refers to the actual construction of the proposed reverse osmosis (RO) desalination facility on Robben Island and includes land clearing, earthworks, installation of bulk services (i.e., water, sewerage, roads, stormwater, electricity etc.), building, etc.

3. DESCRIPTION OF THE PROPOSED DEVELOPMENT

3.1. Location

Farm 1436, Robben Island, is approximately 13km from Table Bay Harbour, Cape Town. Access to the Island can be obtained via a ferry from Table Bay Harbour to Murray's Bay Harbour (see **Figure 1**). The proposed development will occur on the existing desalination plant structure on Robben Island, hereafter referred to as "the site".

Table 1: Surveyor General codes (21-digit codes), coordinates and size of the cadastral land parcel.

Property	SG Code	Latitude (S)	Longitude (E)
FARM 1436	C01600000000143600000	33°; 81'; 14.298	18°; 37; 35.580

A **Locality Map** is attached as **Annexure A**.

3.2. SCOPE OF THE DEVELOPMENT

The proposed reverse osmosis (RO) desalination facility will be constructed within the existing desalination plant structure as stipulated in **Section C3.1.2** of the Tender Document. The proposed works will include the design, manufacture, installation, commissioning
& acceptance period and 6 months trial operation of an appropriate desalination system.

3.2.1. Background & Scope of Works

Robben Island is currently supplied with potable water from a reverse osmosis (RO) desalination plant that was constructed in 1998. This facility is the only potable water source for Robben Island. The existing infrastructure is old and currently manually operated without any recovery energy system in place. The proposal aims to replace the existing RO desalination plant with a new desalination plant including new technology that allows the facility to be automated to ensure ease of operation with an energy recovery system installed. See **Annexure B** for the Site Development Plan.

As stipulated in the Tender Document, the scope of works entails a reverse osmosis (RO) desalination facility that could produce desalinated water at a rate of 220m³/day (instantaneous production capacity of 12.22 m³/h), but with supporting infrastructure such as electrical supply, MCC, LV installation, HVAC, sea water abstraction pump and manifold replacement.

The new desalination plant has the following limitations:

- It must be constructed within the existing desalination plant structure so that an Environmental Impact assessment (EIA) will not be required; and
- It must be constructed while the existing plant remains in operation in order to ensure that the residents of the Island have sufficient water during the construction phase.

3.2.2. Legislative Requirements

Section C3.1.2 of the Tender Document states that the proposed development will occur on the existing desalination plant structure and therefore, in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) as amended ("NEMA") and Environmental Impact Assessment (EIA) Regulations, 2014 (as amended) [GN No. R.326 of 2017], no Environmental Impact Assessment will be required. Should any existing Environmental Authorisations, or any such approvals, be required, the provisions of NEMA and EIA Regulations, 2014 (as amended) will apply.

Figure 1: An aerial image indicating the site location.

4. ROLES AND RESPONSIBILITIES

This section deals with the responsibilities of various parties during the Design and Construction Phase of any development. A flow diagram (**Figure 2**) illustrates the roles and responsibilities of the various parties.

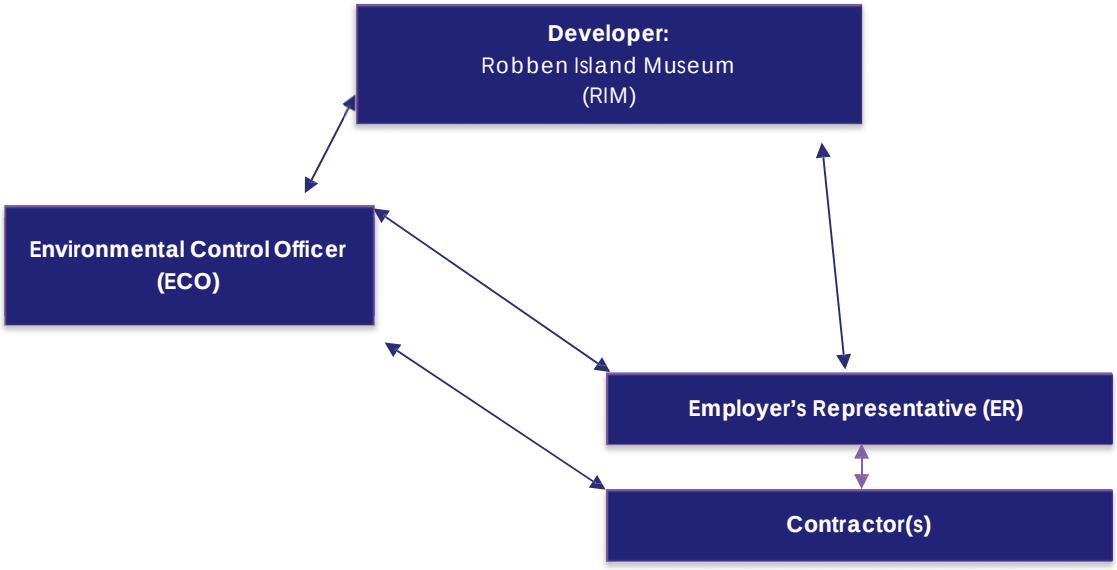

Figure 2: Flow diagram illustrating roles and responsibilities.

The implementation of this EMP requires the involvement of several stakeholders, each fulfilling a different but crucial role to ensure sound environmental management during the construction phase.

The following stakeholders will be involved with the EMP during the construction phase.

4.1. The Robben Island Museum

Under South African environmental legislation, the Developer [Robben Island Museum (RIM)] is accountable for the potential impacts of the activities that are undertaken and are responsible for managing these impacts, both in the construction and operational phases. The RIM, therefore, has overall and total environmental responsibility to ensure that the EMP is implemented and that both the EMP and any other approvals are always complied with. The RIM is also responsible for ensuring that all other environmental-related legislation is complied with.

The RIM is responsible for the development and implementation of the conditions of any approvals in terms of the planning and design of the development and construction thereof.

The RIM remains fully responsible for the implementation of this EMP, and compliance with the any other approval.

The RIM has overall responsibility for ensuring that the ER/Contractor complies with the conditions this EMP or any such approval once received.

Amongst the general responsibilities above the RIM is also completely and solely responsible for:

- Enforcing compliance with this EMP by the ER/Contractor
- Appointing an ECO
- Ensuring that all of the RIM's, staff, representatives, contractors, consultants, and any other agent operating under the employment of the RIM comply with the EMP and any other environmental and water-related approvals.
- Ensuring that all the necessary authorisations and permits have been obtained.

- Read the ECO's Environmental Monitoring Report, considering the ECO's observations and recommendations and, taking action where required.

4.2. THE EMPLOYER'S REPRESENTATIVE

The Employer's Representative (ER) would act as the Robben Island Museum (RIM's) on-site implementing agent and has the responsibility to ensure that the RIM's responsibilities are executed in compliance with relevant legislation and the EMP.

Any on-site decisions/inputs regarding environmental management are ultimately the responsibility of the ER.

The on-site ER will have the following responsibilities in terms of the implementation of the Construction phase of this EMP and assisting the RIM to ensure compliance with EMP and any other environmental and water-related approvals:

- Ensuring, in conjunction with the RIM, that the authorisations and permits have been obtained and conditions have been met.
- Assist the RIM with the appointing of an ECO, and where required by other approvals.
- The ER will ensure that the appointed ECO is paid timeously thereby ensuring an ongoing ECO service.
- Should the RIM or the ER change or cancel the ECO's services (either verbally, in writing or implied due to non-payment of fees) or should the ECO terminate their services the ER must notify The Robben Island Museum of this in writing within 7 days.
- Take action regarding any non-compliance that is reported on or noted.
- Ensuring that the RIM is aware of any environmental non-compliance on site.
- Considering the ECO's observations and recommendations.
- Ensuring that the ECO is made aware of any changes in terms of the project.
- Reviewing and approving the Contractor's method statements.
- Ensuring that all contractors and sub-contractors are implementing and adhering to the EMP and meeting the requirements of the and statutory approvals.
- Ensuring that all works are occurring within the permitted areas.
- Assisting the Contractor in finding environmentally responsible solutions to problems.
- Ordering the removal of person(s) and/or equipment not complying with the EMP specifications.
- Ensure that the ECO is provided with any documentation required from the project team or Contractors.
- Issuing fines for transgressions of site rules and penalties for contravention of the EMP with input from the ECO and providing proof in this regard.

4.3. THE CONTRACTOR

The Contractor is bound by the requirements of this EMP. The Contractor will be subject to the issuance of penalties by the ER as stipulated herein. Any damage to the environment temporary or otherwise as a result of non-compliance with this EMP will be made good at the Contractor's cost. In addition, the Contractor will have the following responsibilities:

- Ensure that all senior and management staff involved with the project are aware and familiar with the requirements of this EMP.
- To ensure that all staff and Sub-contractors attended and undergo the necessary environmental site inductions.
- Maintain a register of all staff and Sub-contractors that have undergone an environmental site induction.
- The Contractor will adhere to and comply with all of the requirements and specifications of this EMP. Any non-compliance must be reported to the ECO and ER immediately.
- Ensuring that all Sub-contractors and service providers comply with this EMP.
- Read the ECO's Environmental Monitoring Reports and take action as required.

The Contractor is fully responsible for all Sub-contractors and service providersand their compliance with this EMP on site. The Contractor will ensure that all Sub-contractors and services providers are made aware of the requirements of the EMP and that they have a responsibility to comply with the EMP.

4.4. THE ENVIRONMENTAL CONTROL OFFICER

The ECO will be an independent environmental consultant appointed by the RIM. The role of the ECO is to assist with the monitoring, and where possible to provide guidance in terms of environmental matters.

The ECO will regularly monitor and review the on-site environmental management and implementation of this EMP.

The ECO is not responsible for enforcing compliance with the EMP or any other environmental and water-related legislation. This is the responsibility of the RIM and authorities. The role of the ECO is that of a monitoring and supportive function and advising the RIM of non-compliance in terms of the conditions of the EMP and/or any other related legislation/permits.

The ECO's duties consist of the following:

- Where required, provide assistance in terms of the notice of commencement.
- Conducting regular site inspections at the frequency as stipulated in **Section 5.1** of this EMP.
- The ECO will assist with the environmental induction training of site staff.
- Monitoring and verifying as far as possible adherence to the EMP.
- Monitoring and verifying that environmental mitigation measures are in place, where necessary, to facilitate keeping environmental impacts to a minimum.
- Reporting to the RIM and the ER any relevant observations made during site inspections.
- The ECO will report all noted/observed non-compliances with the EMP to the RIM's representative.
- As far as possible advise the ER regarding environmental matters that may become an issue.
- Reviewing the Contractor's construction method statements together with the ER.
- The ECO will make recommendations to the ER with regards to the issuing of penalties under the EMP.
- Facilitating the maintaining of open and direct lines of communication between the ER, Employer, Contractor and where necessary, the public, about environmental matters.
- Assisting with the appointing of the relevant specialists (botanists, wetland specialists, etc.), as required, to advise the Engineer, the RIM or ER.
- Assist the Contractor with basic awareness training of all construction staff, as to the requirements for working on the site.
- Assisting the Contractor in finding environmentally responsible solutions to problems.
- Monitoring the undertaking by the Contractor of environmental awareness training for all personnel and Sub-contractors coming onto the site and assisting with this where necessary.
- Advising on the removal of person(s) and/or equipment not complying with the specifications (*via* the ER).
- Reporting to the RIM on the implementation of the EMP regularly.
- Where necessary, recommend additions and/or changes to the EMP to the RIM.
- The ECO will draft an Environmental Monitoring Report every month (except during shutdown periods). This Environmental Monitoring Report will be submitted to the Contractor, ER and the RIM.

5. MONITORING

Monitoring is an important tool in determining the effectiveness of management actions by measuring changes in the environment. These could be in the form of fixed-point photography where an area is photographed on a regular/seasonal basis to ascertain changes, monitoring of a particular aspect such as water quality parameters, recordings of animal movement from a fixed point etc. The most important aspect of any monitoring programme is consistency and continuity. This will ensure a level of scientific accuracy to determine baselines/thresholds and measure changes/deviations, which then drive management reactions.

The Environmental Monitoring Reports drafted by the ECO will include photographs taken during the site inspections. The report will, to the best of the ECO's ability and information provided to them, be a true reflection of concerns and observations noted on site. The report will highlight environmental aspects relating to the construction phase of the project during the reporting period.

5.1. EMP COMPLIANCE MONITORING AND FREQUENCY

The **Developer (The Robben Island Museum) and Contractor(s)** are responsible for monitoring all construction activities on a **day-to-day** basis to ensure compliance with the EMP and other applicable environmental-related approvals and/or permits, throughout the construction phase of the development.

The **appointed ECO** will undertake compliance monitoring to ensure that the EMP is implemented throughout the development phase. The findings and outcomes of these audits will be recorded in the **Environmental Monitoring Report** that will be submitted to the to the Contractor, ER and the Robben Island Museum.

5.1.1. Access to Site

Access to the site is subject to rules and regulations of the RIM. Strict adherence by the Contractor and all his staff to RIM rules and regulations is obligatory.

5.1.2. Recommended Monitoring Frequency for this Development

ECO monitoring (site visits) must be undertaken **twice a month**, until such time that the installation of services infrastructure in all phases of the development is completed, or as per required by the RIM.

5.2. COMPLAINTS REGISTER

The Contractor shall keep a current and up-to-date complaints register. The complaints register is to be a record of all complaints received from communities, stakeholders, and individuals. The Complaints Record shall:

- Record the name and contact details of the complainant.
- Record the time and date of the complaint.
- Contain a detailed description of the complaint.
- Where relevant and appropriate, contain photographic evidence of the complaint or damage.
- Contain a copy of the Contractor's written response to each complaint received and keep a record of any further correspondence with the complainant. The Contractor's written response will include a description of any corrective action to be taken and must be signed by the Contractor and affected party. Where a damage claim is issued by the complainant, the Contractor shall respond as described below.

The Contractor shall:

1. Ensure that all queries, complaints, and claims are dealt with within an agreed timeframe.
2. Ensure that any or all agreements are documented and signed by all parties and a record of the agreement is kept in the EMP file.
3. Ensure that the complainants' telephone numbers are made available to all landowners and affected parties.
4. Ensure that contact with affected parties is always courteous.

6. EMP REPORTING

6.1. DOCUMENTATION

The documentation listed below must be kept on-site in the form of an **Environmental File**, to record compliance with the EMP. The Environmental File must include, but is not limited to:

- Copy of the EMP.
- Copy of all other licences/permits.
- Environmental Method statements compiled by the Contractor.
- Environmental register, which shall include:
    - Complaints register.
    - Incident register – including copies of notification of Emergencies and Incidents, this must be accompanied by a photographic record.
- Waste Documentation such as Waste- and Sewerage Disposal Certificates.
- Material Safety Data Sheets for all hazardous substances.
- Written Corrective Action Instructions.

Please Note a copy of the EMP and ECO's Environmental Monitoring Reports must be kept at the Contractor's site office and must be made available to any authorised official upon request.

7. MANAGEMENT AND MONITORING PROCEDURES

This section addresses all issues relating to the physical construction, preparation for construction, monitoring during construction, decommissioning of non-permanent items on the site as well as the rehabilitation directly after construction is completed.

7.1. ENVIRONMENTAL INDUCTION AND AWARENESS TRAINING

The ECO in consultation with the Contractor shall ensure that adequate environmental awareness training of senior site personnel takes place and that all construction workers receive an induction on the importance and implications of the EMP. The presentation shall be conducted, as far as is possible, in the employees' language of choice.

As a minimum, training should include:

- Explanation of the importance of complying with the EMP.
- Discussion of the potential environmental impacts of construction activities.
- The benefits of improved personal performance.
- Employees' roles and responsibilities, including emergency preparedness.
- Explanation of the mitigation measures that must be implemented when carrying out their activities.
- Explanation of the specifics of this EMP and its specification (No-Go areas, etc.)
- Explanation of the management structure of individuals responsible for matters pertaining to the EMP.

On the appointment of Sub-contractors and/or new staff it will be necessary to undertake induction training sessions to ensure that they understand the importance and implications of the EMP. The

Contractor and ECO must keep records of all environmental training sessions, including names, dates and the information presented.

It is recommended that the **Environmental Awareness Training** is provided on a regular basis until construction is completed to remind all staff and personnel of the importance of the EMP.

Notwithstanding the specific provisions of this particular section, it is incumbent upon the Contractor to convey the sentiments of the EMP to all personnel involved with the works.

Annexure D contains useful **Environmental Awareness Material**.

7.2. PUBLIC LIAISON AND COMMUNICATION

Open, transparent, and good relations with island residents and local staff are an essential aspect of the successful management and mitigation of environmental impacts.

The RIM must ensure that the island residents are informed and updated throughout the construction phases. Sufficient signage should be erected around the site (including at the entrance), informing the island residents of the construction activities taking place. The signboards should include the following information:

- The name of the Contractor.
- The name and contact details of the site representative to be contacted in the event of emergencies or complaint registration.

7.3. WORK HOURS

Hours of work on the site shall be limited to that accepted by the local authority. Construction will be limited to day-time hours only (between 07:00 AM and 5:00 PM). If construction is required outside of these times, written permission is to be obtained from the ER and Robben Island Museum.

7.4. TEMPORARY SITE CLOSURE

In the event of a temporary site closure occurring such as the builder's holidays, temporary suspension of works or any period of inactivity longer than **seven (7) working days** the Contractor is to notify the ECO. The Contractor shall check the site according to the requirements of the ECO and ensure that all items are addressed. The Contractor will provide a brief written report (refer to the **Temporary Shutdown Checklist** included under **Annexure E**) regarding site compliance to the ER and ECO before the temporary shutdown date.

7.5. HEALTH AND SAFETY

The Contractor shall always observe the OHS Act and ensure adequate safety precautions on the site.

Telephone numbers of emergency services, including the local firefighting service, shall be displayed conspicuously in the Contractor's office. No weapons (firearms, airguns, daggers etc.) are permitted on site. The Contractor shall ensure that contact details of the local medical services are available to the relevant construction personnel before construction works start.

7.6. METHOD STATEMENTS

Method Statements (MS) are written submissions by the Contractor to the ER (with input from the ECO) in response to the requirements of this EMP or a request by the ER or ECO. A minimum requirement will consist of the listed MS below. Further, MS's may be requested by the ER or ECO.

The Contractor shall be required to prepare method statements for several specific construction activities and/or environmental management aspects as specified. **Annexure C** provides an example of a **Method Statement Template**. It is the Contractors responsibility to ensure that the required method statements are drafted and submitted.

The Contractor shall not commence the activity for which a method statement is required until the ER has approved the relevant method statement.

MS must be submitted at least **seven (7) business days** before the date on which approval is required (start of the activity). Should the MS be rejected this will be done so with a comment. The seven-day submission period will commence once again on the re-submission of the MS. Should the MS be submitted, and no response (acceptance or rejection) be obtained within **seven (7) business days** from the ER or ECO the MS will be considered as having been accepted and work can commence in line with the submitted MS.

Failure to submit a MS may result in the suspension of the activity concerned until the appropriate MS has been submitted and approved.

An approved MS shall not absolve the Contractor from any of his obligations or responsibilities in terms of the contract. However, any damage caused to the environment through activities undertaken without an approved MS shall be rehabilitated at the Contractor's cost and to the satisfaction of the ECO and ER.

The MS shall cover relevant details with regard to:

- Construction procedures and location of the construction site.
- Start date and duration of the procedure.
- Materials, equipment, and labour to be used.
- How materials, equipment and labour would be moved to and from the site as well as on-site during construction.
- Storage, removal and subsequent handling of all materials, excess materials, and waste materials of the procedure.
- Emergency procedures in case of any reasonably potential accident or incident which could occur during the procedure.
- How mitigation measures will be employed.
- Compliance or non-compliance with the EMP Specification and motivation if non-compliant.

7.6.1. Method Statements Required

Based on the specifications in this EMP, the following MS are required as a minimum, and additional MS may be requested as required.

MS1: ***Site Camp Layout and establishment***

A Site Camp Layout Plan and the method of establishment of the construction camp, i.e., all offices, accommodation facilities, large volume cement batching areas, storage & stockpiling areas, workshops, and all other areas/facilities required for the undertaking of activities required for completion of the project must be provided. The plan shall include the location and layout of waste storage, ablution facilities, stockpiling and spoil areas and hazardous material storage areas. The decommissioning and removal of these facilities on completion of construction works shall also be detailed.

MS2: ***Site clearing***

The Contractor shall submit a site clearing MS for all areas where the Contractor is required to or intends to, clear vegetation within the development footprint. The MS shall clearly indicate what is to be cleared and how this will be done, where and how cleared material would be stored or disposed of. This MS will also detail the setting aside of topsoil for rehabilitation.

MS3: ***Cement and concrete batching***

This MS details cement storage, concrete batching areas and methods, method of transport of cement and concrete, storage, and disposal of used cement bags, etc.

MS4: ***Traffic control and accommodation***

The Contractor shall submit an MS for approval, detailing how traffic is to be accommodated within the development during construction. Cognisance must be taken of any no-go areas.

MS5: ***Solid waste control system***

The Contractor shall submit an MS detailing a solid waste control system (storage, provision of bins, site clean-up schedule, bin clean-out schedule, rubble disposal/reuse, rubble removal frequency etc.) to the ER for approval.

MS6: ***Wastewater control system***

The Contractor shall submit an MS to the ER detailing how wastewater would be collected from all wastewater generating areas, as well as storage and disposal methods. If the Contractor intends to carry out any on-site wastewater treatment, this should also be included.

MS7: ***Dust control***

The Contractor shall submit an MS to the ER detailing how potential dust and windblown sand will be monitored and addressed on site. The Contractor will consider the recommendations above while bearing in mind that these are not the only available solutions.

MS8: ***Soil erosion prevention and sedimentation control***

The Contractor shall submit an MS to the ER detailing how soil erosion and sedimentation control will be implemented, methods to be used and rehabilitation of disturbed areas.

MS9: ***Hazardous substances & Emergency Procedures***

The Contractor shall provide an MS detailing the hazardous substances/materials that are to be used during construction, as well as the storage, handling, and disposal procedures for each substance as well as materials such as rubble soil and water contaminated with hazardous substances. The details of the disposal service providers (if required), supplier and suitable DEAT approved disposal sites that will be used by the Contractor are to be included. In addition, this MS will include an emergency procedure plan that will detail responses relating to the leaking or spillage of fuel oils or other hazardous substances.

This method statement shall in no way override, replace, void, or offer any exemption from neither any relevant legislation nor the requirements of the OHS Act.

MS10: *Rehabilitation*

Should vegetation rehabilitation be required as a result of disturbance, this must be addressed in this MS. Rehabilitation details relating to plant species (all indigenous and suitable to the vegetation type), plant numbers, irrigation and establishment, planting methods etc. must also be detailed.

8. IMPACT MANAGEMENT OUTCOMES AND ACTIONS

This section describes activities associated with the proposed development and associated infrastructure. There are numerous activities identified for the proposed development and for each activity a set of prescribed impact management outcomes and associated management actions have been identified. RIM are responsible to ensure the implementation of these controls for all projects as a minimum requirement for mitigating the impact of construction-related activities.

The tables in this section describe the management outcomes associated with the proposed development, and for each activity, a set of prescribed impact management outcomes and associated management actions have been identified.

Tables key/legend:

The table below provides an understanding of the structure of the impact management outcomes and actions tables provided in this section.

Management Outcome:	***What** impact needs to be avoided?*
Management Actions:	
***Mitigation and management measures** are required to reduce the potential impacts.*	
Project Specific Management Actions:	
Specific mitigation and management measures as recommended in the specialists' reports or contained in the relevant approvals.	
Implementation:	
Responsible party:	***Who** needs to implement the management actions?*
Method of implementation:	***How** should the actions be implemented?*
Timeframe for implementation:	***When** do the actions need to be implemented?*
Monitoring:	
Responsible person:	***Who** should monitor compliance?*
Frequency:	***How often** should monitoring occur?*
Evidence of compliance:	***Proof** of compliance (e.g., reporting, photographs, etc.)*

8.1. PRE-CONSTRUCTION MANAGEMENT

It is recommended that sustainable design considerations are implemented during the planning phase to ensure that the impacts associated with the development are avoided, minimised, or managed before construction commences.

8.1.1. Appointment of an ECO

The ER or the RIM must appoint a suitable, experienced ECO to monitor the implementation and compliance with the EMP.

The ECO should be notified a **minimum of three (3) weeks before the commencement of site activities** to ensure that the necessary notifications, if required, can be made.

Depending on the speed and nature of the works being undertaken and the performance of the Contractors on-site the ECO will undertake two **site visits per month** (excluding during shut down periods).

The ECO will produce an **Environmental Monitoring Report** once per month (excluding shutdown periods). This Environmental Monitoring Report will be submitted to the Contractor and the ER. The report will highlight environmental aspects relating to the construction phase of the project during the reporting period.

8.1.2. Updating Relevant Development Documents / Reports

The RIM and Contractor shall ensure that the EMP, Site Plans and all the relevant documents required are up to date and approved by the relevant authority before the commencement of the construction activities, where applicable.

8.1.3. Induction and Awareness Training

Management Outcome:	Ensure that adequate environmental awareness training of senior site personnel takes place and that all construction workers receive an induction on the importance and implications of this EMP.
Management Actions:	
All requirements provided under **Section 7.1** of this EMP must be applied.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor will ensure that all the above management actions are complied with and implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance with the EMP. b) The ECO to provide details in Environmental Monitoring Report.

8.2. CONSTRUCTION MANAGEMENT

These Construction Phase requirements are aimed at using Best Practise Principles and/or specialist recommendations to manage the impacts on the environment during the construction of the development.

8.2.1. Site Demarcation

Management Outcome:	Impacts on the environment are minimised when constructing new infrastructure and the development footprint is kept to a demarcated site area.
Management Actions:	
a) Method Statement required – see **MS1**. b) The "site" refers to all areas required for construction purposes and not necessarily the property boundaries. The site will be limited as far as possible to reduce the development footprint. c) The boundaries of the site shall be demarcated before any work commencing on the site. The site demarcations shall be removed when the site is decommissioned. d) All construction activities, materials, equipment, and personnel will be restricted to within the demarcated site areas. The boundaries of the construction activities must be demarcated to restrict construction activities within the site. e) The use of danger tape for demarcation purposes is discouraged and must be limited as far as possible. Brightly coloured droppers and coloured nylon cord/netting/fencing/wire with markers must be considered as an alternative to danger tape. f) The demarcations must be maintained and ensure that materials used for construction on the site do not blow onto or move outside the demarcated site and environs. g) Construction workers, vehicles and works are forbidden to access any private property unless approval has been granted by the ER in writing after the landowner has given permission. **Fencing:** a) It will be the responsibility of the Contractor to decide on an appropriate system of protective fencing for the site, if required, and approved by the ER. b) The use of danger tape for demarcation purposes is discouraged and must be limited as far as possible. Brightly coloured droppers and coloured nylon cord/fencing wire with markers must be considered as an alternative to danger tape.	
Project Specific Management Actions:	
Requirements from Tender Document: a) The camp site shall be properly and neatly fenced using temporary fencing with secure access control. The Contractor shall be responsible for providing and maintaining his own security arrangements for the duration of the Contract.	
Implementation:	
Responsible party:	ER and the Contractor(s)
Method of implementation:	a) The boundary of the site will be agreed upon and approved by the ER. b) The Contractor shall ensure that the approved construction area will be adequate to cover the project without further space adjustments being required at a later date. Changes must be approved by the ER and a MS must be submitted. c) The method of demarcating the boundaries shall be determined by the Contractor and agreed to by the ER before any work is undertaken. d) The Contractor shall ensure that all works, labour, and materials remain within the boundaries of the site unless otherwise agreed in writing with ER. It will be the responsibility of the Contractor to decide on an appropriate system of protective fencing for the site if required.
Timeframe for implementation:	Before commencement of the construction phase.

Monitoring:	
Responsible person:	ECO
Frequency:	Before commencement of the construction phase and whenever there are significant changes to the Site Camp Layout Plan.
Evidence of compliance:	ECO to obtain records from the Contractor and report in the Environmental Monitoring Report.

8.2.2. Site Camp Establishment & Site Facilities Management

Management Outcome:	Clean and well-maintained toilet facilities, eating areas and potable water are available to all staff to minimise the risk of disease and impact on the environment and health impacts.

Management Actions:

a) Method Statement required – see **MS1**.
b) Construction camps and associated facilities shall be established in a manner that does not adversely affect the environment.
c) The construction area shall be kept to a minimum necessary for construction activities.
d) The Site Layout Plan must be submitted to the ECO accompanied with the MS.
e) The Site Camp Layout Plan will indicate the placement and location of, *inter alia*, the following:
   i) Site offices.
   ii) Stores, silos, and stockpile areas.
   iii) Large plant and vehicle parking area.
   iv) Ablution facilities.
   v) Haul routes.
   vi) Site access.
   vii) Temporary waste storage area.
   viii) Large volume fuel storage (tanks or mobile fuel trailers) areas.
   ix) plant nursery.
f) The Site Camp Layout Plan shall take cognisance of access for deliveries and services. These activities should not result in the disturbance of the environment.
g) Suitable areas for maintenance and refuelling, large volume cement/concrete batching etc. must be identified by the ER in consultation with the ECO.
h) The Site Camp Layout Plan shall also indicate security requirements (including temporary and permanent fencing, lighting etc.).
i) The construction site should be secured against unauthorised entry.
j) Only security personnel may be accommodated at the construction site during the development phase.

Ablution facilities:

a) Mobile chemical toilets (1 for every 15 workers on-site) to be installed onsite if no other ablution facilities are available.
b) The use of ablution facilities and or mobile toilets must be used at all times and no indiscriminate use of the veld for ablutions is permitted under any circumstances.
c) Where mobile chemical toilets are required, the following must be ensured:
   i) Toilets are located no closer than 100 m to any watercourse or water body.
   ii) Toilets are secured to the ground to prevent them from toppling due to wind or any other cause.
   iii) No spillage occurs when the toilets are cleaned or emptied, and the contents are managed under the EMP.
   iv) Toilets have an external closing mechanism and are closed and secured from the outside when not in use to prevent toilet paper from being blown out.
   v) Toilets are to be emptied before long weekends and workers' holidays and must be locked after working hours.
   vi) Toilets are serviced regularly, and the ECO must inspect toilets to ensure compliance with health standards.
d) Copies of the waste disposal certificates must be included in the Environmental File to be checked by the ECO.

Eating areas:

a) Adequate temporary shade must be provided within the construction areas to ensure that site personnel do not move off-site to eat.
b) Suitable refuse bins with lids must be provided in all eating areas to the satisfaction of the ER. The bins must be weatherproof and scavenger proof and approved by the ER.
c) If deemed necessary by the ER, the Contractor shall demarcate designated eating areas.
d) No feeding of wild animals shall be permitted. Food and food products are to be stored in such a way so as not to attract scavenging animals.

Water Provision:

a) Safe drinking water fit for human consumption must be provided at the site offices and all other working areas.
b) All drinking water must be from a legal source and comply with recognised standards for potable use.
c) The provisions of the National Water Act, 1998 (Act No. 36 0f 1998) and its Regulations for taking water from natural water resources must be complied with.
d) No water may be abstracted from streams, rivers, wetlands, or boreholes **unless** the necessary water use authorisations have been obtained from the DWS.
e) If water is stored on-site, drinking water and multi-purpose water storage facilities shall be distinguished and demarcated with appropriate signage.
f) No water is to be wasted on site. Any leaks are to be reported and repaired immediately. All pipes, taps, and associated infrastructure are to be maintained and in good working order.
g) A suitable container should be placed underneath all drinking water taps or associated infrastructure to prevent water wastage and reuse water for other construction activities.

Site Safety and Security:

a) The construction site should be secured against unauthorised entry.
b) All personnel must be adequately trained and informed of the tasks that they are expected to perform. This is required for their safety as well as the safety of colleagues and other interested and/or affected parties.
c) Construction workers will be supervised on-site during the development phase.
d) No unauthorised person shall be allowed onto the site.
e) All personnel must be transported to and from the site daily.
f) The movement of all personnel on-site must be monitored through a rollcall system.
g) No personnel, except for security personnel may are allowed to stay overnight on site.
h) Adequate fencing needs to be provided around the site. Fencing needs to be checked and maintained during the construction phase.
i) The Contractor must ensure that his equipment is protected.
j) Solid and construction waste should not accumulate on-site as this could attract rodents and also poses a safety hazard.
k) All excavated areas and/or holes should be demarcated.
l) Maintain environmental incidents register in which all environmental incidents (e.g., accidental spillages etc.) are logged

Project Specific Management Actions:

Requirements from the Tender Document:

a) The Site of Works will be as defined by the limits of construction shown on the drawings, plus any additional space required for the erection of a site camp. An area at the Murray's bay harbour will be made available to the contactor for his site camp. This site at the Murray`s Bay harbour will be necessary for offloading and stockpiling of materials. All surplus or excavated material will be stockpiled at the site camp before being shipped to the mainland to spoil/waste facilities.
b) Access to the site is subject to rules and regulations of the Robben Island Museum (RIM). Strict adherence by the Contractor and all his staff to RIM rules and regulations is obligatory.
c) An area at the desalination plant will be made available to the contactor for his site camp. This site will be necessary for offloading and stockpiling of materials. The whole site in terms of the conditions of Contract consists of the following area:
    i) The existing desalination plant site

ii) Stockpile area at the existing desalination plant site
iii) Spoil site (to be identified before commencement of contract)
iv) All roads used to haul materials to and from the works

d) The type and size of construction vehicles that the Contractors intends using on the existing road is subject to the approval by RIM prior to importing to the Island. Any damages caused to the roads used during the construction shall be repaired to the satisfaction of RIM and the Engineer and at the cost of the contractor. The island has a speed limit of 40km/h.

e) The camp site shall be properly and neatly fenced using temporary fencing with secure access control. The Contractor shall be responsible for providing and maintaining his own security arrangements for the duration of the Contract.

f) The Contractor shall provide, maintain and remove his own facilities to the satisfaction of the Engineer. The Contractor shall provide the area around his office, stores and sheds (i.e. the "Camp") with adequate security fences to ensure that unauthorised persons do not enter the camp area and security personnel should he deem it necessary. The tendered sums as scheduled by the Contractor, whether grouped or individually, shall include all costs for the installation, maintenance and removal of the fencing as specified, in addition to all other facilities specified and as required by the Contractor for his own purposes.

Implementation:	
Responsible party:	ER and the Contractor(s)
Method of implementation:	a) Before the Contractor takes handover of the site, the Contractor will submit to the ER a Site Camp Layout Plan. This plan must be approved and signed off by the ER with input from the ECO. b) The ER will ensure that the ECO is involved in the establishment of the Site Camp Layout before the commencement of the proposed action. c) Before construction can begin, the Contractor shall submit to the ER for approval a site establishment **method statement**. d) A copy of the approved Site Camp Layout Plan will be provided to the ECO before the commencement of construction. Changes to the Site Camp Layout Plan must be approved by the ER.
Timeframe for implementation:	Before the commencement of the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Before commencement of the construction phase and whenever there are significant changes to the Site Camp Layout Plan.
Evidence of compliance:	ECO to obtain records from the Contractor and report in the Environmental Monitoring Report.

8.2.3. No-Go Areas

Management Outcome:	Access to No-Go areas prevented.
Management Actions:	
a) Method Statement required – see **MS1**. b) Identification of No-Go areas is to be informed by the environmental assessment, site walkthrough, and any additional areas identified during development. c) Unless the boundary of the No-Go areas can be identified, the relevant specialist (botanist, aquatic ecologist etc.) must be appointed by the ER to identify the relevant boundaries physically on site. The positions of the No-Go area boundary, identified by the specialist, will be recorded either with a GPS unit or by a surveyor. Once the boundary has been identified by the specialist and recorded the Contractor must demarcate the boundary accordingly. d) Erect, demarcate and maintain a temporary fence around the perimeter of any No-Go area. e) Fencing of No-Go areas is to be undertaken in accordance with **Section 8.2.2: Fencing**; and f) Unauthorised access and development related activity inside No-Go areas is prohibited. g) Should any vegetation be required to be retained on site, the contractor should demarcate all vegetation sufficiently (with shade cloth, plastic or other suitable material), as per the recommendation of the ER/ ECO. Vegetation to be retained on site should be regarded as a "No-Go" area and all construction activities and materials should not be undertaken within the area."	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	ER and Contractor
Method of implementation:	a) No-Go area demarcation must be approved by the ER. b) The ER may declare additional No-Go areas at any time during the construction phase as deemed necessary and/or at the request of the ECO and/or specialist.
Timeframe for implementation:	Before commencement of the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Before commencement of the construction phase and whenever there are significant changes to the Site Camp Layout Plan.
Evidence of compliance:	ECO to obtain records from the Contractor and report in the Environmental Monitoring Report.

8.2.4. Access, Roads, and Traffic Management

Management Outcome:	Minimise impact on the environment through the planned and restricted movement and parking of vehicles on site.
Management Actions:	
a) Method Statements required – see **MS1 & MS4**. b) Traffic along roads must be accommodated at all times. c) Construction activities and deliveries may not interfere with the public road system. d) All the required signage and hazard warnings are to be put in place. e) All drivers must have an appropriate and valid driver's licence. f) All relevant construction vehicles must be roadworthy and in an acceptable working condition. g) All relevant permits for abnormal loads must be applied for and obtained from the relevant authority as required. h) Access points to and from the site as well as roadways in front of the site are to be kept clean and free from stone, sand, and grit. These areas must be swept regularly. i) All construction vehicles, when on-site and on the surrounding property, will not exceed the speed of 25km per hour, to ensure the safety of vehicles, personnel, and the environment, and to lessen environmental degradation. Drivers who exceed the speed limit must be fined or dismissed by the Contractor or ER. j) Access to the site must be gained at the designated areas as determined by the ER. As far as possible use should be made of existing haul routes, tracks, and roads. The creation of short-cut paths/routes or temporary vehicular tracks is to be strictly prevented. If temporary routes are required, this must be presented in an MS for approval by the ER with input from the ECO.	
Project Specific Management Actions:	
Requirements from Tender Document: a) The type and size of construction vehicles that the Contractors intends using on the existing road is subject to the approval by RIM prior to importing to the Island. Any damages caused to the roads used during the construction shall be repaired to the satisfaction of RIM and the Engineer and at the cost of the contractor. The island has a speed limit of 40km/h.	
Implementation:	
Responsible party:	The Contractor and ER
Method of implementation:	a) The Contractor must ensure that all the management actions are implemented. b) Should there be a need to undertake work that will impact traffic the Contractor must ensure that all the required permissions have been obtained from the appropriate traffic authorities in writing. c) The Contractor is responsible for ensuring that all vehicles are roadworthy.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	ECO to obtain records from the Contractor and report in the Environmental Monitoring Report.

8.2.5. Workshop, Equipment Maintenance and Storage

Management Outcome:	Soil and groundwater contamination is minimized.
Management Actions:	
a) All vehicles and equipment shall be kept in good working order to maximise efficiency and minimise pollution. Any leaks or similar mechanical problems are to be reported and repaired immediately. b) No repairs and refuelling of construction vehicles are allowed to take place near any wetlands or watercourses. c) As far as possible servicing of plant and equipment will be undertaken off-site. Should emergency maintenance be required all precautions will be taken to prevent environmental impact. d) All emergency maintenance and refuelling of the plant on site shall take place at designated locations approved by the ER. Drip trays will be used for all refuelling and similar activities. This is to prevent any spillage at may contaminate the environment. e) The Contractor shall ensure that no contamination of soil, vegetation or stormwater occurs within the development area. Where practical, all maintenance of plant and equipment shall be performed in the workshop or preferably off-site. If it is necessary to do maintenance on-site and outside of the workshop area, the Contractor shall obtain the approval of the ER before commencing these activities. f) Drip trays shall be used to collect used oil, lubricants, etc. during maintenance. Drip trays shall be provided for all stationary plants, generators, pumps, and compressors. Drip trays shall be inspected and emptied daily and closely monitored during rain events to ensure that they do not overflow. g) All waste material in bunds and drip trays is to be managed as hazardous waste. All static plants (stationary > 6 months) shall be located within a bunded area with an impermeable surface. h) Washing of vehicles and plants shall be restricted to urgent maintenance requirements only. Adequate wastewater collection facilities shall be provided. The use of detergents for washing shall be restricted to low phosphate and nitrate concentration as well as being a low type detergent.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor will ensure that all of the above management actions are complied with and implemented. b) The Contractor will ensure that drip trays are being used at all times and that there are enough drip trays available on site.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.6. Storage, Handling, Use and Disposal of Hazardous Substances

Management Outcome:	Safe storage, handling, use and disposal of hazardous substances.
Management Actions:	
a) Method Statement required – see **MS9**. b) The use and storage of hazardous substances to be minimised and non-hazardous and non-toxic alternatives substituted where possible. c) All hazardous substances must be stored in suitable containers as defined in the MS. d) Containers must be clearly marked to indicate contents, quantities, and safety requirements. e) All hazardous substances, such as fuel and lubricants, must be stored on-site on an impermeable layer, within a secured and demarcated bunded area. The bunded area will be of sufficient capacity to contain a spill/leak from the stored containers. f) An alphabetical Hazardous Chemical Substance (HCS) control sheet will be drawn up and kept up to date on a continuous basis. g) All hazardous chemicals that will be used on-site will have Material Safety Data Sheets (MSDS). h) All employees working with HCS will be trained in the safe use of the substance, according to the safety data sheet. i) Employees handling hazardous substances/materials must be aware of the potential impacts and follow appropriate safety measures. Appropriate personal protective equipment must be made available. j) The Contractor must ensure that diesel and other liquid fuel, oil and hydraulic fluid are stored in appropriate storage tanks or bowsers. k) The tanks/ bowsers must be situated on a smooth levelled impermeable surface (concrete) with a permanent bund. The impermeable lining must extend to the crest of the bund and the volume inside the bund must be 130% of the total capacity of all the storage tanks. l) Provision must be made for refuelling at the storage area by protecting the soil with an impermeable ground cover. m) Where dispensing equipment is used, a drip tray must be used to ensure small spills are contained. n) All empty externally dirty drums must be stored on a drip tray or within a bunded area. o) No unauthorised access into the hazardous substances' storage areas shall be permitted. p) No smoking must be allowed within the vicinity of the hazardous storage areas. q) Adequate fire-fighting equipment must be made available at all hazardous storage areas. r) When refuelling away from the dedicated refuelling station is required, a mobile refuelling unit must be used. Appropriate ground protection impermeable measures such as drip trays must be used. s) An appropriately sized spill kit kept onsite relevant to the scale of the activities involving the use of hazardous substances must be available at all times. t) The responsible operator must have the required training to make use of the spill kit in emergencies. u) In the event of a spill, contaminated soil must be collected in containers and stored in a central location and disposed of according to the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). The ECO shall be informed of any spillages.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor will ensure that all of the above management actions are complied with and implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.7. Cement / Concrete Batching

Management Outcome:	To control concrete and cement batching activities to minimise spillages and contamination of soil, surface water and groundwater.
Management Actions:	
a) Method Statement required – see **MS3**. b) Concrete mixing must be carried out on an impermeable surface (such as on boards and/or within a bunded area with an impermeable surface) or make a hard surface and remove it when done. c) Concrete mixing areas must be fitted with a containment facility for the collection of cement laden water. This facility must be impermeable to prevent soil and groundwater contamination. d) Bagged cement must be stored in an appropriate facility and at least 32m away from any watercourses, gullies and drains, and site fencing. e) A washout facility must be provided for washing concrete associated equipment. Water used for washing must be restricted. f) Hardened concrete from the washout facility or concrete mixer can either be appropriately reused in construction-related activities or disposed of at an appropriately licenced disposal facility or on top of a building rubble stockpile as long as it does not leech out. g) Empty cement bags must be secured with adequate binding material if these will be temporarily stored on-site and contained in either a bin-type container (drum) or bags to prevent them from blowing away. h) Sand and aggregates containing cement must be kept damp to prevent the generation of dust (Refer to **Section 8.2.12: Dust Control**) i) Any excess sand, stone and cement must be removed or reused from the site on completion of the construction period and disposed of at a licensed disposal facility.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor will ensure that all of the above management actions are complied with and implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.8. Housekeeping

Management Outcome:	A neat and well-maintained site to minimise visual impacts.
Management Actions:	
a) No litter should be left on site and regular litter patrols should be undertaken. b) Any natural feature (e.g., rocks, etc.) situated on or around the site for survey or any other purposes shall not be defaced, painted, damaged, or marked unless agreed beforehand with the ER. Any features affected by the Contractor or his Sub-contractors in contravention of this clause shall be restored and rehabilitated to the satisfaction of the ER. c) All construction areas must always be kept neat and tidy. Different materials and equipment must be kept in designated areas and storing/stockpiling shall be kept orderly as demarcated in the Site Camp Layout Plan. d) Site camp lighting must be minimal and cause the least visual impact at night. All light sources must be shielded so that only the area that needs to be lit is lit. No neon or backlit signage is to be allowed. No floodlights are permitted. Security lighting must be placed such that it is not a nuisance to residents and visitors to the area. Shields may be required to prevent lights from being visible from other parts of the protected area.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor will ensure that all of the above management actions are complied with and implemented. b) The Contractor will ensure that the site is neat and well-maintained.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.9. Solid Waste Management

Management Outcome:	Wastes are appropriately stored, handled, and safely disposed of at a licensed waste facility.

Management Actions:

a) Method Statement required – see **MS5**.
b) The ER is responsible for ensuring that the Contractor implements and adheres to the waste management requirements and all relevant legislation.
c) The Contractor shall ensure that all facilities are maintained in a neat and tidy condition and the site shall be kept free of litter. Measures shall be taken to reduce the potential for litter and negligent behaviour concerning the disposal of all refuse. At all places of work, the Contractor shall provide litter bins, containers/skips and refuse collection facilities for later disposal.
d) Solid waste may be temporarily stored on-site in a designated area approved by the ER before collection and disposal. The minimum requirements for a Waste Storage Facility, consists of five ready fence panels covered with shade cloth, and one panel to be movable for access and emptying. The structure will have a roof (plastic covered ready fence panel, or similar, to protect from the rain) to ensure the structure is weather-proof. The floor is to be lined with DPC plastic to prevent ground or soil contamination from waste residue. If a waste skip is to be used for this purpose it must be kept covered with shade cloth.
e) Solid waste must be removed as often as required (when the containment area is full) or as instructed by the ER or ECO to a licensed waste disposal site. Recyclable waste should be separated and recycled, if possible, and opportunities provided on-site to facilitate the collection of recyclable waste products. Staff should be trained in waste segregation and storage. Arrangements should be made with the relevant recycling companies for the transportation or collection of various wastes.
f) Bins and containers/skips shall be covered, tip-proof, weatherproof and scavenger proof.
g) No burning, on-site burying or dumping of waste shall occur. Used (empty) cement bags shall be collected and stored in weatherproof containers to prevent windblown cement dust and water contamination. Used cement bags shall not be used for any other purpose and shall be disposed of every week *via* the solid waste management system.
h) The Contractor is responsible for ensuring that any Sub-contractors on-site manage and dispose of their waste in line with this EMP. The Contractor will instruct all Sub-contractors to follow waste management procedures.
i) Disposal certificates will be obtained and sent to the ECO for all waste disposed of.

Domestic Waste

a) The Contractor shall provide refuse bins with lids to the satisfaction of the ER, for all construction areas.
b) Refuse shall be collected and removed from all areas weekly, or as requested by the ER or ECO.
c) Domestic waste shall be transported to the approved refuse disposal site in covered containers or trucks.

Construction Rubble/Waste

a) Inert construction rubble shall be disposed of at a site approved by the ER. The ER will be responsible for ensuring that rubble is disposed of by the Contractor at the site approved and that the rubble can be legally disposed of at the said site. Rubble stockpiles will be kept consolidated and at a reasonable size. Rubble will be removed regularly and/or at the request of the ECO.
b) Clean building rubble free from plastic, wood, wire metal, tar, asphalt or similar may be crushed and reused for specific purposes (e.g., road sub-base, concrete etc.) within the parameters set in the National Environmental Management: Waste Act 59 of 2008, (as amended) (NEM: WA). Rubble may not be buried on-site for the sake of easy disposal.
c) All other solid waste or contaminated materials shall be disposed of offsite at an approved landfill site. The Contractor shall supply the ER with certificates of disposal or similar proof to indicate legal disposal. Copies of these will be provided to the ECO.
d) Any crushing and reuse of clean building rubble must fall within the thresholds allowed in terms of the NEM: WA. All local by-laws must be adhered to. Should the volumes and area required to exceed these parameters a Waste Licence will be required in terms of the Act.

e) The reusing of construction rubble as fill material must be done under the supervision of the Engineer and ECO.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor will ensure that all of the above management actions are complied with and implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.10. Hazardous Waste Management

Management Outcome:	Hazardous wastes are appropriately stored, handled, and safely disposed of at a licensed waste facility.
Management Actions:	
a) Method Statement required – see **MS9**. b) Hazardous waste must be stored in designated bunded areas. c) All hazardous waste (including bitumen, old oil etc.) shall be disposed of at an approved hazardous landfill site, or hazardous waste facility, which is licensed to receive such waste. Alternatively, the Contractor may appoint a reputable (the Contractor must take steps to ensure that the waste Contractor is legitimate and reputable) waste management service provider to remove and dispose of hazardous waste. d) The Contractor must provide disposal certificates to the ER copies will be provided to the ECO. The ER will ensure that this process is followed by the Contractor. e) Under no circumstances shall the spoiling of tar or bituminous products on the site, over embankments, or any burying, be allowed. Unused or rejected tar or bituminous products shall be returned to the supplier's production plant or reputable recycler where practicable as an alternative to disposal. f) Used oil, lubricants, cleaning materials, etc. from vehicles, machinery or bund areas shall be collected in holding tanks and sent back to the supplier or removed from the site by a specialist oil recycling company as an alternative to disposal. g) Once a purpose manufactured hydrocarbon spill remediation product has been used or has been used to treat contaminated materials (soil, rubble etc.) the resulting waste must be disposed of at a facility licensed to receive such waste.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor will ensure that all of the above management actions are complied with and implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.11. Noise Control

Management Outcome:	To prevent unnecessary noise to the environment by ensuring that noise from construction activity is mitigated.
Management Actions:	
a) Hours of work on the site shall be limited to that accepted by the local authority. Construction will be limited to day-time hours only (between 07:00 AM and 5:00 PM). If construction is required outside of these times, written permission is to be obtained from the ER and the Robben Island Museum. b) The Contractor shall be responsible for compliance with the Western Cape Noise Control Regulations, 2013 and all other relevant legislation concerning noise. c) All equipment and vehicles must be maintained to minimise noise from engines and ensure adherence to the Noise Regulations (SANS 10103). d) The Contractor shall endeavour to keep noise-generating activities to a minimum. e) The Contractor shall endeavour to, as far as possible, warn any local communities and residents that could be disturbed by noise-generating activities, such as blasting or piling, well in advance and shall keep such activities to a minimum. f) Construction processes and machinery/vehicles with the lowest noise emission values available must be utilised. g) All plants, equipment and vehicles are to have effective silencers/mufflers fitted that would otherwise cause a noise level exceeding 85dB. Exhaust systems are to be in good repair with no holes in the piping. h) No sound amplification equipment (hooters, loud music speakers, sirens etc.) is to be used on-site except in emergencies. i) Excessively noisy plants or plants requiring repairs are to be removed from the site.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor will ensure that all of the above management actions are complied with and implemented. b) The Contractor shall be responsible for compliance with the Western Cape Noise Control Regulations, 2013 and all other relevant legislation concerning noise.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.12. Dust Control

Management Outcome:	Dust prevention measures are applied to minimise the generation of dust.
Management Actions:	
a) Method Statement required – see **MS7**. b) The creation of nuisance/precipitant dust is controlled by the National Dust Control Regulations (R.827, 1 November 2013) promulgated under the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM: AQA). The Contractor will ensure that the specifications of these regulations are met at all times. c) Take all reasonable measures to minimisethe generation of dust as a result of project development activities to the satisfaction of the ECO. d) Removal of vegetation must be avoided until soil stripping is required and similarly exposed surfaces must be re-vegetated or stabilised as soon as is practically possible. e) Excavation, handling, and transport of erodible materials must be avoided under high wind conditions or when a visible dust plume is present. f) During high wind conditions, the ECO will evaluate the situation and make recommendations as to whether dust damping measures are adequate, or whether working will cease altogether until the wind speed drops to an acceptable level. g) Where possible, soil stockpiles must be located in sheltered areas where they are not exposed to the erosive effects of the wind. h) Where erosion of stockpiles becomes a problem, erosion control measures must be implemented at the discretion of the ECO. i) Vehicle speeds must not exceed 40km/h along dust roads or 20km/h when traversing unconsolidated and non-vegetated areas. j) Appropriate dust suppression measures must be used when dust generation is unavoidable, e.g., dampening with non-potable water, particularly during prolonged periods of dry weather in summer. Such measures must also include the use of temporary stabilising measures (e.g., chemical soil binders, straw, brush packs, chipping). k) Straw stabilisation must be applied at a rate of one bale/10m² and harrowed into the top 100 mm of top material, for all completed earthworks. l) For significant areas of excavation or exposed ground, spray water or wet areas using trucks to minimise the spread of dust. m) Stockpiles may not exceed 2m in height and shall be covered with tarpaulin or similar materials.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor will ensure that all of the above management actions are complied with and implemented. b) The Contractor shall ensure that the generation of dust is minimised and shall implement a dust control programme.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.13. Stormwater and Wastewater Management

Management Outcome:	To avoid pollution and erosion as a result of stormwater or wastewater runoff.

Management Actions:

Wastewater:

a) Wastewater from activities such as washing tools, batching and similar, will be collected in a drum, conservancy tank or any similar container. This water may then be re-used for batching or for wetting and compacting sub-base material during road surfacing.
b) An impermeable sump lined with thick DPC plastic may be constructed by the Contractor to collect wastewater from batching and tool washing. The sump will be open to allow the water to evaporate. Care must be taken to ensure that input does not exceed the evaporation rate and that no overflow from the sump occurs. This is of particular importance during the wet season. Once the sump is dry the remaining material at the bottom of the sump will be disposed of with the general waste and rubble.
c) The Contractor shall construct a sump within the designated construction area to the satisfaction of the ER and ECO.
d) Small volume wastewater collected from washing and other small volume cement work activities will be disposed of on top of the general rubble pile where it will be absorbed. This will be done in such a way as to ensure that there is no runoff from the rubble pile to the surrounding areas. The wastewater shall not be of such volume that it will saturate the entire body of rubble or will soak through the rubble pile.
e) Runoff from fuel depots/bunds/workshops/machinery washing areas and water contaminated with petro-chemicals and hydrocarbons shall be addressed as indicated in the hazardous waste section of this document.
f) Water from kitchens, showers, sinks and toilets etc. shall be discharged into a conservancy tank for removal from the site or be plumbed into a sewer line if this is available.
g) The ER's approval must be obtained by the Contractor before the discharge of any contaminated water into sewer systems.
h) At no point will wastewater from tool washing, batching, grouting, cleaning, showers, kitchens, or similar sources be permitted to enter or be disposed of, *inter alia*, in the following manner:
    i) Into a stormwater system.
    ii) Directly onto bare soil.
    iii) Within 50m of a wetland.
    iv) Into a watercourse or on the bank of a watercourse.

Stormwater:

i) The Contractor shall take reasonable measures to control the erosive effects of stormwater runoff during the construction phase. The Contractor shall use silt screens to prevent overland flow from causing erosion.
j) Point source discharge of stormwater must be prevented on slopes as this will lead to erosion of the unstable slope with loss of vegetation and resultant deep donga erosion. Any stormwater outlets must be constructed in such a manner as to ensure no soil or bank erosion takes place.
k) The use of straw bales as filters, which are placed across the flow of overland stormwater flows, may be used as an erosion protection measure. The ploughing-in of straw offers limited protection against stormwater runoff-induced erosion and shall be used as an erosion protection measure. The Contractor shall be liable for any damage to downstream property caused by the diversion of overland stormwater flows.
l) Drip trays shall be used for all pumps, generators, etc. to prevent water contamination as a result of fuel spills or leaks.

Project Specific Management Actions:

None.

Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor must ensure that wastewater is correctly managed on-site to the satisfaction of the ER. The Contractor will ensure that all Sub-contractors comply with the requirements to manage wastewater on site.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.14. Topsoil

Management Outcome:	Impacts on the environment are minimised when topsoil is removed, and sufficient topsoil is available for rehabilitation.
Management Actions:	
a) Method Statement required – see **MS2**. b) Topsoil is considered to be the natural soil covering, including all the vegetation and organic matter. c) Sufficient topsoil (up to 300 mm) must be stripped and stockpiled separately for the rehabilitation purposes of disturbed areas on-site after construction. d) Any topsoil stripped from the site must be stockpiled separately from other materials. If not, enough topsoil is available after stripping, then additional topsoil must be acquired. Any acquired topsoil must be approved by the ER. e) Stripped topsoil shall be stockpiled in areas agreed with the ER for later use in re-vegetation and shall be adequately protected. f) As far as is practicable topsoil should not be stripped or stockpiled when it is wet or raining, to prevent unnecessary compaction. g) Topsoil stockpiles shall be convex and no more than 2m high. Stockpiles shall be shaped so that no surface water ponding can take place. h) Topsoil stockpiles shall be protected from erosion by wind and rain by providing suitable stormwater and cut off drains and/or by establishing suitable temporary vegetation. Stockpiles shall not be covered with materials such as plastic that may cause them to compost or would kill the seed bank. i) Topsoil stockpiles shall be monitored regularly by the Contractor to identify any alien plants, which shall be removed when they germinate to prevent contamination of the seed bank. j) Any topsoil contaminated by hazardous substances shall not be used and shall be disposed of as per the hazardous waste requirements of this document.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor shall be held responsible for the replacement, at his own cost, for any unnecessary loss of topsoil required for rehabilitation purposes due to his failure to work according to the approved method statements and the requirements of this EMP.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	ECO to provide details in the Environmental Monitoring Report.

8.2.15. Earthworks, Stockpiling and Stockpile Areas

Management Outcome:	To reduce erosion and sedimentation as a result of stockpiling.
Management Actions:	
a) Method Statement required – see **MS1**. b) Stockpile areas must be within the designated area to the satisfaction of the ER and ECO. c) The areas for the stockpiling of excavated and imported material shall be indicated and demarcated on the site plan submitted in writing to the ER for his approval together with the Contractor's proposed measures for prevention, containment, and rehabilitation against environmental damage. d) All material that is excavated during the project development phase (either during piling, if required, or earthworks) must be stored appropriately on-site to minimise impacts to watercourses, wetlands, and water bodies. e) All stockpiled material must be maintained and kept clear of weeds and alien vegetation growth by undertaking regular weeding and control methods. f) No stockpiling of materials that could leach out and cause pollution may occur. g) **Stockpiles must not exceed 2m in height.** h) During periods of strong winds and heavy rain, the stockpiles should be covered with appropriate material (e.g., cloth, tarpaulin etc.). i) Where possible, sandbags (or similar) should be placed at the bases of the stockpiled material to prevent erosion of the material. j) Stockpiles shall be positioned and sloped to create the least visual impact. k) No foreign material generated/deposited during construction shall remain on-site on completion. Areas affected by stockpiling shall be reinstated to the satisfaction of the ER. l) As dealt with under the dust control section (**Section 8.2.12**) of this document stockpiles may need to be covered as a dust control measure. m) No stockpiling will take place within 20m of any watercourse or from the boundary of any wetland buffer (i.e., 32m buffer).	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor will ensure that all of the above management actions are complied with and implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.16. Vegetation Clearing

Management Outcome:	Vegetation clearing is restricted to the authorised development footprint of the proposed infrastructure.
Management Actions:	
a) No vegetation clearing shall take place without the approval of the MS by the ER. b) No vegetation clearing shall take place until the site boundaries and "No-Go" areas are clearly demarcated. c) All litter and non-organic material must be removed from the area to be cleared before the clearing of vegetation commences. d) Vegetation clearing of the site must be limited as far as possible. e) Vegetation clearing may not extend beyond the site boundary. If large areas are to be developed consideration should be given to a phased clearing approach to limit potential impacts resulting from large areas standing cleared for an extended period. f) Indigenous plant material, not removed during search and rescue, can be removed from cleared areas and maybe stockpiled for mulching. g) Alien vegetation may be used for mulching if it is not in the seed. h) Alien vegetation to be cleared should not be sent to a landfill, but instead chipped and/or composted, either on-site or at a licensed facility. Green and organic waste generated through general and maintenance activities should also not be sent to landfills. i) Permits may be required to remove or translocate protected plants or those of conservation concern and must be obtained before this happens.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor must ensure that all the management actions above are implemented. b) The Contractor shall be responsible for informing all employees about the need to prevent any harmful effects on natural vegetation to be retained on the construction site or beyond the site boundaries as a result of their activities.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	ECO to provide details in the Environmental Monitoring Report.

8.2.17. Protection of Fauna

Management Outcome:	Minimise disturbance to fauna.
Management Actions:	
a) The Contractor shall ensure that no hunting, trapping, shooting, poisoning or otherwise disturbance of any fauna takes place. b) The feeding of any wild animals is prohibited. No food or food products will be stored in such a way to attract scavengers. c) No interference with livestock must occur without the landowner's written consent and with the landowner or a person representing the landowner being present. d) The use of pesticides is prohibited unless approved by the ER. e) No domestic pets are permitted on site. f) Drainage structures (e.g., gutters, drains, sumps, ditches) must be designed, as far as possible, so that they do not act as pitfall traps for small creatures. They should either have gently sloping edges or be adequately covered to prevent creatures from falling into them.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor must ensure that all the management actions above are implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	ECO to provide details in the Environmental Monitoring Report.

8.2.18. Protection of Watercourses

Management Outcome:	Pollution and contamination of the watercourse environment, as well as potential erosion, are prevented.
Management Actions:	
a) All construction works should not be undertaken within 32 m of any watercourse on site, unless authorised in a Water Use Licence and / or an Environmental Authorisation. b) All watercourses and water bodies (if any) must be protected from direct or indirect spills of pollutants such as solid waste, sewage, cement, oils, fuels, chemicals, aggregate tailings, wash and contaminated water or organic material resulting from the Contractor's activities. c) In the event of a spill, prompt action must be taken to clear the polluted or affected areas. d) Where possible, no development equipment must traverse any seasonal or permanent wetland. e) Appropriate rehabilitation and re-vegetation measures for the riverbanks must be implemented timeously. In this regard, the banks should be appropriately and incrementally stabilised as soon as development allows.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The RIM and Contractor
Method of implementation:	The Contractor must ensure that all the management actions above are implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	ECO to provide details in environmental audit reports.

8.2.19. Protection of Heritage Resources

Management Outcome:	The impact on heritage resources is minimised.
Management Actions:	
a) If any archaeological remains (including but not limited to fossil bones and fossil shells, coins, indigenous and/or colonial ceramics, any articles of value or antiquity, stone artefacts, and bone remains, structures and other built features, rock art and rock engravings are discovered during construction, the findings must immediately be reported to HWC and must not be disturbed further until the necessary approval has been obtained from HWC. b) Should any human remains/burial or archaeological material be disturbed, exposed, or uncovered during construction, these should immediately be reported to the South African Heritage Resources Agency (021 462 4502) and Heritage Western Cape (021 483 9685). The ECO and ER are also to be informed. An archaeologist will be required to remove the remains at the expense of the RIM. c) The Contractor may not, without a permit issued by the relevant heritage resources authority, destroy damage, excavate, alter, deface, or otherwise disturb archaeological material.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	The Contractor must ensure that all the management actions above are implemented.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	ECO to provide details in the Environmental Monitoring Report.

8.2.20. Emergency procedures

Management Outcome:	Emergency procedures are in place to enable a rapid and effective response to all types of environmental emergencies.

Management Actions:

a) Method Statement required – see **MS9**.
b) Compile an Emergency Response Action Plan (ERAP) before the commencement of the proposed project.
c) The Emergency Plan must deal with accidents, potential spillages, and fires in line with relevant legislation. On-site emergency plans must be reviewed regularly.
d) All staff must be made aware of emergency procedures as part of environmental awareness training.
e) The relevant local authority must be made aware of a fire as soon as it starts.
f) In the event of an emergency, the necessary mitigation measures to contain the spill or leak must be implemented (see **Section 8.2.6: Storage, handling, use and disposal of hazardous substances**).
g) The RIM must ensure that "Any emergency incident, originating at the facility, which falls within the definition of section 30(1) of NEMA, must be dealt with by the facility as per Section 30 of NEMA". In the event of any incident, the facility must ensure containment by the responsible person and report the incident to the ER and the ECO.

Spills and Leaks

h) Any significant spills and leaks of oil, petrol or diesel from fuel storage areas must be immediately reported to the operations manager and ECO on-site.
i) In the event that a significant spillage/leakage of product and/or hazardous substances are released onto land or into water resources, the following procedures must be followed:
j) The spillage or leakage must immediately be contained, followed by the appropriate clean-up and remediation of the affected area.
k) In the event of a significant spill or leak of hazardous substances (petrol, diesel, cement, etc.) used during the construction or operational phases, such incident must be reported to all the ER and the ECO.
l) The Contractor shall ensure that his employees are aware of the procedure to be followed for dealing with spills and leaks, which shall include notifying the, ER and ECO. The Contractor shall ensure that the necessary spill response/hydrocarbon remediation materials (e.g., chemcap, spill-sorb, drizzat pads, enretech, OilCap and peat moss) and equipment for dealing with spills and leaks are available on-site at all times. The source of the spillage shall be isolated. The Contractor shall contain the spillage using sand berms, sandbags, pre-made booms, sawdust, or absorbent materials. Treatment and remediation of the spill areas shall be undertaken to the reasonable satisfaction of the ER.
m) The Contractor shall submit his emergency procedure (to be detailed in **MS9**) before bringing site any hazardous substances on-site.
n) All spills or accidents involving such materials are to be recorded by the Contractor. The Contractor is responsible for ensuring that these records are submitted to the ECO. The clean-up of spills and any damage caused by the spill shall be for the Contractor's account.

Project Specific Management Actions:

None.

Implementation:

Responsible party:	The RIM & Contractor
Method of implementation:	a) The RIM must ensure that any emergency incident, originating at the facility, which falls within the definition of section 30(1) of NEMA must be dealt with by the facility in accordance with Section 30 of NEMA. b) The Contractor will ensure that all of the above management actions are complied with and implemented. c) The Contractor shall take all reasonable steps to avoid increasing the risk of spills and leaks activities on site.

Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.21. Fire Prevention

Management Outcome:	Prevention of uncontrollable fires.
Management Actions:	
a) The Contractor shall ensure that basic fire-fighting equipment is available at all construction areas and facilities. The workforce should be appropriately trained in the use of all equipment. b) Smoking shall not be permitted in those areas where it is a fire hazard. Such areas shall include any workshop and fuel storage areas and areas where the vegetation or other material may promote the rapid spread of an initial flame. A fire extinguisher of the appropriate type must be present when welding or other "hot" activities are undertaken. c) In terms of the Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965), burning is not permitted as a disposal method. d) The Contractor shall appoint a fire officer who shall be responsible for ensuring immediate and appropriate action in the event of a fire. The Contractor shall ensure that all site personnel are aware of the procedure to be followed in the event of a fire. e) Any work that requires the use of fire or open flame may only take place at a designated area approved by the ER and must be supervised at all times. Serviced fire-fighting equipment shall be available. f) It is recommended that, if cooking is to take place on-site, purpose-made gas cookers be considered before the use of cooking fires. No fires are to be made on-site unless situated in a designated and demarcated area approved by the ER away from high-risk areas and in a contained fireplace (not on the bare ground). A fire extinguisher will be in this area at all times. Under no circumstances will there be more than one fire on the site at a time, or for the fire to be left unattended. The Contractor will also consider the prevailing weather conditions. g) Wood and branches will not be harvested from the site as fuel.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor will ensure that all of the above management actions are complied with and implemented. b) The Contractor shall take all reasonable steps to avoid increasing the risk of fire through activities on site.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor to ensure compliance. b) The ECO to provide details in the Environmental Monitoring Report.

8.2.22. Public Safety

Management Outcome:	All precautions are taken where possible to minimise the risk of injury, harm, or complaints.
Management Actions:	
a) Identify fire hazards, demarcate, and restrict public access to these areas as well as notify the local authority of any potential threats e.g., fuels etc. b) All unattended open excavations must be adequately fenced or demarcated. c) Adequate protective measures must be implemented to prevent unauthorised access to and climbing of partly constructed structures and protective scaffolding. d) Ensure structures vulnerable to high winds are secured. e) Maintain an incidents and complaints register in which all incidents or complaints involving the public are logged.	
Project Specific Management Actions:	
None.	
Implementation:	
Responsible party:	The Contractor
Method of implementation:	a) The Contractor shall at all times observe the OHS Act and ensure adequate safety precautions on the site. b) The Contractor will be responsible for the supervision of construction personnel on-site during the construction phase.
Timeframe for implementation:	Throughout the construction phase.
Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	Throughout the construction phase.
Evidence of compliance:	a) The Contractor must keep a record of all construction personnel on-site. b) ECO to provide details of any safety or security incidents in the Environmental Monitoring Report.

8.2.23. Rehabilitation

Management Outcome:	No environmental degradation occurs as a result of the development.

Management Actions:

a) Method Statement required – see **MS10**.
b) The Contractor shall ensure that all temporary structures, equipment, materials, waste, and facilities used for construction activities are decommissioned and removed upon completion of the activity. The Contractor shall clear and clean the construction site to the satisfaction of the ER upon completion of the construction.
c) The Contractor will undertake all rehabilitation of areas disturbed as a result of activities on-site to the satisfaction of ER. Expenses incurred in rehabilitating the site shall be for the Contractor's account.
d) The Contractor will be responsible for any costs resulting from rehabilitation required due to non-compliance with this EMP.
e) It may be necessary to obtain specialist (e.g., botanical, horticultural etc.) input before undertaking the required rehabilitation.
f) No invasive plant species should be introduced to the site. All invasive alien species should be eradicated from the disturbed sites. Non-indigenous and non-endemic species are permitted.
g) All areas disturbed by construction activities within the demarcated site, storage, stockpiling areas, etc. shall be rehabilitated to the satisfaction of the ER.
h) The need for vegetation rehabilitation, resulting from the Contractor's non-compliance with the EMP, will be for the Contractor's account and will be carried out to the satisfaction of the ER.
i) "No-Go" areas or areas outside of the approved demarcated site will be rehabilitated with the intention of restoring the area to the same or better condition than it was before the disturbance occurred. Only locally indigenous plants will be used. Where required the necessary specialist must be appointed to oversee and advise on the rehabilitation process.
j) No construction equipment, vehicles or unauthorised personnel shall be allowed onto re-vegetated areas.

Weed, diseases and pest control

a) The Contractor shall be responsible for ensuring that all re-vegetated areas remain free of all invasive alien and indigenous weed species during the contract and establishment period.
b) Weeding, removal methods and storage of this material shall be undertaken in such a manner that prevents the re-infestation of the cleaned areas.
c) All dead plant material shall be removed immediately as it may become a fire hazard.
d) The Contractor shall ensure that all plants are disease and pest free. Any methods used to control any diseases or pests, including the use of herbicides and pesticides, must be approved by the ER.

Project Specific Management Actions:

Requirements of the Tender Document

a) On completion of the Works, or when ordered by the Engineer, the Contractor shall remove all temporary buildings and latrines and restore the Site to a clean and sanitary condition to the satisfaction of the Engineer and rehabilitate the area in accordance with the EMP.

Implementation:

Responsible party:	The Contractor
Method of implementation:	The Contractor will ensure that all of the above management actions are complied with and implemented.
Timeframe for implementation:	After the construction works ended.

Monitoring:	
Responsible person:	The Contractor and ECO
Frequency:	After the construction works ended.
Evidence of compliance:	a) The Contractor to ensure compliance . b) The ECO to provide details in the Environmental Monitoring Report.

9. COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

The EMP forms part of the Contract Documentation and is thus a legally binding document. It is also necessary for the Contractor to make provisions as part of their budgets for the implementation of the EMP.

In terms of NEMA, an individual responsible for environmental damage must pay costs both to the environment, human health and preventative measures to reduce or prevent additional pollution and/or environmental damage from occurring. This is referred to as the Polluter Pays Principle, Section 28 of the NEMA embodies the polluter pays principle.

It is the responsibility of the ECO to report matters of non-compliance to the ER, who in turn is tasked with reporting such matters to the RIM.

9.1. PROCEDURES

The Contractor shall comply with the environmental specifications and requirements of this EMP on an ongoing basis and any failure on his part to do so will entitle the ER to impose a penalty.

In the event of non-compliance, the following recommended process shall be followed:

- The ECO shall issue a notice of non-compliance to the ER, stating the nature and magnitude of the contravention. A copy shall be provided to RIM.
- The ER will issue this notice to the Contractor.
- The Contractor shall act to correct the transgression within the period specified by the ER.
- The Contractor shall provide the ER with a written statement describing the actions to be taken to discontinue the non-compliance, the actions taken to mitigate its effects and the expected results of the actions. A copy shall be provided to the ECO and RIM.
- In the case of the Contractor failing to remedy the situation within the predetermined time frame, the ER shall impose a monetary penalty (spot fine) based on the conditions of the contract.
- Should the transgression be a blatant disregard of conditions of the EMP, the ER can at their discretion immediately issue a fine and require the remediation (without first giving the contractor a chance to remediate).
- In the case of non-compliance giving rise to physical environmental damage or destruction, the ER shall be entitled to undertake or to cause to be undertaken such remedial works as may be required to make good such damage and to recover from the Contractor the full costs incurred in doing so.
- In the event of a dispute, a difference of opinion, etc. between any parties in regard to or arising out of an interpretation of the conditions of the EMP, disagreement regarding the implementation or method of implementation of conditions of the EMP any party shall be entitled to require that the issue be referred to specialists for determination.
- The ER on advice from the ECO shall at all times have the right to stop work and/or certain activities on-site in the case of non-compliance or failure to implement remediation measures

9.2. OFFENCES AND PENALTIES

Any avoidable non-compliance with the conditions of the EMP shall be considered sufficient ground for the imposition of a penalty. Possible offences, which should result in the issuing of a contractual penalty, include, but are not limited to:

- Unauthorised entrance into No-Go areas.
- Catching and killing of wild or domestic animals.
- Unauthorised damage or removal of natural vegetation.
- Unauthorised camp establishment, including stockpiling, storage, etc.
- Hydrocarbons or hazardous material: negligent spills or leaks and insufficient storage.
- Ablution facilites: non-use, insufficient facilites and maintenance.
- Late method statements or failure to submit method statements.
- Insufficient solid waste management, including clean-up of litter, unauthorised dumping etc.
- Erosion due to negligence or non-performance.
- Excessive cement or concrete spillage or contamination.
- Insufficient fire control and unauthorised fires.

- Non-induction of staff.

Annexure C: Method Statement – Example Template

METHOD STATEMENT (MS)

NB! Contractor to ensure Method Statements are submitted at least 7 business days prior to work commencing on site.
It is the Contractors responsibility to submit the required MS timeously to the ER.

Project title:			
Method Statement for:		**MS number:**	
Date drafted:		**Revision:**	

Date Requested by Employee Representative (ER):		**Date Submitted:**	
Date Response Required by:		**Date Work Start:**	

Review Schedule		
Date	**Authority**	**Comment**

CONTRACTOR NOTE:
Method statements should address the following:

WHAT Brief description of the work to be undertaken
HOW Detailed description of the process of work, methods and materials
WHERE Description/sketch/map of locality of work (where applicable)
WHEN Due commencement date and completion date estimate (day/night work)

Description of actions required: WHAT Brief description of the work to be undertaken.			
Frequency: How often required?			
Commencement date: WHEN Start date.		**Expected date of completion:** End date.	
Location & description of work area: WHERE Description/sketch/map of locality of work (where applicable)			
Required materials & equipment: WITH WHAT Detailed description of the materials & equipment to be used.			
Step-by-step plan of how the action(s) will be carried out: HOW Detailed description of the process of work and methods.			
Storage/ disposal of materials and waste: HOW/WHERE Detailed description of how materials and waste will be stored/ disposed.			
Responsible party/ Contractor: WHO is responsible for works?			
Submitted to:		**Date of submission:**	

APPROVALS:	ECO	ER	CONTRACTOR
Signature:			
Date:			

Annexure D: Environmental Awareness Material

Environmental Management during Construction.

The why, what and how.

BUT WHY…

… should we care about the environment?

The environment provides us with everything we need to survive – food, water, fuel, air, etc. Human activity uses resources and has an impact on those resources. Managing our resource use and ensuring that our impact is minimised will ensure that these resources are not depleted.

The Constitution says that all people in South Africa have the right to a healthy environment. If you damage the environment, you are taking away that basic right of others as well as future generations – your children and grandchildren!

… environmental management if there is already conservation?

Historically, development and environmental conservation have been in conflict, because conservation was understood as the protection of resources, and development as the use, or exploitation of resources. The two competed for the same resources, but both are needed! Enter: SUSTAINABLE DEVELOPMENT.

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable development thus aims to improve the quality of human life while living within our ecological means = the wise use of resources!

… environmental management of construction?

South Africa's effort to attain sustainable development is based on the concept of Integrated Environmental Management (IEM). The purpose of IEM is to resolve or lessen any negative environmental impacts and to enhance positive aspects of development.

IEM is designed to ensure that the environmental consequences of development proposals are understood and adequately considered in the planning, implementation and management of all developments.

It is intended to guide, rather than impede the development process by providing a method of gathering, analysing and utilising information about the environmental impacts of development. IEM and other principles of environmental management are set out in the National Environmental Management Act, 1998 (No. 107 of 1998) ("NEMA").

BUT WHAT…

… exactly is the 'environment'? What if we're not working near rivers or fynbos or leopard toad habitat?

The environment is not only the 'conservation-worthy' such as rare plants and endangered animals. The environment is everything around you!

It is made up of living things (e.g. people, plants & animals) and non-living things (e.g. soil, water, buildings & cars). People and man-made things are also important parts of the environment.

Protection of the environment means that all living and non-living things are protected. During construction, Environmental Management Programmes (EMPr's) are implemented not only to protect fynbos or leopard toads but also to protect people (both on site and off), property (houses, cars, etc.) as well as natural resources such as water, air and soil.

… do EMPr's do? What does this mean for my contract?

EMPr's are tools to facilitate environmental management during the construction phase of development projects and thereby avoid unnecessary impacts to the environment.

In the past, the functionality and efficiency of EMPr's were hampered by resistance from contractors and engineers, the difficulties of costing for compliance and the lack of legal enforceability.

Now EMPr's are stipulated in the Environmental Authorisations (EA) as a condition of the approval to go ahead with the development, in other words it is legally binding.

When you sign a contract do work on a project with an EMPr, you are legally bound to comply with that EMPr!

Methods of implementing EMPr's are becoming more and more stringent and issues of enforceability are being addressed. Those individuals and companies that are familiar with compliance with EMPr's will be at a competitive advantage!

… do EMPr's consist of?

EMPr's usually contain an environmental policy statement, organisational structure detailing the responsibilities and authorities involved in the project, procedures for communication and record-keeping and environmental specifications.

EMPs are adapted to the scale and sensitivity of the construction project. They can be thick documents detailing specifications for every eventuality specifically adapted to the project, or they can be short and brief documents setting out standard environmental procedures and controls. Sometimes EMPr's include extensive penalty and incentive schemes.

A WORD ON METHOD STATEMENTS

A method statement can be requested or proposed when an activity is either not included in the EMP at all, if the EMPr specifications for an activity is not deemed adequate, if an activity is required that is not allowed by the EMPr, etc. In other words, when the EMPr does no give enough information to manage the environmental impact of a specific activity.

A method statement is defined as a written submission by the Contractor setting out the plant, materials, labour and method proposed to carry out an activity. Method statements must provide enough detail that the environmental impact of the activity can be assessed. Method statements must therefore be submitted well in advance of the activity (usually at least 5 days but sometimes more).

Method statements are therefore an extension of the EMPr, are also legally binding and are intended to ensure that the environmental implications of an activity outside of the EMP can be addressed.

Method statements usually require the approval by the engineer, the ECO/ESO/DEO, etc. before the activity can take place. If such an activity takes place without approval and result in environmental damage, the contractor is responsible for the cost of rehabilitation/clean-up/etc.

…is an ECO, ESO, DEO, etc.?

EMPs usually require the appointment of an ECO, ESO, DEO, etc. to oversee the implementation of and compliance with the EMPr on behalf of the engineer or the contractor(s). Ultimate responsibility for compliance with the EMPr lies with the contractor(s) and the engineer.

ESO = Environmental Site Officer – usually on site permanently or often. Can be independent consultant or from contractor/engineer.

ECO = Environmental Control Officer – usually visits site on a regular basis and audits compliance with the EMPr. Usually independent consultant.

DEO = Designated Environmental Officer – usually on site permanently, usually member of contractor or engineer site staff.

Organisational structures and responsibilities differ from project to project and depend on environmental sensitivity of the project, scale of the project, etc. Increasingly nowadays, each party is required to appoint their own person responsible for environmental management on site, e.g. the engineer would have an ESO/ECO and the main contractor(s) would have an ESO/DEO etc.

It is therefore important to familiarise yourself with that part of the EMP that deals with organisation and responsibilities for each contract that you are involved in.

BUT HOW…

…do EMPr's promote sustainable development?

They don't!

It is the people on site that protect the environment. The EMPr, like any other plan or policy, is not worth anything if there isn't a commitment from those working on the project to compliance with the EMPr.

…can I ensure my work comply with the EMPr?

Environmental specifications in different EMPr's can vary from vague to very detailed.

- Firstly, it is obviously important to know what those specifications are, vague or not, so **READ THE DOCUMENT**! Ignorance does not absolve you from your responsibility. A copy of the EMPr must be kept at the site office at all times.
- It also helps to understand WHY those specifications are there – some things are obvious but others may not be. Some EMPr's may have specifications that are not relevant. Don't be afraid to question the EMPr; it can only increase its efficiency!
- Know where the sensitive areas on site are – watercourses, wetland areas, residential areas, etc. – and be extra vigilant when working in these areas.

Mostly environmental management of construction activities and compliance with EMPr's require only common sense and with good housekeeping the battle is half won!

The enclosed environmental handout sets out the standard environmental specifications.

DO'S AND DON'TS

Workers & equipment must stay inside the site boundaries at all times.
Nobody may enter areas marked as No-Go areas.

Why? Construction activities, equipment and people cause damage and disturbance to the area surrounding the site. As small an area as possible will be affected if all workers and equipment stay within the site boundaries. This is especially important if there are people who live around the site or natural areas around the site which should not be disturbed.

Do not swim in or drink from streams.
Do not throw oil, petrol, diesel, concrete or rubbish in streams.
Do not work in the stream without direct instruction.
Do not damage the banks or plants of streams.

Why? River water may be polluted which could make you sick.
Oil, petrol, diesel, concrete or rubbish will kill plants and animals living in the water. They may also make people who may drink the water downstream sick. Rubbish in the stream also makes it look ugly.
People and machinery working in the stream will damage it and kill plants and animals living in the stream. It may also cause erosion, which is expensive to repair.
The plants on the edge of the stream bind the soil together and prevent soil from getting washed away. Soil washed into a stream may affect people using the water downstream (e.g. for irrigation).

Protect animals on the site.
Ask your supervisor to remove animals found on site.

Why? Animals are an important part of the environment. All animals have a purpose, even snakes which catch mice and rats. Other important animals are owls, chameleons and frogs.

Do not damage or cut down any trees or plants without permission.
Do not pick flowers.

Why? Some plants are rare and may take a long time to grow back, if at all. Plants in the "no go" areas should not be damaged.
Some plants will die if their flowers are picked. Rare plants may be lost.

Put cigarette butts in a rubbish bin.
Do not smoke near gas, paints or petrol.
Do not light any fires without permission.
Know the positions of fire fighting equipment.
Report all fires.
Do not burn rubbish/ vegetation without permission.

Why? Leaving a burning cigarette butt on the ground may lead to runaway fires which are dangerous to construction workers, people living around the site, equipment, houses, plants and animals.
Smoking near flammable material is dangerous and may cause an explosion.
Lighting a fire without permission may cause a runaway fire (see above).
Reacting quickly to fires that break out will prevent them from spreading and causing damage.

DO'S AND DON'TS

Work with petrol, oil & diesel only in designated areas.
Report any petrol, oil & diesel leaks or spills.
Use a drip tray under vehicles & machinery.
Empty drip trays after rain & throw away were instructed.

Why? Designated areas should have measures to protect against petrol, oil & diesel spills. Oil, petrol and diesel can drip onto the soil and soak into it. Plants will not grow and animals will not live in dirty soil.
It also looks ugly to people living around the area.
Drip trays will prevent oil, petrol or diesel from soaking into the soil and killing plants and animals.
If drip trays are not emptied they may overflow and pollute the surrounding soil. If oil, petrol or diesel are put into a stream, plants and animals living in the stream will be killed. They may also make people who may drink the water downstream sick. Ask your supervisor where drip tray water may be disposed of on site.

Try to avoid producing dust – wet dry ground and stockpiles.

Why? Dust can be irritating to people and can reduce production on site. It can cause problems such as eye irritations and coughs. It also reduces visibility on and around the site, which can be dangerous to drivers and pedestrians, and can cause damage to the surrounding environment.
Soil should not be made too wet because that will cause safety problems and soil may be washed away.

Do not make loud noises around the site, especially near schools and homes.
Report or repair noisy vehicles.

Why? Loud noises are irritating to workers and people living around the site. Loud noise can also be harmful to people (especially children) and affect their hearing.
By keeping vehicles in good condition, loud noise can be prevented.

Use the toilets provided.
Report full or leaking toilets.

Why? Sewage attracts flies and other irritating pests. If the site is near a river or stream, sewage makes the water smell and people who swim in it or use it to wash their clothes will get sick. It also causes plants to grow too much which blocks the river, which may cause flooding of houses and property.
Regular emptying of toilets is hygienic and will also prevent overflows.

Use designated eating and drinking area.
Make sure that you eat where there is a rubbish bin nearby.
Never eat near a river or stream.
Put packaging & leftover food into rubbish bins.

Why? Eating areas generate a lot of rubbish and litter (e.g. bottles and packets) which will pollute the site and surrounding areas. Therefore, eating must be done near bins which are placed in the eating.
Rubbish in a stream looks ugly and can be harmful to people's health. It may also kill the plants and animals living in the stream. Rubbish and food left lying around will attract pests (such as rats) which are dangerous to people and cause a health hazard. Also, rubbish left lying around is ugly and unpleasant to look at.

DO'S AND DON'TS

Do not litter! Use rubbish bins provided.
Ask your supervisor for a bin if there is none.
Report full bins to your supervisor.
The responsible person should empty bins regularly.

Why? Littering is unacceptable. It is also dangerous and unhealthy to adults, children and animals walking around the area. Not putting the lid back on the bin will cause rubbish to be blown away.
Regularly emptying bins will prevent litter and rubbish flying around the site.

Always keep to the speed limit.
Drivers - check & report leaks.
Ensure loads are secure & do not spill.

Why? Speeding is dangerous to people who live in the area, especially children. Speed kills!
Faulty vehicles are dangerous to the driver, pedestrians and other motorists. Leaks can also pollute the ground and water and smoke from vehicles can cause health problems.
This is a potential danger to other motorists. Also, do not overload vehicles.

Know all the emergency phone numbers.

Why? Prompt reaction to an accident, fire or spill will reduce the risk of serious damage to the environment and to workers.

If rules are broken:

- **Spot fines**
- **Removal from site.**
- **Construction may be stopped.**

Why? Failure to adhere to the EMP may result in spot fines being issued to the company. It is then the Site Agent's responsibility to collect these fines from guilty individuals and he may even deduct fines off your wages.
The fines are meant to act as an incentive for workers to take the EMPr seriously.
A person may be removed from site if they continually disregard the specifications in the EMPr.
If the EMPr is not adhered to, the local Environmental Authority may stop construction.

Report any breaks, floods, fires, leaks and injuries to your supervisor.

Annexure E: Temporary Shutdown Checklist

TEMPORARY SHUTDOWN CHECKLIST

In the event of a temporary site closure for any period of **inactivity longer than 7 business days** the Contractor is to notify the ECO. The Contractor / DEO shall check the site, ensuring that the following items are addressed and report on compliance to the ER and ECO:

Fuels / Flammables / Hazardous Materials Store

1. Fuel stores are as low in volume as practicable. ☐
2. There are no leaks. ☐
3. Stores and outlets are locked. ☐
4. Bund areas are emptied fire extinguishers are serviced and accessible. ☐
5. Emergency and management contact numbers are available and displayed. ☐
6. There are no stores or containers within the 1:50 year flood line. ☐

Safety

7. Site safety checks have been carried out in accordance with the Occupational Health and Safety ☐
   Act, 1993 (Act No. 85 of 1993) prior to site closure.
8. All trenches and manholes are secured. ☐
9. Emergency and management contact details are available and prominently displayed. ☐
10. Security personal has been briefed and has the facilities to contact and be contacted by the ☐
    relevant management and emergency personnel.
11. Night hazards such as reflectors, lighting, traffic signage, etc. have been checked and are in place ☐
    where required.
12. Scaffolds and other structures vulnerable to high winds are secured. ☐

Erosion

13. Dust mitigation measures such as straw, binding agents or similar are in place. Sand and spoil ☐
    stockpiles to be stabilised or covered with shade cloth.
14. Excavated slopes and stock piles are at stable angles and able to accommodated normal ☐
    expected flows. ☐

Water and Pollution Management

15. Toilets to be emptied and secured. Plumbed toilets are to have no water leakages. ☐
16. Refuse bins are to be emptied and secured. ☐
17. Cement and materials store is secured. ☐
18. Plant remaining on site to have as little remaining fuel as possible and are to be checked for leaks. ☐
    Suitable drip trays are to be placed and secured under all remaining plant.
19. All other drip trays already in use are to be checked and emptied. ☐

Contractor: **Signature:** **Date:**